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Preface

This volume contains the papers presented at IEMA-2017: 1st International Conference on Industrial Engineering and Management Applications held on February 20-22, 2017 in Mehran University of Engineering and Technology, Jamshoro, Sindh, Pakistan. The conference is organized by Department of Industrial Engineering and Management, Mehran University of Engineering and Technology (MUET) in collaboration with Department of Industrial Engineering, UET Peshawar.

The conference was opened by the Vice Chancellor of the Mehran University of Engineering and Technology, Jamshoro, Sindh, Pakistan, Professor Dr. Muhammad Aslam Uqaili, who cordially welcomed the participants from all over the world and gave a brief introduction of the University and the research conducted there. IEMA-2017 will offer an excellent International Conference for sharing knowledge and results in Industrial Engineering and Management. The aim of IEMA-2017 conference is to provide a platform to the researchers and practitioners from both academia and industry to meet and share cutting-edge development in the industry 4.0.

The scientific program consisted of plenary sessions and parallel sessions and included the following topics:

- Six Sigma and TQM for Industry 4.0
- Production Planning and Inventory Control
- Health and Safety
- Lean and Agile Manufacturing
- CAD/CAM/CIM
- Intelligent Manufacturing
- Rapid Manufacturing
- Engineering Economy and Cost Analysis
- Modeling and Simulation
- Sustainable Manufacturing
- Ergonomics and Human factors
- Operations Management
- Supply Chain Management
- Application of IoT
- Logistics and Transportation Management
- Big Data Analytics
- Project Management
- Entrepreneurship
- GIS and Remote Sensing

We gratefully acknowledge the financial support from Higher Education Comission of Pakistan; Mehran University of Engineering and Technology; Al-Abass Group; Omni-Group; Damco; MTW Pak Assembling Industries (Pvt.) Ltd; Techno World Instrument Service. We would also like to thank the local people from Mehran UET and UET Peshawar for their contributions and help – without them we would not have been able to organize this great conference.

This volume was edited by Prof. Dr. Hussain Bux Marri, Prof. Dr. Sahar Noor, Dr. Shakeel Shaikh, and Dr. Muhammad Saad Memon.

Important conference-related links:

Conference Program: http://iema.muet.edu.pk/program

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We appreciate the help of EasyChair for its effective conference management.

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FLOWSHOP SCHEDULING PROBLEMS: STILL A CHALLENGE

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Abstract: Production scheduling is normally treated and considered to be most significant subject in planning and operation of manufacturing systems. Flowshop and job shop scheduling problems mainly deal with completion times of a set of jobs on a set of machines. However, in recent manufacturing and operations management, on time delivery is considered as a significant factor due to high competition in market. In this paper ***n*** jobs ***m*** machines flowshop scheduling problem with the objective of minimizing the makespan is considered without allowing pre-emption. Heuristic and Genetic Algorithm (GA) are used to solve small and large size problems considering makespan as a performance criterion. Results of the proposed heuristic and GA are compared with other known heuristics and found better than the most of the published techniques in flowshop scheduling. The New proposed heuristic works well for small size problems while GA outperforms the new proposed and available heuristics for large size problems. A detailed example is given to illustrate the new proposed heuristic and GA.

1. INTRODUCTION

FlowShop Scheduling process sequence of *n* jobs on *m* machines in the same order i.e., every job must be processed on machines from 1, 2... ***m*** in the same order, (Dipak et al. 2007). Heuristics are practical experienced techniques considered for solving problems. Permutation flowshop scheduling problem represented as “PFSP” is mostly studied in operations research, (Framinam et al. 2004). This scenario can be defined as ***n*** jobs have to be processed on each one of the ***m*** machines and each job follows the same route of machines. Heuristic and algorithms are used to find solution good enough where exact search techniques are impractical, (Framinam et al. 2004). Generally there are $(n!)^m$ different schedules of jobs. As an exceptional case, researchers concentrate on the development of permutation schedules where jobs arrangement is the same on all machines. As a result, ***n!*** Possible schedules are considered. This problem is considered as $n/m/P/C_{max}$ or as $F/prmu/C_{max}$, (Ashwani et al. 2006). Flowshop scheduling decides an ideal grouping of ***n*** jobs to be processed on ***m*** machines in same order, (Pawel et al. 2008). Permutational flowshop scheduling is a specific case where same job sequence is followed in all given set of machines i.e. processing order of the jobs on machines is the same. Since flowshop problems are known to be NP-complete, (Pawel et al. 2008). Simple exact optimization methods such as integer programming, Garey et al. 1976) or branch and bound, have the limitations of Solving with only small-sized problems because of their exponential computational time characteristic, (Srikar et al 1986). There is no known efficient way to locate a solution in the first place, the most outstanding and notable characteristic of NP-complete problems is that no fast solution is known. As the size of the problem increases the time required to solve problem increase directly using any known algorithm. Once a decision taken in constructive heuristics, it cannot be altered or changed, (Bestwick et al. 1976). Makespan represents the completion time of last job on last machine once sequence is created using constructive technique. The permutation flowshop problem requires finding order of ***n*** jobs to be processed on ***m*** machines. Jobs are processed in order machine 1, machine 2… and machine ***m***. following the notation of (Graham et al. 1979), the PFSP to minimize makespan is represented as $\mathbf{F}\boldsymbol{m}|\boldsymbol{prmu}|\mathbf{C}_{max}$. Since $\mathbf{F}\boldsymbol{m}|\boldsymbol{prmu}|\mathbf{C}_{max}$ is considered as NP-hard for m>2 by Rinnooy (1976) and Garey *et al.* (1976), many heuristics and metaheuristics are been proposed in the literature to obtain best solutions in reasonable computational time.

Each machine can process one job at a time without preemption. No job can jump over any other job which means the order in which jobs are processed on machine 1 is maintained throughout the system. Another common assumption is that shop floor is empty at the time of scheduling decision so each machine and all jobs are available at time zero. (Pawel et al 2007) used improvement heuristics, in this paper initial sequence is considered and attempted to improve it as we proceed.

2. OBJECTIVE

The objective is to find an n-job sequence to minimize the Makespan. The notation of the PFSP can be set as follows:

Table 1. Different Parameters

Notation:	**Parameters:**
n,m	Number of jobs and machines respectively
$\mathbf{P_{ij}}$	Processing time of job j on machine I (Permutation flow shop layout)
$\mathbf{T_c}$	Completion time of all jobs on all given set of machines
$\mathbf{t_c(i, j)}$	Completion time of job j on machine i
$\mathbf{A_j}$	Slope Index

Processing time of each job is represented as tp (i, j). The objective function is to minimize the makespan;

$$Tc\ (Mi, Jj) = \max \{ tc\ (Mi\text{-}1, Jj), tc\ (Mi, Jj\text{-}1)\} + tp\ (Mi, Jj) \tag{1}$$

3. PROPOSED HEURISTIC

Step 1: Arrange n jobs in non-increasing order of their total processing durations.

Step 2: Divide the sequence in sub-sequences which consists of jobs that are not repeated in any sub-sequence.

Step 3: Permutate each sub-sequence and select the best partial sequences that have minimum makespan value.

Step 4: Rejoin (or regroup) all those sub-sequences that has best Makespan value and calculate makespan for the final sequence.

4. GENETIC ALGORITHM FOR SEQUENCING PROBLEM

In order to use GA for sequencing issues, there is practical difficulty as in traditional GA's, the chromosome representation is by means of string of 0's and 1's and the result of genetic operator is a valid chromosome. However this is not the same in case of permutation to represent the solution of a problem for sequencing problem. The proposed algorithm is described as following:

Step 1. Population size is represented by a number of chromosomes according to permutation of selected jobs. Representation of all jobs in one chromosome has unique order and contains all jobs.

Step 2. Using MakeSpan as a fitness function, generate initial sample consisting of chromosomes.

Step 3. Each chromosome in sample is selected as Parent 1 and second chromosome is selected as parent 2. Apply PMX for Crossover operator to P1 and P2 and generate Child chromosomes. If makespan of child chromosomes are better as compare to parent 1 and parent 2, replace child chromosomes with the worse parents P1 and parent P2 chromosomes.

Step 4. Randomly select child chromosomes for mutation operator (which is used to diversify the population in Applied GA) and compute the MakeSpan of each chromosome in the child sample.

Step 5. If MakeSpan of child chromosomes are best then stop else go to step 2.

5. NEH (NAWAZ, ENSCORE, HAM) ALGORITHM

NEH [1983] has following steps to create a sequence as it is constructive Heuristic.

Step 1. Arrange n jobss in non-increasing order of their total processing durations.

Step 2. Select the first two jobs and schedule them in order to reduce the partial makespan of these two jobs.

Step 3. For k= 3 to n, repeat step 4 as following,

Step 4. Introduce the kth job at the place which reduces the partial makespan among the k possible ones.

6. PALMER'S HEURISTIC

Palmer's Heuristic comprises of two portions:

Step 1. n jobs and m machines static flowshop problem are computed by slope index as,

$$A_j = -\sum[m-(2i-1)]P_{ij} \quad (2)$$

Step 2. Order jobs in sequence based on descending order of Aj values.

7. CAMPBELL, DUDEK, SMITH (CDS) ALGORITHM

The algorithm consists of two surrogates where p = m-1. Each surrogate problem is solved using Johnson Rule [9]. Value of each surrogate problem is solved using Johnson's Rule. The sequence of each surrogate consists of minimum value of MakeSpan after applying Johnson's Rule for scheduling jobs on m machines.

8. COMPARISON (EXAMPLE)

Considering the processing time in following table for each job on each specific machine.

Table 2. Processing time for each Job for each available Machine

No.	Machine 1	Machine 2	Machine 3	Machine 4
Job 1	10	2	5	4
Job 2	11	4	4	7
Job 3	8	7	3	2
Job 4	6	1	4	2
Job 5	2	9	10	3
Job 6	13	5	3	4
Job 7	7	7	1	6
Job 8	7	7	1	6
Job 9	8	2	9	3
Job 10	4	5	7	2

9. EXPERIMENTAL RESULTS

The proposed Heuristic and Applied GA algorithm had been implemented with MATLAB software on personal computer with CPU 1.80GHz and memory size is 8.00GB and operating system is Windows 8. Heuristic and Applied GA algorithm had been tested on different assumed data set and the result is compared with pre-searched heuristic such as CDS, Palmer's and NEH heuristics. Proposed Heuristic has a total of 48 possible sequences for 10 jobs giving the same result as that of NEH algorithm. In following table there are many experimental results represented for different data set including 60 jobs at most with 10 machines. Jobs are randomly increased with each experimental test and results are compared with other known heuristics. It is observed that proposed heuristic give same result as that of known heuristic. The results are summarized in following table. Applied GA is limited due to the fact that MATLAB can perform Permutation until 10 jobs only and observing results it is found that Applied GA offer best results from rest of the Heuristic.

Table 3. Comparison of Results

MakeSpan (C_{max}) Values						
n,m	**CDS**	**Palmer's**	**NEH**	**P.Heuristic**	**Applied GA**	**Opt.**
10,3	23	23	23	23	23	100%
20,3	43	43	43	43	N/A	100%
30,3	132	122	120	122	N/A	80%
10,4	83	88	83	83	83	100%
20,4	83	97	83	85	N/A	70%
30,4	94	84	83	86	N/A	65%
20,5	59	58	55	59	N/A	60%
10,7	63	61	56	56	56	100%
50,7	212	200	187	139	N/A	80%
10,8	45	39	37	36	36	100%
20,8	72	63	59	64	N/A	50%
50,8	160	140	131	145	N/A	75%
10,10	182	175	164	164	164	100%
40,10	134	126	107	118	N/A	55%
60,10	192	180	157	174	N/A	45%

10. CONCLUSIONS

Table 3 shows results using different type of data sets for given number of jobs and machines, there are many possible ways in which we can re-arrange the final sequence of proposed Heuristic because we have varieties in which we can order the sub-sequence itself due to the fact that minimum value of Makespan is obtain in different order for each sub-sequence. Proposed Heuristic generates more number of minimum makespan sequences as compare to NEH algorithm.

Hence it is observed that proposed heuristic for PFSP provides better results than NEH, algorithms while maintain the same algorithmic complexity. Such heuristic has a great scope in industry where ***n*** jobs are required to be scheduled on ***m*** machines for greater production and efficient utilization of resources. Secondly Applied GA is presented to solve the flowshop scheduling problem. Applied GA represents global search technique method. The performance of Applied GA is presented in experimental result table which shows that Applied GA is competitive. Due to MATLAB software limitation we can only perform permutation of 10 jobs and 'applied GA' gives best results considering at most 10 jobs at a time.

11. REFERENCES

1. Ashwani Kumar D. (2006), Multi-Objective FlowShop Scheduling using Metaheuristic
2. Bestwick P, Hastings N (1976) A new bound for machine scheduling. Oper Res Q 27:479 – 487.
3. Dipak Laha , Uday Kumar Chakraborty, (2007), Int. J. Information and Communication Technology, Vol. 1, No. 1
4. Framinam, J., Gupta, J., and Leisten, R, (2004). A review and classification of heuristics for permutation flowshop scheduling with makespan objective. Journal of the Operational Research Society, 55(12):1243-1255.
5. Garey MR, Johnson DS, Sethi R (1976) The complexity of flowshop and jobshop scheduling. Math Oper Res 1:117–129
6. Ignall, E. and Schrage, L. (1965) ‘Application of the branch-and-bound technique to some flowshop scheduling problems’, Operations Research, Vol. 13, pp.400–412.
7. Johnson, S.M. (1954) ‘Two and three stage production schedules with set-up times included’, Naval Research Logistics Quarterly, Vol. 1, pp.61–68.
8. Kreyszig, E. (1972) ‘Advanced Engineering Mathematics’, New York: John Wiley. Lomnicki, Z.A. (1965) ‘A branch-and-bound algorithm for the exact solution of the three- machine scheduling problem’, Operational Research Quarterly, Vol. 16, pp.89–100.
9. Koulamas, C. (1998) ‘A new constructive heuristic for the flowshop scheduling problem’, European Journal of Operations Research, Vol. 105, pp.66–71.
10. Nawaz, M., Enscore Jr., E.E. and Ham, I. (1983) ‘A heuristic algorithm for the m-machine n-job flowshop sequencing problem’, OMEGA International Journal of Management Science, Vol. 11, pp.91–95.
11. Palmer, D.S. (1965) ‘Sequencing jobs through a multi-stage process in the minimum total time a quick method of obtaining a near-optimum’, Operational Research Quarterly, Vol.16 No. 1, pp.101–107.
12. Pawel J. Kalczynski, Jerzy Kamburowski, (2008), Journal Computers and Operations Research, Volume 35, Issue9
13. Rinnooy Kan, A.H. G. (1976). Machine Scheduling Problems: Classification, Complexity and computations. Martinus Nijhoff, The Hague.
14. Srikar BN, Ghosh S (1986) A MILP model for the n-job, m-stage flowshop with sequence dependent set-up times. Int J Prod Res 24:1459–1474

PRODUCT DESIGNING WITH SHAPE MEMORY ACTUATORS: A REVIEW OF SHAPE MEMORY ACTUTOR APPLICATIONS

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Abstract: The Industrial Engineering applications involve designing and developing the products that could meet customer requirements. The emphasis is upon developing the products that are less complex, compact in volume and are easy to maintain. Shape Memory Actuators are best alternate to the traditional electrically driven and hydraulic actuators. These are made up of metallic alloys called Shape Memory Alloys (SMAs). SMAs are the smart materials which have the capability to memorize the pre deformed shape. These materials can regain their original shape/ form when they are subjected to a memorization process. SMAs are widely being used in a number of applications, however, in this paper, automobile applications, bio medical applications, robotic applications and aero space applications are discussed. This paper aims at increasing the interest of researchers in the field of Shape Memory Actuators.

1. INTRODUCTION

One of the appealing areas of industrial engineering applications is to design and develop the products, considering both ergonomic and economic factors. The need for miniaturization and lighter systems have resulted in the development of smart actuators which are not only compact in size but at the same time they are lighter in weight (Jani, Leary et al. 2014) and can work effectively and efficiently. About 200 actuation tasks are performed in the automobiles by using traditional Direct Current (DC) motors, which are uneconomic in mass, space and reliability (Ölander 1932). The researchers are more weight conscious in space exploration and in aviation industry. With the increasing number of competitors and reduced product life cycle, the emphasis is up on developing the low cost products which are also easy to design and develop.

SMAs are best alternate to traditional actuators due to their compact size and high power to weight ratio. An SMA actuator is found to exhibit highest power to weight ratio as it can lift more than 100 times of its weight (S. S. Winzek B 2004), a Flexinol® SMA actuator having diameter of 0.51 mm can generate a pull force of 3560 grams (Dynalloy 2011). However, their applications are still limited to the systems which are not energy conscious and where working frequency is smaller.

2. OVERVIEW OF SMAs

SMA belong to the class of smart materials which can memorize the pre deformed shape. These materials return to their original shape/form when undergo a memorization process which is either heating or magnetic field dependent (Jani, Leary et al. 2014). SMAs are generally heated using Joule heating which heats the alloys by taking advantage of the electrical resistance offered by these alloys to the flow of current. In common electrical engineering this heating is called power losses or I^2R losses. Flexinol® wire of 0.15 mm diameter offers a resistance of 55 Ohms per meter to the flow of current (Dynalloy 2011). Depending upon the type of motion required, the SMAs are available in different forms, like wires, helical springs, torsion springs, cantilever springs and torsion tubes (Jani, Leary et al. 2014).

When these alloys are subjected to heating and cooling they undergo a phase transformation, as shown in Figure 1.

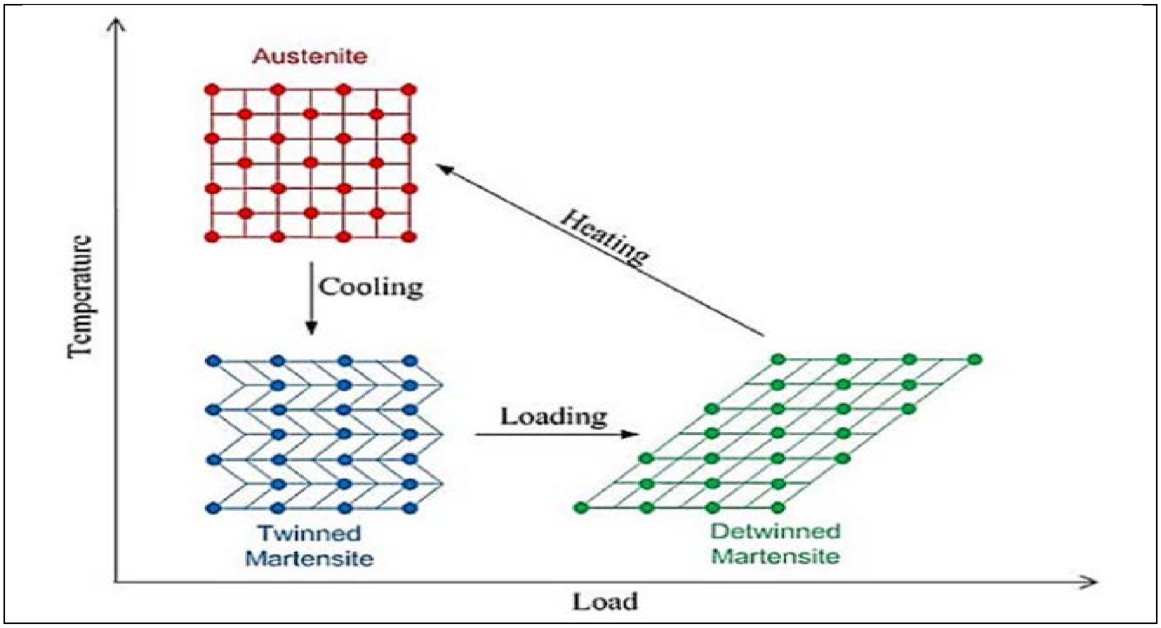


Figure 1: Phase Transformation in SMAs (DAUDPOTO, MEMON et al.).

A low temperature phase is called Martensite phase in which SMAs are relatively soft an posses lower value of Young's modulus, whereas High Temperature Phase is called Austenite in which SMAs have higher value of Young's modulus (Teh 2008). From Figure 1, when SMAs are heated the phase transforms Detwinned Martensite to Austanite, and when they are cooled off the phase Transforms to Twinned Martensite. However the mechanical loading in the form of dead weight or bias spring turns this Twinned Martensite to Detwinned Martensite. This phase transformation is called Shape Memory Effect (SME).

The SMAs are available in various compositions like Fe-Mn-Si, Cu-Zn-Al, Cu-Al-Ni. However, the discovery of SME in Nickel-Titanium (Ni-Ti) alloys in 1962 by William Buehler and Federick Wang gave these alloys a wide recognition (Buehler, Gilfrich et al. 1963). Ni-Ti alloys began a new era of research in various fields, of them robotics and bio medical are noticeable.

3. APPLICATIONS OF SMA

SMA applications can be widely found in but are limited to, consumer products and industrial applications (Wu and Schetky 2000), structures and composites (Furuya 1996), automotive (Butera, Coda et al. 2007), aerospace (Bil, Massey et al. 2013), biomedical (Petrini and Migliavacca 2011) and robotics (Furuya and Shimada 1990; Eren, Mavroidis et al. 2002; Kheirikhah, Rabiee et al. 2011). However, automobile, bio medical, robotic and aero space applications will be further discussed in detail.

3.1. Automobile Applications

In a family car about 200 actuation tasks are performed by traditional actuators (Jani, Leary et al. 2014). The modern drive by wire concept has motivated the researchers to develop the actuators systems using novel smart materials. The car manufacturers are weight conscious as it directly affects the fuel consumption of the vehicle. Therefore, the manufacturers are nowadays focusing upon smart materials which are not only small in volume, but at the same instant they are light weight and less complex. The automobile actuators can be categorized as (a) low power actuators for comfort and aesthetic aspects, (b) actuators having high power to control vehicles and (c) actuators with high frequency to control engine performance (Butera, Coda et al. 2007). SMA actuators are suitable for first category, and are applicable for second category, since these actuators have low working frequency therefore, they are either not suitable or less suitable for third category.

SMA elements are either used as linear actuators like rear view mirror folding, climate control flaps adjustment and lock/latch controls; or as active thermal actuators like in engine temperature control, carburetion and engine lubrication and power train clutches (Stoeckel 1990). Shape memory elements due to attractive morphing capability are being applied in aerodynamics and aesthetics applications (Jani, Leary et al. 2014).

The era of SMA applications in automobiles began with the incorporation of thermally actuated pressure control valve for smooth gear shifting in Mercedez-Benz in 1989 (Stöckel 1995). American automotive manufacturer General Motors (GM) claim that they had been working on SMAs since mid 1990's (2010) they also claim to have more than 200 patents in their credit so far. Mercedez have used SMA actuated lumbar support in the car seats for passenger comfort, these were developed by Actuator Solutions GmbH (Jani, Leary et al. 2014). Following the footsteps of Mercedez, various leading automobile manufacturers like BMW, General Motors (GM), Hyundai, Ford, Porsche and Volkswagen (VW) have applied this in their products (Jani, Leary et al. 2014). Keeping in view the ergonomic and safety requirements, GM have been working to develop 'grab handle' to facilitate the door opening. Other potential areas of SMA actuators as though by GM is to generate electricity from exhaust heat using SMA actuators, a smart louver that could control the flow of air into the engine compartment and an air dam that could reduce the drag and assuring the aero dynamic structure at high speeds (Gehm 2007; Jani, Leary et al. 2014). The Fiat group has claimed to develop rear view mirror which actuated by SMA actuators, headlight actuators, fuel filling lid and locking mechanism using SMA actuators (Jani, Leary et al. 2014).

Various properties, like; light weight, mechanical simplicity, high power-to-weight ratio, spark free operations have made SMA actuator a best alternate to traditional electromagnetic and hydraulic actuators in automotives. J.M Jani et al. (Jani, Leary et al. 2014) have given a detailed table of present and potential SMA actuator applications in the area of automotives. However, the need is to develop a close relation between Shape Memory Material Societies (SMMS) and industries to explore new areas of SMA actuators applications in automotives. Current and potential areas of applications in a car are shown in Figure 2.

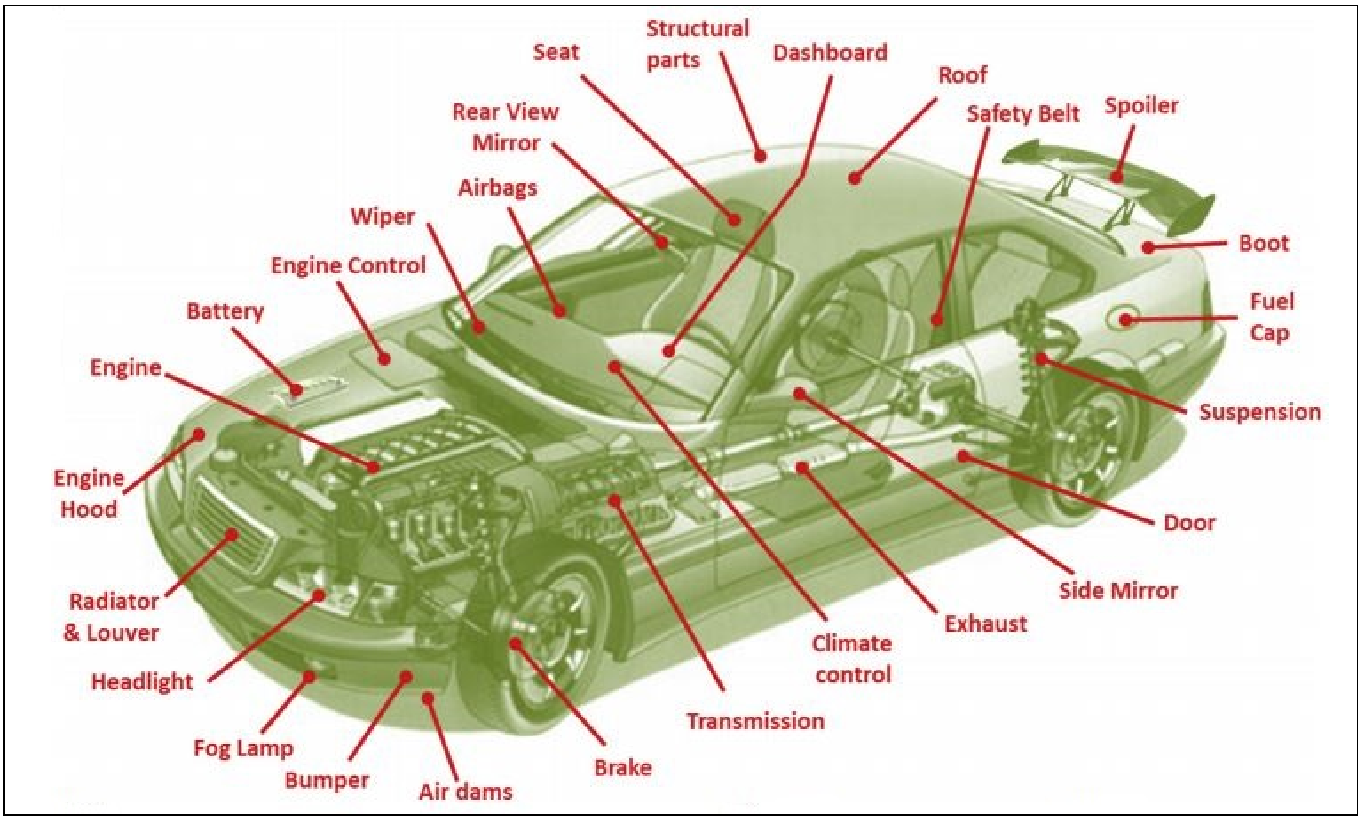


Figure 2: Current and Potential SMA Applications in a Family Car (Jani, Leary et al. 2014).

3.2 Biomedical Applications

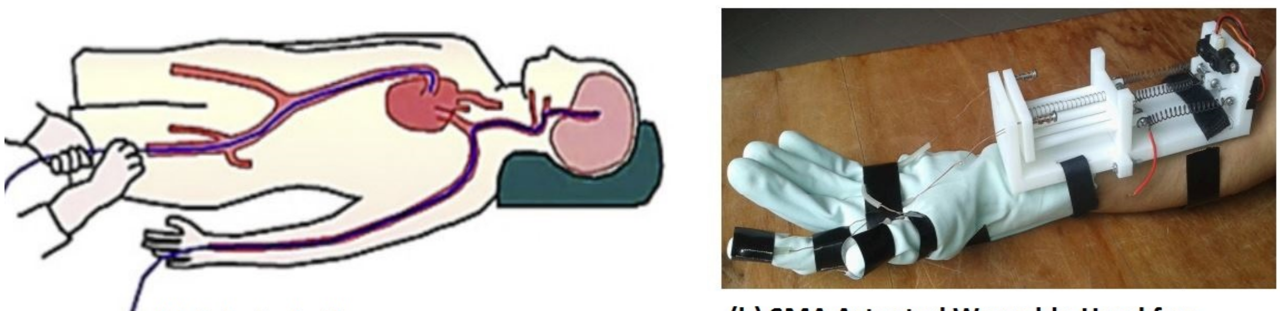
The bio-compatibility of Nickel-Titanium (Ni-Ti) shape memory alloys have made them feasible to be applied in various bio-medical applications (Mantovani 2000). SMAs are used in neurology, cardiology and interventional radiology in different ways (Morgan 2004).

The first bio medical application of SMAs was reported in 1971 when George B. Andreasen developed the orthodontic bridge wires (Kauffman and Mayo 1997). SMAs have made catheterization more novel and easy, as they have made catheter motion accurate with higher bending angles (Lim, Park et al. 1996). The work on catheter development started when Dario and Montesi (Dario and Montesi 1994), developed active catheter tip, however, the use of SMAs in catheterization was further proceeded by Guo et al. , when they developed miniature active catheter (Guo, Fukuda et al. 1994).

A micro valve for drug delivery to patient is also one of the bench marking applications of SMAs. Reynaerts et al. (Reynaerts, Peirs et al. 1995), while working on Brite-Euram project developed an SMA actuated drug delivery apparatus that could deliver small amount of medicine to the patient, hence avoiding the injections. Naresh V. Datla et al. (Datla, Honarvar et al. 2012) developed an SMA actuated needle for the surgery purpose that could be easily navigated inside the muscles of a human body.

SMAs are widely applied in the rehabilitation of neuromuscular disorders. These disorders affect ones muscle movement hence leading to temporary or permanent disability. Each year about 15 million people are affected by stroke, of them 5 million die whereas 5 million face a lifelong disability (2012). SMAs are used in the development of neuromuscular rehabilitation devices. In this concern Hamid et al. (Hamid, Makhdoomi et al. 2015) developed a SMA based assistive wearable hand which could provide maximum of 1.6N of gripping force. Matsubara et al. (Matsubara, Okamoto et al. 2012), developed a prosthetic hand consisted of SMA spring for actuation purpose. Copaci et al. (Copaci, Flores et al. 2017), developed an SMA actuated wearable exoskeleton for elbow joint. This exoskeleton apparatus is light in weight and is less noisy as compared to others developed with traditional hydraulic or electromechanical actuators.

Hence, rehabilitation devices can be developed for lower jaw rehabilitation, upper and lower limb rehabilitation as well. Figure 3 shows SMA applications in bio medical area.



(a) Catheterization

(b) SMA Actuated Wearable Hand for Grasping

Figure 3: Biomedical Applications of SMAs (Haga, Tanahashi et al. 1998; Hamid, Makhdoomi et al. 2015).

3.3 Robotic Applications

If a mechanical device is programmed to perform a number of applications, it is most likely an industrial robot (Craig 2005). Advancement in the smart materials has opened new dimensions in robotic actuation systems. Ability to operate at low voltage is another competitive advantage of using SMAs as actuators especially in robotics (Coral Cuellar, Rossi et al. 2012).The shape memory alloy actuators have significant applications in the area of robotics. The need to develop the light weight robots with more degrees of freedom incorporated with less complexity in design have forced the researchers to work on Shape Memory Materials (SMMs). The SMA actuators provide all solutions in one pack. SMA applications in robots are not much recent. The SMAs as micro-actuators or artificial muscles were first developed in 1980s (Honma and Miwa 1985; Kuribayashi 1986). Today most of the SMA applications in the domain of robotics are biologically inspired, and they are successfully being applied in air, ground and water robots(Pornsin-Sirirak, Tai et al. 2001; Shin, Kim et al. 2008; Wang, Hang et al. 2008; Koh and Cho 2010; Villanueva, Smith et al. 2011). First ever SMA actuated humanoid robot is named as The Lara , it is actuated with 34 SMA wire actuators. Since the SMA actuators can best mimic the human muscles, therefore, they are preferred in robot exoskeleton, robot grippers, robotic hand and robotic legs (Loh, Yokoi et al. 2006; Matsubara, Okamoto et al. 2012; Marco Salerno 2016). Chee Seon et al. (Loh, Yokoi et al. 2006), developed SMA mechanism to actuate a robotic finger, which is actuated with two SMA actuators. Taylor et al. (Taylor and Au 2016) developed SMA actuated robotic hand which is light in weight and is provided with forced cooling. However, with increasing the working frequency of SMA actuators, their applications in robotic domain can be further extended. Figure 4 shows SMA actuator applications in robots.

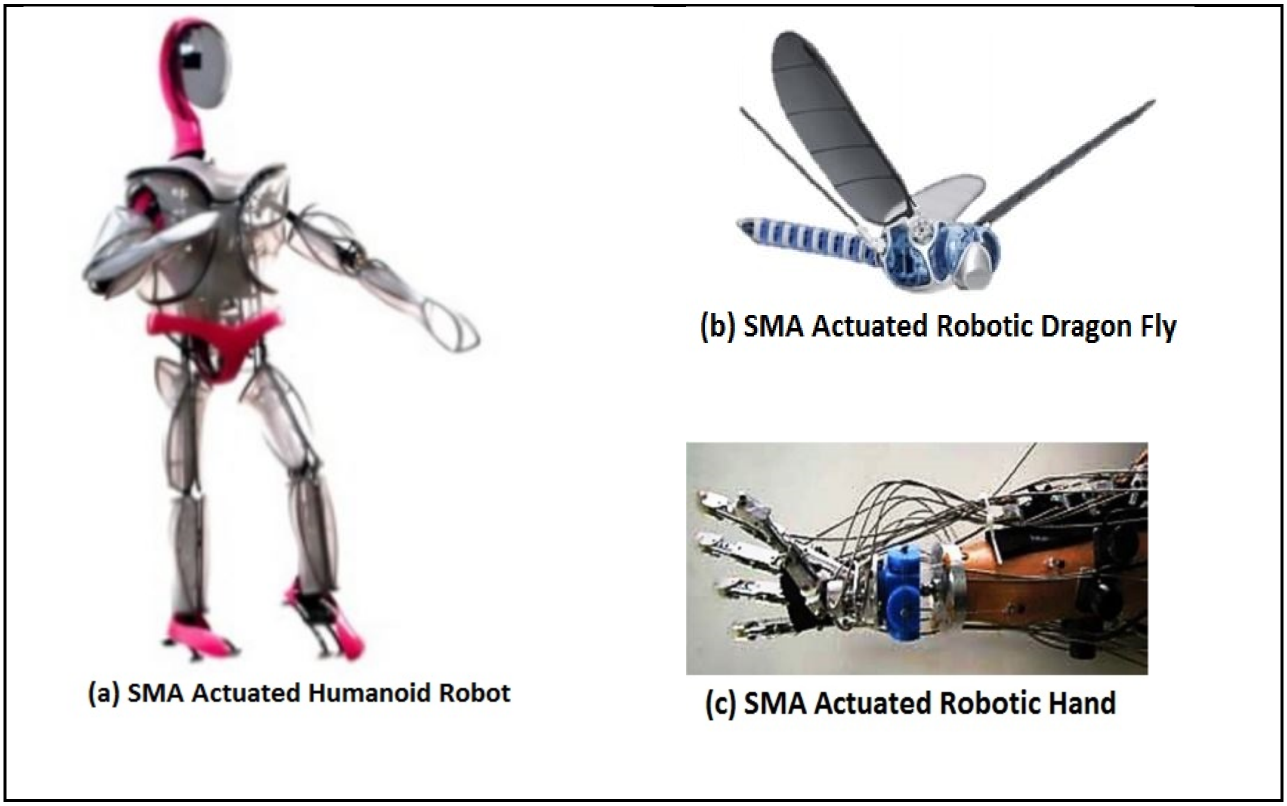


Figure 4: SMA Actuator Applications In Robotics (Loh, Yokoi et al. 2006; Jani, Leary et al. 2014).

3.4 Aerospace Applications

The successful journey of SMA applications in the aerospace industry begun in 1971 with their application as coupling for hydraulic lines in F-14 fighter jets (Hartl, Mooney et al. 2010). Compactness and ability to with stand high dynamic loads have attracted the researchers to study SMAs for aero space applications (Van Humbeeck 1999; Godard, Lagoudas et al. 2003). Various research programs like the one funded by Advanced Research Projects agency (DARPA) were carried out on developing morphing capability for air craft wings (Kudva 2004). The DARPA project aimed at developing SMA actuated 'smart wings' for airplanes. Another noticeable work in aerospace application was carried out under Smart Aircraft and Marine Propulsion System Demonstration (SAMPSON) project which emphasized upon application of SMAs in aircraft engine nozzles at inlets to obtain flying benefits according to flight conditions (Quan and Hai 2015). Boeing developed Reconfigurable engine nozzle fan chevron, known as Variable Geometry Chevron (VGC) actuated with SMA actuators. The VGC aimed at morphing chevron shape to optimize engine performance by increasing cruise performance and decreasing community noise (Mabe, Calkins et al. 2008). The VGC are currently installed at Boeing 777-300ER with GE-115B engines.

SMA applications are also extended to space research. The SMA applications in space research can be categorized in two categories depending upon the properties of SMAs. Utilizing the pseudoelastic properties of SMAs these are ideal towards solving the problem of low-shock release in spacecrafts (Hartl and Lagoudas 2007). However, Shape Memory Effect (SME) property of SMAs is utilized to actuate various components of spacecrafts (Birman 1997; Godard, Lagoudas et al. 2003). The Hubble space telescope and like are installed with SMA actuator element for release and unfolding mechanisms for solar panels (MH, EH et al. 1996). Valves and apertures used in analysis instruments of Rosetta mission (2004) and Pathfinder-Sojourner Mission (1997) were actuated with SMA elements (Jenkins, Landis et al. 1997; Allegranza, Gaillard et al. 2014). Figure 5 shows SMA actuated VGC on Boeing 777 aircraft.

Figure 5: Boeing Variable Geometry Chevron Engine (Hartl, Mooney et al. 2010).

4. CONCLUSION

In this review paper some of the Shape Memory Alloy (SMA) actuator applications in the areas of automobiles, bio medical, robotics and aero space are discussed and their limitations are highlighted. The SMA actuators fulfill both economic and ergonomic requirements of any product. Bio compatibility, light weight and design simplicity have attracted the researchers and designers to apply SMA actuators rather than traditional electro mechanical and pneumatic actuators. SMA actuators are widely being applied in automobiles, robotics, bio medical and aero space applications. However, some of the SMA actuator limitations are still hindrances towards their wide spread applications, of them low operational frequency and high power consumption are on top. In order to enhance the SMA applications, a close collaboration between SMA research societies and product designers is unavoidable.

REFERENCES

. "The Lara Project." from http://www.thelaraproject.com/Lara.html.

(2010). Advanced Assembly and Materials for Transportation Applications. Assembly Magezine, A.Webber.

(2012). Management of Ischaemic Stroke. Putrajaya., Ministry of Health Malaysia.

Allegranza, C., L. Gaillard, et al. (2014). Actuators for Space Applications: State of the Art and New Technologies, Actuator.

Bil, C., K. Massey, et al. (2013). "Wing morphing control with shape memory alloy actuators." Journal of Intelligent Material Systems and Structures **24**(7): 879-898.

Birman, V. (1997). "Review of mechanics of shape memory alloy structures." Applied Mechanics Reviews **50**(11): 629-645.

Buehler, W. J., J. Gilfrich, et al. (1963). "Effect of low-temperature phase changes on the mechanical properties of alloys near composition TiNi." Journal of applied physics **34**(5): 1475-1477.

Butera, F., A. Coda, et al. (2007). "Shape memory actuators for automotive applications." Nanotec IT newsletter. Roma: AIRI/nanotec IT: 12-16.

Copaci, D., A. Flores, et al. (2017). Wearable Elbow Exoskeleton Actuated with Shape Memory Alloy. Converging Clinical and Engineering Research on Neurorehabilitation II, Springer**:** 477-481.

Coral Cuellar, W., C. Rossi, et al. (2012). SMA-Based Muscle-Like Actuation in Biologically Inspired Robots: A State of the Art Review, Intech.

Craig, J. J. (2005). Introduction to robotics: mechanics and control, Pearson Prentice Hall Upper Saddle River.

Dario, P. and M. Montesi (1994). Shape memory alloy microactuators for minimally invasive surgery. Int. Conf. Shape Memory Superelastic Technologies, Asilomar.

Datla, N. V., M. Honarvar, et al. (2012). Towards a nitinol actuator for an active surgical needle. ASME 2012 Conference on Smart Materials, Adaptive Structures and Intelligent Systems, American Society of Mechanical Engineers.

DAUDPOTO, J., A. A. MEMON, et al. "Actuation Characteristics of 0.15 mm Diameter Flexinol® and Biometal® Wire Actuators for Robotic Applications."

Dynalloy, I. (2011). "Technical characteristics of flexinol actuator wires." CA: Tustin.

Eren, Y., C. Mavroidis, et al. (2002). B-spline based adaptive control of shape memory alloy actuated robotic systems. ASME 2002 International Mechanical Engineering Congress and Exposition, American Society of Mechanical Engineers.

Furuya, Y. (1996). "Design and material evaluation of shape memory composites." Journal of Intelligent Material Systems and Structures **7**(3): 321-330.

Furuya, Y. and H. Shimada (1990). "Shape memory actuators for robotic applications." Engineering aspects of shape memory alloys: 338-355.

Gehm, R. (2007). "Smart materials spur additional design possibilities." Automotive engineering international (April 2007 ed.), SAE: 46-47.

Godard, O. J., M. Z. Lagoudas, et al. (2003). Design of space systems using shape memory alloys. Smart Structures and Materials, International Society for Optics and Photonics.

Guo, S., T. Fukuda, et al. (1994). Micro catheter system with active guide wire-structure, experimental results and characteristic evaluation of active guide wire catheter using ICPF actuator. Micro Machine and Human Science, 1994. Proceedings., 1994 5th International Symposium on, IEEE.

Haga, Y., Y. Tanahashi, et al. (1998). Small diameter active catheter using shape memory alloy. Micro Electro Mechanical Systems, 1998. MEMS 98. Proceedings., The Eleventh Annual International Workshop on, IEEE.

Hamid, A. M. B., M. R. Makhdoomi, et al. (2015). Development of a Shape Memory Alloy (SMA) Based Assistive Hand. Advanced Materials Research, Trans Tech Publ.

Hartl, D., J. Mooney, et al. (2010). "Use of a Ni60Ti shape memory alloy for active jet engine chevron application: II. Experimentally validated numerical analysis." Smart Materials and Structures **19**(1): 015021.

Hartl, D. J. and D. C. Lagoudas (2007). "Aerospace applications of shape memory alloys." Proceedings of the Institution of Mechanical Engineers, Part G: Journal of Aerospace Engineering **221**(4): 535-552.

Honma, D. and Y. Miwa (1985). "Iguchi,“Micro Robots and Micro Mechanisms Using Shape Memory Alloy to Robotic Actuators,"." J. of Robotic Systems **2**(1): 3-25.

Jani, J. M., M. Leary, et al. (2014). "Shape Memory Alloys in Automotive Applications." Applied Mechanics & Materials(663).

Jani, J. M., M. Leary, et al. (2014). "A review of shape memory alloy research, applications and opportunities." Materials & design **56**: 1078-1113.

Jenkins, P. P., G. Landis, et al. (1997). Materials Adherence Experiment: technology [space power]. Energy Conversion Engineering Conference, 1997. IECEC-97., Proceedings of the 32nd Intersociety, IEEE.

Kauffman, G. B. and I. Mayo (1997). "The story of nitinol: the serendipitous discovery of the memory metal and its applications." The chemical educator **2**(2): 1-21.

Kheirikhah, M. M., S. Rabiee, et al. (2011). A review of shape memory alloy actuators in robotics. RoboCup 2010: Robot Soccer World Cup XIV, Springer**:** 206-217.

Koh, J.-S. and K.-J. Cho (2010). Omegabot: Crawling robot inspired by ascotis selenaria. Robotics and Automation (ICRA), 2010 IEEE International Conference on, IEEE.

Kudva, J. N. (2004). "Overview of the DARPA smart wing project." Journal of Intelligent Material Systems and Structures **15**(4): 261-267.

Kuribayashi, K. (1986). "A new actuator of a joint mechanism using TiNi alloy wire." the International journal of Robotics Research **4**(4): 47-58.

Lim, G., K. Park, et al. (1996). "Future of active catheters." Sensors and Actuators A: Physical **56**(1): 113-121.

Loh, C. S., H. Yokoi, et al. (2006). New shape memory alloy actuator: design and application in the prosthetic hand. 2005 IEEE Engineering in Medicine and Biology 27th Annual Conference, IEEE.

Loh, C. S., H. Yokoi, et al. (2006). New shape memory alloy actuator: design and application in the prosthetic hand. Engineering in Medicine and Biology Society, 2005. IEEE-EMBS 2005. 27th Annual International Conference of the, IEEE.

Mabe, J. H., F. T. Calkins, et al. (2008). Variable area jet nozzle using shape memory alloy actuators in an antagonistic design. The 15th International Symposium on: Smart Structures and Materials & Nondestructive Evaluation and Health Monitoring, International Society for Optics and Photonics.

Mantovani, D. (2000). "Shape memory alloys: Properties and biomedical applications." JOM **52**(10): 36-44.

Marco Salerno, M., IEEE, Ketao Zhang, Member, IEEE, Arianna Menciassi, Senior Member, IEEE, and Jian S. Dai, Senior Member, IEEE (2016). "A Novel 4-DOF Origami Grasper With an SMA-Actuation System for Minimally Invasive Surgery." IEEE TRANSACTIONS ON ROBOTICS

Matsubara, S., S. Okamoto, et al. (2012). Prosthetic hand using shape memory alloy type artificial muscle. International Multi Conference of Engineers and Computer Scientists.

MH, L., K. EH, et al. (1996). "Report on alternative devices to pyrotechnics on spacecraft."

Morgan, N. (2004). "Medical shape memory alloy applications—the market and its products." Materials Science and Engineering: A **378**(1): 16-23.

Ölander, A. (1932). "An electrochemical investigation of solid cadmium-gold alloys." Journal of the American Chemical Society **54**(10): 3819-3833.

Petrini, L. and F. Migliavacca (2011). "Biomedical applications of shape memory alloys." Journal of Metallurgy **2011**.

Pornsin-Sirirak, T. N., Y. Tai, et al. (2001). "Titanium-alloy MEMS wing technology for a micro aerial vehicle application." Sensors and Actuators A: Physical **89**(1): 95-103.

Quan, D. and X. Hai (2015). "Shape Memory Alloy in Various Aviation Field." Procedia Engineering **99**: 1241-1246.

Reynaerts, D., J. Peirs, et al. (1995). Design of a SMA-actuated implantable drug delivery system. Micro Machine and Human Science, 1995. MHS'95., Proceedings of the Sixth International Symposium on, IEEE.

S. S. Winzek B, R. H., Sterzl T, Ralf Hassdorf, Thienhaus S, et al. (2004). ""Recent developments in shape memory thin film technology.,"." Mater Sci Eng:.

Shin, B., H.-Y. Kim, et al. (2008). Towards a biologically inspired small-scale water jumping robot. 2008 2nd IEEE RAS & EMBS International Conference on Biomedical Robotics and Biomechatronics, IEEE.

Stöckel, D. (1995). "The Shape Memory Effect–phenomenon, alloys and applications." 报告 (2000 年), NDC, Nitinol Devices & Components 公司, 美国加利福尼亚州 Fremont, www. nitinol-europe. com/pdfs/smemory. pdf (2007 年 12 月 24 日浏览).

Stoeckel, D. (1990). "Shape memory actuators for automotive applications." Engineering aspects of shape memory alloys: 283.

Taylor, F. and C. Au (2016). "Forced air cooling of shape memory alloy actuators for a prosthetic hand." Journal of Computing and Information Science in Engineering.

Teh, Y. H. (2008). Fast, accurate force and position control of shape memory alloy actuators, Australian National University.

Van Humbeeck, J. (1999). "Non-medical applications of shape memory alloys." Materials Science and Engineering: A **273**: 134-148.

Villanueva, A., C. Smith, et al. (2011). "A biomimetic robotic jellyfish (Robojelly) actuated by shape memory alloy composite actuators." Bioinspiration & biomimetics **6**(3): 036004.

Wang, Z., G. Hang, et al. (2008). "A micro-robot fish with embedded SMA wire actuated flexible biomimetic fin." Sensors and Actuators A: Physical **144**(2): 354-360.

Wu, M. H. and L. Schetky (2000). Industrial applications for shape memory alloys. Proceedings of the international conference on shape memory and superelastic technologies, Pacific Grove, California.

AN ECONOMIC PRODUCTION QUANTITY MODEL WITH IMPERFECTION IN PROCESS AND TRANSPORTATION COST FOR A SINGLE STAGE PRODUCTION SYSTEM

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Abstract: Determining an optimal batch quantity in a production system has been the primary focus recently among researchers. While most of the work has been reported to explore the traditional optimal inventory level in ideal cases, little appears to have been done with random defective rate, rework process, backorders and transportation. Recently, several researchers have proposed their models, which dealt in one way or the other with the optimum batch quantity in single stage system in which rework is done considering constant defective rate, random defective rate and planned backorders however their model do not consider transportation cost. It is well known that any imperfect production system of real life has random defective rates, backorders and transportation cost. In this direction, the paper extends an inventory model to allow random defective rates, planned backorders and transportation cost. Three different inventory models are developed for three different distribution functions i.e. uniform, triangular, and beta. Some numerical examples are performed to illustrate the inventory models.
Keywords: Economic production quantity, Rework, Random defective rate, Planned backorders, Transportation.

1. INTRODUCTION

Now-a-days, determining an optimal batch size in a traditional production–inventory system has received great attention among researchers. The companies have to choice good decisions regarding inventories in order to survive and grown up in the competitive businesses. Researchers developed several optimal batch size models under various conditions in order to minimize the total system cost. The first inventory model known as economic order quantity (EOQ) model was introduced by Harris (1913) and the second inventory model known as economic production quantity (EPQ) was proposed by Taft, (1918). Ever since, these inventory models have been studied and extended by several researchers and scholars. These models have an important feature which is their robustness with respect to small changes in the parameters. But the EOQ and EPQ inventory models have several assumptions, one of them is that, manufacturing process will necessarily generates good quality products. In reality, there are many situations where the manufacturing process produces defective products due to many reasons i.e. imperfect raw materials, skill level of the workers, machine capability, maintenance policies, or when the manufacturing process goes out of control etc. However, many scholars and practitioners have developed inventory models for modeling different real world situations.

Jamal, Sarker, & Mondal, (2004) developed an EPQ inventory model which determines optimal lot size in a single stage production system in which rework is done considering two different operational policies i.e. immediate rework and rework after N production cycles. This kind of inventory models with rework has attracted the attention of several researchers such as Sarkar, Chaudhuri, & Sana (2010), Sarkar, Sana, & Chaudhuri (2010, 2011a, 2011b), Sarker, Jamal, & Mondal (2008) Sana & Chaudhuri (2010), Chung (2011), Sarkar (2012a, 2012b, 2013), Widyadana & Wee (2012), Chang, Su, Yang, & Weng, (2012) and Cárdenas-Barrón, Sarkar, & Treviño-Garza (2013), Cárdenas-Barrón, Taleizadeh, & Treviño-Garza (2012) , just to name a few works. All the above mentioned research assume that proportion of defective products is a constant and known except Cárdenas-Barrón et al. (2012, 2013). Sana & Chaudhuri (2010) explained an economic manufacturing quantity model in an imperfect production process. Extending the research work of Jamal et al. (2004), Cárdenas-Barrón (2009) presented an EPQ model with planned backorders when all defective products are reworked immediately. In other words, the rework process is done during the same production cycle. His inventory model considers the two classical backordering costs (linear and fixed). One assumption in Cárdenas-Barrón (2009) is that the defective rate is constant and known. It is well known that any imperfect production system of real life has random defective rates. In this direction, recently Sarkar, Cárdenas-Barrón, Sarkar, & Singgih, (2014), extended Cárdenas-Barrón (2009) inventory model to allow random defective rates. Basically, he developed three different inventory models for three different distribution density functions such as uniform, triangular and beta.

The above mentioned research has been studied with a substantial interest and it has been found that the transportation cost is considered implicitly as part of fixed ordering or setup cost. According to investigation of National Council of Physical Distribution Management (NCPDM), the cost of transportation, on average, accounted for 6.5% of market revenue (Tseng,

Yue, & Taylor, 2005). It means that transportation cost is very important and special attention should be given to its means and policies. In this direction, this paper extends Sarkar et al. (2014) inventory model by appropriately incorporating transportation cost into the total system cost, means transportation cost is explicitly considered into the model.
The outlines of the paper are as follows. In section 2 mathematical models are developed for distribution functions. In section 3 numerical examples are presented to illustrate the use of the inventory models. Finally, in section 4 concluding remarks and future recomendations of the research are provided.

Table 1. Contribution of authors.

Author(s)	**Imperfect production**	**Constant defective production rate**	**Random defective production rate**	**Backorder**	**Transportation**
Jamal et al. (2004)	√	√			
Cárdenas-Barrón (2008)	√	√			
Cárdenas-Barrón (2009)	√	√		√	
Sana & Chaudhuri (2010)	√		√		
Sarkar, Sana, et al. (2010)	√	√			
Sarkar,Chaudhuri et al. (2010)	√	√			
Chung (2011)	√	√		√	
Sarkar et al. (2011a)	√	√			
Sarkar et al. (2011b)	√	√			
Cárdenas-Barrón et al. (2012)	√	√			
Cárdenas-Barrón et al. (2013)	√	√			
Chang et al. (2012)	√			√	
Sarkar (2012b)	√	√			
Widyadana & Wee, (2012)	√	√			
Sarkar (2013)	√	√			
Sarkar et al. (2014)	√		√	√	
This Paper	√		√	√	√

2. MATHEMATICAL MODEL

This section includes the derivation of an EPQ inventory model in the imperfect production system with random defective rate, rework process, backorders and transportation cost for a single stage production system. The basic concept of the model is shown in Fig. 1. The model consider the setup in which manufacturer takes the raw material from the supplier and process that raw material in a single stage production system to finished products. During the production, some defective items are also produced which are reworked in the same cycle to good quality product. Manufacturer send these finished product to the retailers and also allows backorders. In this system the manufacturer has to bear the transportation cost of receiving raw material from the supplier as well as of backorders.

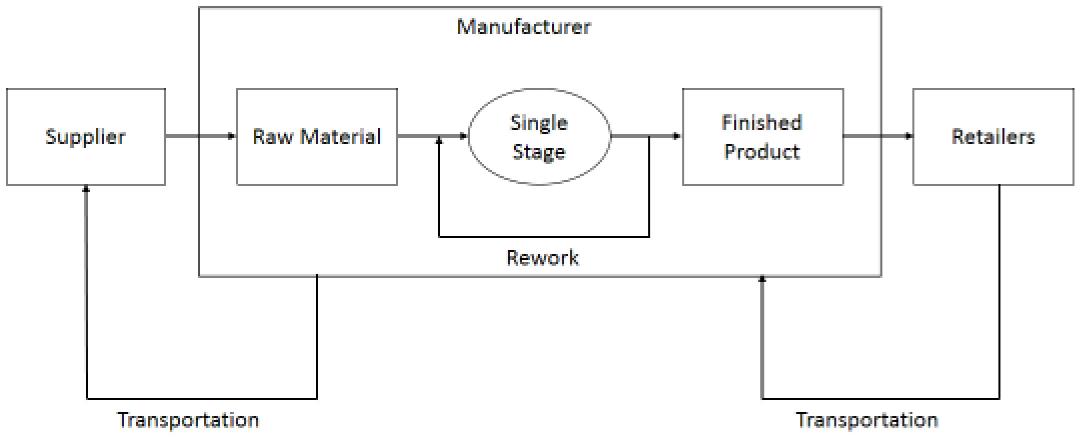

Figure 1. Inventory Flow in an imperfect production system with Supplier and Retailer

The model consider the following notation and assumptions

3.1. Notations:

D demand rate (units per time)
P production rate (units per time, P > D)
Q batch size (units)
B size of backorders (units)
C manufacturing cost of a product ($ per unit)
K cost of a production setup (fixed cost, $ per setup)
S transportation cost (fixed cost, $ per setup)
H inventory carrying cost per product per unit of time, H = iC + w
i inventory carrying cost rate (percentage)
w other inventory costs
W backorder cost per product per unit of time (linear backorder cost)
F backordering cost per product (fixed backorder cost)
V transportation cost for backordering (fixed cost, $ per backorder(
J backordering average (units)
T time between the production runs
TC total cost per unit of time
I average inventory (units)
Imax maximum inventory (units)
R proportion of defective products in each cycle (uniform, beta and triangular)
E[R] expected value of proportion of defective products in each cycle.

3.2. Assumptions:

(1) Demand and production rates are constant and known over horizon planning.
(2) The production rate is greater than demand rate, means there is no shortage.
(3) The proportion of defective products is random variable in each cycle and it follows three different distribution density functions.
(4) The products are 100% screened and the screening cost is ignored.
(5) There is no scrap within cycle and all the defective products are reworked to make perfect quality products.
(6) Inventory holding/carrying costs are based on the average inventory.
(7) Two types of backordering costs are considered, linear backordering cost (backorder cost is applied to average backorders) and fixed backordering cost (backorder cost is applied to maximum backorder level allowed).
(8) There is fixed transportation cost for setup and backorders.
(9) Production and rework is done in the same manufacturing system at the same production rate.
(10) Inventory storage space and the availability of capital is unlimited.
(11) The model is considering for single type of item.
(12) The planning horizon is infinite.

3.3. Mathematical model development:

Based on the above assumptions and notations, inventory model have been developed by considering that the proportion of defective products follows uniform distribution, triangular distribution, and beta distribution.

3.3.1. Case 1: The proportion of defective products follows uniform distribution

The total cost of the system by considering setup cost, transportation cost, inventory cost, backorder cost and production cost is as follows:

$$\mathrm{TC} = \frac{\mathrm{KD}}{\mathrm{Q}} + \frac{\mathrm{SD}}{\mathrm{Q}} + \mathrm{HG} + \frac{\mathrm{FBD}}{\mathrm{Q}} + \mathrm{WJ} + \frac{\mathrm{VBD}}{\mathrm{Q}} + \mathrm{CD}[1 + \mathrm{E(R)}] \quad (1)$$

After, substituting the values of G, J and E(R) for this case from Sarkar et al., (2014) in Eq. (1),

$$\mathrm{TC(Q,B)} = \frac{\mathrm{KD}}{\mathrm{Q}} + \frac{\mathrm{SD}}{\mathrm{Q}} + \frac{\mathrm{HQL}}{2} + \frac{\mathrm{HB^2A}}{2\mathrm{QE}} - \mathrm{HB} + \frac{\mathrm{FBD}}{\mathrm{Q}} + \frac{\mathrm{WB^2A}}{2\mathrm{QE}} + \frac{\mathrm{VBD}}{\mathrm{Q}} + \mathrm{CD}(2 - \mathrm{A}) \quad (2)$$

The total system cost equation consists of two decision variables i.e. Q and B. For minimization of total cost the second order Hessian Matrix is positive definite which implies all principle minors are positive. Therefor for this problem the sufficient conditions are as follows:

$\frac{\partial^2 TC(\mathrm{Q,B})}{\partial \mathrm{Q}^2} > 0$ and $\frac{\partial^2 TC(\mathrm{Q,B})\,\partial^2 TC(\mathrm{Q,B})}{\partial \mathrm{Q}^2\,\partial \mathrm{B}^2} - \left(\frac{\partial^2 TC(\mathrm{Q,B})}{\partial Q \partial B}\right)^2 > 0$

Taking partial derivatives of Eq. (2) with respect to B and Q respectively,

$$\frac{\partial \mathrm{TC}}{\partial \mathrm{Q}} = -\frac{\mathrm{KD}}{\mathrm{Q^2}} - \frac{\mathrm{SD}}{\mathrm{Q^2}} + \frac{\mathrm{HL}}{2} - \frac{\mathrm{HB^2A}}{2\mathrm{Q^2E}} - \frac{\mathrm{FBD}}{\mathrm{Q^2}} - \frac{\mathrm{VBD}}{\mathrm{Q^2}} - \frac{\mathrm{WB^2A}}{2\mathrm{Q^2E}}$$

and

$$\frac{\partial \mathrm{TC}}{\partial \mathrm{B}} = \frac{\mathrm{HBA}}{\mathrm{QE}} - \mathrm{H} + \frac{\mathrm{FD}}{\mathrm{Q}} + \frac{\mathrm{WBA}}{\mathrm{QE}} + \frac{\mathrm{VD}}{\mathrm{Q}}$$

From sufficient conditions,

$$\frac{\partial^2 \mathrm{TC}}{\partial \mathrm{Q^2}} = \left(\frac{2}{\mathrm{Q^3}}\right)\left[(\mathrm{K+S})\mathrm{D} + (\mathrm{F+V})\mathrm{BD} + \frac{(\mathrm{W+H})\mathrm{B^2A}}{2\mathrm{E}}\right]$$

$$\frac{\partial^2 \mathrm{TC}}{\partial \mathrm{B^2}} = \frac{(\mathrm{W+H})\mathrm{A}}{\mathrm{QE}}$$

$$\frac{\partial^2 \mathrm{TC}}{\partial \mathrm{Q}\,\partial \mathrm{B}} = -\left[\frac{(\mathrm{F+V})\mathrm{D}}{\mathrm{Q^2}} + \frac{(\mathrm{W+H})\mathrm{BA}}{\mathrm{Q^2E}}\right]$$

$$\left(\frac{\partial^2 \mathrm{TC}}{\partial \mathrm{Q}\,\partial \mathrm{B}}\right)^2 = \frac{(\mathrm{F+V})^2\mathrm{D}^2}{\mathrm{Q^4}} + \frac{(\mathrm{W+H})^2\mathrm{A^2B^2}}{\mathrm{Q^4E^2}} + \frac{2\mathrm{ABD}(\mathrm{F+V})(\mathrm{W+H})}{\mathrm{Q^4E^2}}$$

$$\frac{\partial^2 \mathrm{TC}\,\partial^2 \mathrm{TC}}{\partial \mathrm{Q^2}\,\partial \mathrm{B^2}} = \frac{(\mathrm{W+H})^2\mathrm{A^2B^2}}{\mathrm{Q^4E^2}} + \frac{2\mathrm{A}(\mathrm{W+H})[(\mathrm{K+S})\mathrm{D} + (\mathrm{F+V})\mathrm{BD}]}{\mathrm{Q^4E}}$$

Therefore,

$$\frac{\partial^2 TC}{\partial Q^2}\frac{\partial^2 TC}{\partial B^2}-(\frac{\partial^2 TC}{\partial Q\,\partial B})^2=\frac{(W+H)^2A^2B^2}{Q^4E^2}+\frac{2A(W+H)[(K+S)D+(F+V)BD]}{Q^4E}-\frac{(F+V)^2D^2}{Q^4}+\frac{(W+H)^2A^2B^2}{Q^4E^2}+\frac{2ABD(F+V)(W+H)}{Q^4E^2}$$

So

$$\frac{\partial^2 TC}{\partial Q^2}\frac{\partial^2 TC}{\partial B^2}-(\frac{\partial^2 TC}{\partial Q\,\partial B})^2=\frac{2DA(K+S)(W+H)}{Q^4E}-\frac{(F+V)^2D^2}{Q^4} \quad (3)$$

For minimizing cost equation, the condition is $\frac{2DA(K+S)(W+H)}{Q^4E}-\frac{(F+V)^2D^2}{Q^4}>0$ i.e. if the expression $\frac{2DA(K+S)(W+H)}{Q^4E}-\frac{(F+V)^2D^2}{Q^4}$ is greater than 0, then sufficient condition of optimality criteria is satisfied. Therefore it may be concluded, that the cost equation is convex when the expression $\frac{2DA(K+S)(W+H)}{Q^4E}-\frac{(F+V)^2D^2}{Q^4}>0$ is satisfied.

To obtain the optimum points, the 1st order partial derivatives with respect to the variables are separately equal to 0. Therefore, for this problem, the necessary conditions are as follows:

$\frac{\partial TC(Q,B)}{\partial Q}=0$ and $\frac{\partial TC(Q,B)}{\partial B}=0$

Taking partial derivatives of Eq. (2) with respect to B,

$$\frac{\partial TC}{\partial B}=\frac{HBA}{QE}-H+\frac{FD}{Q}+\frac{WBA}{QE}+\frac{VD}{Q} \quad (4)$$

From necessary conditions $\partial TC/\partial B=0$ so putting Eq. (4) equal to 0.

$$\frac{HBA}{QE}-H+\frac{FD}{Q}+\frac{WBA}{QE}+\frac{VD}{Q}=0$$

After some simplification,

$$B^*=\frac{[HQ-(F+V)D]}{A(W+H)} \quad (5)$$

Now taking partial derivatives of Eq. (2) with respect to Q,

$$\frac{\partial TC}{\partial Q}=-\frac{KD}{Q^2}-\frac{SD}{Q^2}+\frac{HL}{2}-\frac{HB^2A}{2Q^2E}-\frac{FBD}{Q^2}-\frac{VBD}{Q^2}-\frac{WB^2A}{2Q^2E} \quad (6)$$

Putting value of ‘B’ in Eq. (6) and applying necessary conditions

$$-\frac{KD}{Q^2}-\frac{SD}{Q^2}+\frac{HL}{2}-\frac{\left[\frac{D(F+V)[E(HQ-(F+V))D]}{A(W+H)}\right]}{Q^2}-\left[\frac{A(W+H)\left[\frac{E(HQ-(F+V)D)}{A(W+H)}\right]^2}{2Q^2E}\right]=0$$

After some simplification,

$$Q^{*} = \sqrt{\left[\frac{[2DA(K+S)(W+H) - ED^{2}(F+V)^{2}]}{H[AL(W+H) - EH]}\right]} \tag{7}$$

Substituting the above optimal values in the total cost equation and after some simplification, the optimum cost is,

$$TC^{*} = \frac{\left[\sqrt{[2DA(K+S)(W+H) - ED^{2}(F+V)^{2}]\big[H[AL(W+H) - EH]\big]} + DEH(F+V)\right]}{A(W+H)} + CD(2-A) \tag{8}$$

3.3.2. Case 2: The proportion of defective products follows a triangular distribution

The total cost of the system by considering setup cost, transportation cost, inventory cost, backorder cost, and production cost is as follows:

$$TC = \frac{KD}{Q} + \frac{SD}{Q} + HG_{tri} + \frac{FBD}{Q} + WJ_{tri} + \frac{VBD}{Q} + CD[1 + E(R)] \tag{9}$$

After, substituting the values of G_{tri}, J_{tri} and E(R) for this case from Sarkar et al (2014) in Eq. (9),

$$TC(Q,B) = \frac{KD}{Q} + \frac{SD}{Q} + \frac{HQL_{tri}}{2} + \frac{HB^{2}A_{tri}}{2QE_{tri}} - HB + \frac{FBD}{Q} + \frac{WB^{2}A_{tri}}{2QE_{tri}} + \frac{VBD}{Q} + CD(2 - A_{tri}) \tag{10}$$

Same as the previous model, there are two decision variables Q and B. For minimization of total cost the second order Hessian Matrix is positive definite which implies all principle minors are positive. Therefor for this problem the sufficient conditions are as follows:

$$\frac{\partial^{2}TC(Q,B)}{\partial Q^{2}} > 0 \quad \text{and} \quad \frac{\partial^{2}TC(Q,B)}{\partial Q^{2}}\frac{\partial^{2}TC(Q,B)}{\partial B^{2}} - \left(\frac{\partial^{2}TC(Q,B)}{\partial Q \partial B}\right)^{2} > 0$$

Taking partial derivatives of Eq. (10) with respect to B and Q respectively,

$$\frac{\partial TC}{\partial Q} = -\frac{KD}{Q^{2}} - \frac{SD}{Q^{2}} + \frac{HL_{tri}}{2} - \frac{HB^{2}A_{tri}}{2Q^{2}E_{tri}} - \frac{FBD}{Q^{2}} - \frac{VBD}{Q^{2}} - \frac{WB^{2}A_{tri}}{2Q^{2}E_{tri}}$$

and

$$\frac{\partial TC}{\partial B} = \frac{HBA_{tri}}{QE_{tri}} - H + \frac{FD}{Q} + \frac{WBA_{tri}}{QEtri_{tri}} + \frac{VD}{Q}$$

From sufficient conditions,

$$\frac{\partial^{2}TC}{\partial Q^{2}} = \left(\frac{2}{Q^{3}}\right)\left[(K+S)D + (F+V)BD + \frac{(W+H)B^{2}A_{tri}}{2E_{tri}}\right]$$

$$\frac{\partial^{2}TC}{\partial B^{2}} = \frac{(W+H)A_{tri}}{QE_{tri}}$$

$$\frac{\partial^2 TC}{\partial Q\,\partial B} = -[\frac{(F+V)D}{Q^2} + \frac{(W+H)BA_{tri}}{Q^2E_{tri}}]$$

$$(\frac{\partial^2 TC}{\partial Q\,\partial B})^2 = \frac{(F+V)^2D^2}{Q^4} + \frac{(W+H)^2A_{tri}^2B^2}{Q^4E_{tri}^2} + \frac{2A_{tri}BD(F+V)(W+H)}{Q^4E_{tri}^2}$$

$$\frac{\partial^2 TC\,\partial^2 TC}{\partial Q^2\,\partial B^2} = \frac{(W+H)^2A_{tri}^2B^2}{Q^4E_{tri}^2} + \frac{2A_{tri}(W+H)[(K+S)D+(F+V)BD]}{Q^4E_{tri}}$$

Therefore,

$$\frac{\partial^2 TC\,\partial^2 TC}{\partial Q^2\,\partial B^2} - (\frac{\partial^2 TC}{\partial Q\,\partial B})^2 = \frac{(W+H)^2A_{tri}^2B^2}{Q^4E_{tri}^2} + \frac{2A_{tri}(W+H)[(K+S)D+(F+V)BD]}{Q^4E_{tri}} - \frac{(F+V)^2D^2}{Q^4} + \frac{(W+H)^2A_{tri}^2B^2}{Q^4E_{tri}^2} + \frac{2A_{tri}BD(F+V)(W+H)}{Q^4E_{tri}^2}$$

So

$$\frac{\partial^2 TC\,\partial^2 TC}{\partial Q^2\,\partial B^2} - (\frac{\partial^2 TC}{\partial Q\,\partial B})^2 = \frac{2DA_{tri}(K+S)(W+H)}{Q^4E_{tri}} - \frac{(F+V)^2D^2}{Q^4} \quad (11)$$

For minimizing cost equation, the condition is $\frac{2DA_{tri}(K+S)(W+H)}{Q^4E_{tri}} - \frac{(F+V)^2D^2}{Q^4} > 0$ i.e. if the expression $\frac{2DAtri(K+S)(W+H)}{Q^4Etri} - \frac{(F+V)^2D^2}{Q^4}$ is greater than 0, then sufficient condition of optimality criteria is satisfied. Therefore itmay be concluded, that the cost equation is convex when the expression $\frac{2DA_{tri}(K+S)(W+H)}{Q^4E_{tri}} - \frac{(F+V)^2D^2}{Q^4} > 0$ is satisfied.

To obtain the optimum points, the 1st order partial derivatives with respect to the variables are separately equal to 0. Therefore, for this problem, the necessary conditions are as follows:

$\frac{\partial TC(Q,B)}{\partial Q} = 0$ and $\frac{\partial TC(Q,B)}{\partial B} = 0$

Taking partial derivatives of Eq. (10) with respect to B,

$$\frac{\partial TC}{\partial B} = \frac{HBA_{tri}}{QE_{tri}} - H + \frac{FD}{Q} + \frac{WBA_{tri}}{QE_{tri}} + \frac{VD}{Q} \quad (12)$$

From necessary conditions $\partial TC/\partial B = 0$ so putting Eq. (12) equal to 0.

$$\frac{HBA_{tri}}{QE_{tri}} - H + \frac{FD}{Q} + \frac{WBA_{tri}}{QE_{tri}} + \frac{VD}{Q} = 0$$

After some simplification,

$$B^* = \frac{[HQ-(F+V)D]E_{tri}}{A_{tri}(W+H)} \quad (13)$$

Now taking partial derivatives of Eq. (10) with respect to Q,

$$\frac{\partial \mathrm{TC}}{\partial \mathrm{Q}} = -\frac{\mathrm{KD}}{\mathrm{Q}^2} - \frac{\mathrm{SD}}{\mathrm{Q}^2} + \frac{\mathrm{HL_{tri}}}{2} - \frac{\mathrm{HB^2A_{tri}}}{2\mathrm{Q^2E_{tri}}} - \frac{\mathrm{FBD}}{\mathrm{Q}^2} - \frac{\mathrm{VBD}}{\mathrm{Q}^2} - \frac{\mathrm{WB^2A_{tri}}}{2\mathrm{Q^2E_{tri}}} \tag{14}$$

Putting value of 'B' in Eq. (14) and applying necessary conditions

$$-\frac{\mathrm{KD}}{\mathrm{Q}^2} - \frac{\mathrm{SD}}{\mathrm{Q}^2} + \frac{\mathrm{HL}}{2} - \frac{\left[\frac{\mathrm{D(F+V)}[\mathrm{E_{tri}}(\mathrm{HQ}-(\mathrm{F+V}))\mathrm{D}]}{\mathrm{A_{tri}(W+H)}}\right]}{\mathrm{Q}^2} - \left[\frac{\mathrm{A_{tri}(W+H)}\left[\frac{\mathrm{E_{tri}(HQ-(F+V)D)}}{\mathrm{A_{tri}(W+H)}}\right]^2}{2\mathrm{Q^2E_{tri}}}\right] = 0$$

After some simplification,

$$\mathrm{Q}^* = \sqrt{\left[\frac{[2\mathrm{DA_{tri}(K+S)(W+H)} - \mathrm{E_{tri}D^2(F+V)^2}]}{\mathrm{H}[\mathrm{A_{tri}L_{tri}(W+H)} - \mathrm{E_{tri}H}]}\right]} \tag{15}$$

Substituting the above optimal values in the total cost equation and after some simplification, the optimum cost is,

$$\mathrm{TC}^* = \frac{\left[\sqrt{[2\mathrm{DA_{tri}(K+S)(W+H)} - \mathrm{E_{tri}D^2(F+V)^2}]\left[\mathrm{H}[\mathrm{A_{tri}L_{tri}(W+H)} - \mathrm{E_{tri}H}]\right]} + \mathrm{DE_{tri}H(F+V)}\right]}{\mathrm{A_{tri}(W+H)}} + \mathrm{CD}(2 - \mathrm{A_{tri}}) \tag{16}$$

3.3.3. Case 3: The proportion of defective products follows a beta distribution

The total cost of the system by considering setup cost, transportation cost, inventory cost, backorder cost, and production cost is as follows:

$$\mathrm{TC} = \frac{\mathrm{KD}}{\mathrm{Q}} + \frac{\mathrm{SD}}{\mathrm{Q}} + \mathrm{HG_{beta}} + \frac{\mathrm{FBD}}{\mathrm{Q}} + \mathrm{WJ_{beta}} + \frac{\mathrm{VBD}}{\mathrm{Q}} + \mathrm{CD}[1 + \mathrm{E(R)}] \tag{17}$$

After, substituting the values of G_{beta}, J_{beta} and E(R) for this case from Sarkar et al (2014) in Eq. (17),

$$\mathrm{TC(Q,B)} = \frac{\mathrm{KD}}{\mathrm{Q}} + \frac{\mathrm{SD}}{\mathrm{Q}} + \frac{\mathrm{HQL_{beta}}}{2} + \frac{\mathrm{HB^2A_{beta}}}{2\mathrm{QE_{beta}}} - \mathrm{HB} + \frac{\mathrm{FBD}}{\mathrm{Q}} + \frac{\mathrm{WB^2A_{beta}}}{2\mathrm{QE_{beta}}} + \frac{\mathrm{VBD}}{\mathrm{Q}} + \mathrm{CD}(2 - \mathrm{A_{beta}}) \tag{18}$$

Same as the previous model, there are two decision variables Q and B. For minimization of total cost the second order Hessian Matrix is positive definite which implies all principle minors are positive. Therefor for this problem the sufficient conditions are as follows:

$$\frac{\partial^2 TC(\mathrm{Q,B})}{\partial \mathrm{Q}^2} > 0 \quad \text{and} \quad \frac{\partial^2 TC(\mathrm{Q,B})\,\partial^2 TC(\mathrm{Q,B})}{\partial \mathrm{Q}^2\,\partial \mathrm{B}^2} - \left(\frac{\partial^2 TC(\mathrm{Q,B})}{\partial Q \partial B}\right)^2 > 0$$

Taking partial derivatives of Eq. (18) with respect to B and Q respectively,

$$\frac{\partial \mathrm{TC}}{\partial \mathrm{Q}} = -\frac{\mathrm{KD}}{\mathrm{Q}^2} - \frac{\mathrm{SD}}{\mathrm{Q}^2} + \frac{\mathrm{HL_{beta}}}{2} - \frac{\mathrm{HB^2A_{beta}}}{2\mathrm{Q^2E_{beta}}} - \frac{\mathrm{FBD}}{\mathrm{Q}^2} - \frac{\mathrm{VBD}}{\mathrm{Q}^2} - \frac{\mathrm{WB^2A_{beta}}}{2\mathrm{Q^2E_{beta}}}$$

and

$$\frac{\partial \mathrm{TC}}{\partial \mathrm{B}} = \frac{\mathrm{HBA_{beta}}}{\mathrm{QE_{beta}}} - \mathrm{H} + \frac{\mathrm{FD}}{\mathrm{Q}} + \frac{\mathrm{WBA_{beta}}}{\mathrm{QE_{beta}}} + \frac{\mathrm{VD}}{\mathrm{Q}}$$

From sufficient conditions,

$$\frac{\partial^2 \mathrm{TC}}{\partial \mathrm{Q}^2} = (\frac{2}{\mathrm{Q}^3})[(\mathrm{K+S})\mathrm{D} + (\mathrm{F+V})\mathrm{BD} + \frac{(\mathrm{W+H})\mathrm{B}^2\mathrm{A_{beta}}}{2\mathrm{E_{beta}}}]$$

$$\frac{\partial^2 \mathrm{TC}}{\partial \mathrm{B}^2} = \frac{(\mathrm{W+H})\mathrm{A_{beta}}}{\mathrm{QE_{beta}}}$$

$$\frac{\partial^2 \mathrm{TC}}{\partial \mathrm{Q}\,\partial \mathrm{B}} = -[\frac{(\mathrm{F+V})\mathrm{D}}{\mathrm{Q}^2} + \frac{(\mathrm{W+H})\mathrm{BA_{beta}}}{\mathrm{Q}^2\mathrm{E_{beta}}}]$$

$$(\frac{\partial^2 \mathrm{TC}}{\partial \mathrm{Q}\,\partial \mathrm{B}})^2 = \frac{(\mathrm{F+V})^2\mathrm{D}^2}{\mathrm{Q}^4} + \frac{(\mathrm{W+H})^2\mathrm{A_{beta}^2}\mathrm{B}^2}{\mathrm{Q}^4\mathrm{E_{beta}^2}} + \frac{2\mathrm{A_{beta}}\mathrm{BD}(\mathrm{F+V})(\mathrm{W+H})}{\mathrm{Q}^4\mathrm{E_{beta}^2}}$$

$$\frac{\partial^2 \mathrm{TC}\,\partial^2 \mathrm{TC}}{\partial \mathrm{Q}^2\,\partial \mathrm{B}^2} = \frac{(\mathrm{W+H})^2\mathrm{A_{beta}^2}\mathrm{B}^2}{\mathrm{Q}^4\mathrm{E_{beta}^2}} + \frac{2\mathrm{A_{beta}}(\mathrm{W+H})[(\mathrm{K+S})\mathrm{D} + (\mathrm{F+V})\mathrm{BD}]}{\mathrm{Q}^4\mathrm{E_{beta}}}$$

Therefore,

$$\frac{\partial^2 \mathrm{TC}\,\partial^2 \mathrm{TC}}{\partial \mathrm{Q}^2\,\partial \mathrm{B}^2} - (\frac{\partial^2 \mathrm{TC}}{\partial \mathrm{Q}\,\partial \mathrm{B}})^2 = \frac{(\mathrm{W+H})^2\mathrm{A_{beta}^2}\mathrm{B}^2}{\mathrm{Q}^4\mathrm{E_{beta}^2}} + \frac{2\mathrm{A_{beta}}(\mathrm{W+H})[(\mathrm{K+S})\mathrm{D} + (\mathrm{F+V})\mathrm{BD}]}{\mathrm{Q}^4\mathrm{E_{beta}}} - \frac{(\mathrm{F+V})^2\mathrm{D}^2}{\mathrm{Q}^4} + \frac{(\mathrm{W+H})^2\mathrm{A_{beta}^2}\mathrm{B}^2}{\mathrm{Q}^4\mathrm{E_{beta}^2}} + \frac{2\mathrm{A_{beta}}\mathrm{BD}(\mathrm{F+V})(\mathrm{W+H})}{\mathrm{Q}^4\mathrm{E_{beta}^2}}$$

So

$$\frac{\partial^2 \mathrm{TC}\,\partial^2 \mathrm{TC}}{\partial \mathrm{Q}^2\,\partial \mathrm{B}^2} - (\frac{\partial^2 \mathrm{TC}}{\partial \mathrm{Q}\,\partial \mathrm{B}})^2 = \frac{2\mathrm{DA_{beta}}(\mathrm{K+S})(\mathrm{W+H})}{\mathrm{Q}^4\mathrm{E_{beta}}} - \frac{(\mathrm{F+V})^2\mathrm{D}^2}{\mathrm{Q}^4} \tag{19}$$

For minimizing cost equation, the condition is $\frac{2\mathrm{DA_{beta}}(\mathrm{K+S})(\mathrm{W+H})}{\mathrm{Q}^4\mathrm{E_{beta}}} - \frac{(\mathrm{F+V})^2\mathrm{D}^2}{\mathrm{Q}^4} > 0$ i.e. if the expression $\frac{2\mathrm{DA_{beta}}(\mathrm{K+S})(\mathrm{W+H})}{\mathrm{Q}^4\mathrm{E_{beta}}} - \frac{(\mathrm{F+V})^2\mathrm{D}^2}{\mathrm{Q}^4}$ is greater than 0, then sufficient condition of optimality criteria is satisfied. Therefore it may be concluded, that the cost equation is convex when the expression

$\frac{2\mathrm{DA_{beta}}(\mathrm{K+S})(\mathrm{W+H})}{\mathrm{Q}^4\mathrm{E_{beta}}} - \frac{(\mathrm{F+V})^2\mathrm{D}^2}{\mathrm{Q}^4} > 0$ is satisfied.

To obtain the optimum points, the 1st order partial derivatives with respect to the variables are separately equal to 0. Therefore, for this problem, the necessary conditions are as follows:
$\partial TC(Q,B)/\partial Q = 0$ and $\partial TC(Q,B)/\partial B = 0$
Taking partial derivatives of Eq. (18) with respect to B,

$$\frac{\partial \mathrm{TC}}{\partial \mathrm{B}} = \frac{\mathrm{HBA_{beta}}}{\mathrm{QE_{beta}}} - \mathrm{H} + \frac{\mathrm{FD}}{\mathrm{Q}} + \frac{\mathrm{WBA_{beta}}}{\mathrm{QE_{beta}}} + \frac{\mathrm{VD}}{\mathrm{Q}} \tag{20}$$

From necessary conditions $\partial TC/\partial B = 0$ so putting Eq. (20) equal to 0.

$$\frac{\mathrm{HBA_{beta}}}{\mathrm{QE_{beta}}} - \mathrm{H} + \frac{\mathrm{FD}}{\mathrm{Q}} + \frac{\mathrm{WBA_{beta}}}{\mathrm{QE_{beta}}} + \frac{\mathrm{VD}}{\mathrm{Q}} = 0$$

After some simplification,

$$B^* = \frac{[HQ - (F + V)D]E_{beta}}{A_{beta}(W + H)} \tag{21}$$

Now taking partial derivatives of Eq. (18) with respect to Q,

$$\frac{\partial TC}{\partial Q} = -\frac{KD}{Q^2} - \frac{SD}{Q^2} + \frac{HL_{beta}}{2} - \frac{HB^2A_{beta}}{2Q^2E_{beta}} - \frac{FBD}{Q^2} - \frac{VBD}{Q^2} - \frac{WB^2A_{beta}}{2Q^2E_{beta}} \tag{22}$$

Putting value of 'B' in Eq. (22) and applying necessary conditions

$$-\frac{KD}{Q^2} - \frac{SD}{Q^2} + \frac{HL}{2} - \frac{\left[\frac{D(F+V)[E_{beta}(HQ-(F+V))D]}{A_{beta}(W+H)}\right]}{Q^2} - \left[\frac{A_{beta}(W + H)\left[\frac{E_{beta}(HQ-(F+V)D)}{A_{beta}(W+H)}\right]^2}{2Q^2E_{beta}}\right] = 0$$

After some simplification,

$$Q^* = \sqrt{\left[\frac{[2DA_{beta}(K + S)(W + H) - E_{beta}D^2(F + V)^2]}{H[A_{beta}L_{beta}(W + H) - E_{beta}H]}\right]} \tag{23}$$

Substituting the above optimal values in the total cost equation and after some simplification, the optimum cost is,

$$TC^* = \frac{\left[\sqrt{[2DA_{beta}(K + S)(W + H) - E_{beta}D^2(F + V)^2][H[A_{beta}L_{beta}(W + H) - E_{beta}H]]} + DE_{beta}H(F + V)\right]}{A_{beta}(W + H)} + CD(2 - A_{beta}) \tag{24}$$

3. NUMERICAL EXPERIMENTS

Closed form solution obtained in equations (8), (16) and (24) has been verified. The input data used, has been taken from Sarkar et al. (2014) and has been reordered by considering additional parameters i.e. fixed transportation cost (K) and transportation cost for backordering (V).

Example 1. The values of the following parameters are to be taken in appropriate units: D = 300 units/year, a = 0.03, b = 0.07, P = 550 units/year, W = \$10/unit/year, H = \$50/unit/year, F = \$1/unit short, V = \$1/unit short, K = \$50/lot size, S = \$20/lot size, C = \$7/unit. Then, the optimal solution is
[TC^* = \$2792.45/year, Q^* = 105.30 units, B^* = 33.10 units.]

Example 2. The values of the following parameters are to be taken in appropriate units: D = 300 units/year, a = 0.03, b = 0.04, c = 0.07 P = 550 units/year, W = \$10/unit/year, H = \$50/unit/year, F = \$1/unit short, V = \$1/unit short, K = \$50/lot size, S = \$20/lot size, C = \$7/unit. Then, the optimal solution is
[TC^* = \$2787.71/year, Q^* = 105.08 units, B^* = 33.18 units.]

Example 3. The values of the following parameters are to be taken in appropriate units: D = 300 units/year, α = 0.03, β = 0.07, P = 550 units/year, W = \$10/unit/year, H = \$50/unit/year, F = \$1/unit short, V = \$1/unit short, K = \$50/lot size, S = \$20/lot size, C = \$7/unit. Then, the optimal solution is
[TC^* = \$3183.42/year, Q^* = 118.56 units, B^* = 19.59 units.]

4. CONCLUSION AND FUTURE RECOMMENDATIONS

Previously, Sarkar et al. (2014) developed a mathematical model by considering transportation cost as part of ordering cost. This research has explicitly incorporated transportation cost into the total system cost. Same as the previous research the proposed article have taken the three different probabilistic function i.e. uniform, triangular and beta for the proportion of defective items. Furthermore, from the numerical examples, it has been concluded that the minimum cost can be obtained for the case of triangular distribution. The model can be further extended through the incorporation of variable transportation cost.

REFERENCES

1. Cárdenas-Barrón, Leopoldo Eduardo. (2008). Optimal manufacturing batch size with rework in a single-stage production system–a simple derivation. *Computers & Industrial Engineering, 55*(4), 758-765.

2. Cárdenas-Barrón, Leopoldo Eduardo. (2009). Economic production quantity with rework process at a single-stage manufacturing system with planned backorders. *Computers & Industrial Engineering, 57*(3), 1105-1113.

3. Cárdenas-Barrón, Leopoldo Eduardo, Sarkar, Biswajit, & Treviño-Garza, Gerardo. (2013). An improved solution to the replenishment policy for the EMQ model with rework and multiple shipments. *Applied Mathematical Modelling, 37*(7), 5549-5554.

4. Cárdenas-Barrón, Leopoldo Eduardo, Taleizadeh, Ata Allah, & Treviño-Garza, Gerardo. (2012). An improved solution to replenishment lot size problem with discontinuous issuing policy and rework, and the multi-delivery policy into economic production lot size problem with partial rework. *Expert Systems with Applications, 39*(18), 13540-13546.

5. Chang, Horng-Jinh, Su, Rung-Hung, Yang, Chih-Te, & Weng, Ming-Wei. (2012). An economic manufacturing quantity model for a two-stage assembly system with imperfect processes and variable production rate. *Computers & Industrial Engineering, 63*(1), 285-293.

6. Chung, Kun-Jen. (2011). The economic production quantity with rework process in supply chain management. *Computers & Mathematics with Applications, 62*(6), 2547-2550.

7. Harris, Ford W. (1913). How many parts to make at once.

8. Jamal, AMM, Sarker, Bhaba R, & Mondal, Sanjay. (2004). Optimal manufacturing batch size with rework process at a single-stage production system. *Computers & Industrial Engineering, 47*(1), 77-89.

9. Sana, Shib Sankar, & Chaudhuri, Kripasindhu. (2010). An EMQ model in an imperfect production process. *International Journal of Systems Science, 41*(6), 635-646.

10. Sarkar, Biswajit. (2012a). An EOQ model with delay in payments and stock dependent demand in the presence of imperfect production. *Applied Mathematics and Computation, 218*(17), 8295-8308.

11. Sarkar, Biswajit. (2012b). An inventory model with reliability in an imperfect production process. *Applied Mathematics and Computation, 218*(9), 4881-4891.

12. Sarkar, Biswajit. (2013). A production-inventory model with probabilistic deterioration in two-echelon supply chain management. *Applied Mathematical Modelling, 37*(5), 3138-3151.

13. Sarkar, Biswajit, Cárdenas-Barrón, Leopoldo Eduardo, Sarkar, Mitali, & Singgih, Moses Laksono. (2014). An economic production quantity model with random defective rate, rework process and backorders for a single stage production system. *Journal of Manufacturing Systems*, *33*(3), 423-435.

14. Sarkar, Biswajit, Chaudhuri, Kripasindhu, & Sana, Shib Sankar. (2010). A stock-dependent inventory model in an imperfect production process. *International Journal of Procurement Management, 3*(4), 361-378.

15. Sarkar, Biswajit, Sana, Shib Sankar, & Chaudhuri, Kripasindhu. (2010). Optimal reliability, production lot size and safety stock in an imperfect production system. *International Journal of Mathematics in Operational Research*, *2*(4), 467-490.

16. Sarkar, Biswajit, Sana, Shib Sankar, & Chaudhuri, Kripasindhu. (2011a). An economic production quantity model with stochastic demand in an imperfect production system. *International Journal of Services and Operations Management, 9*(3), 259-283.

17. Sarkar, Biswajit, Sana, Shib Sankar, & Chaudhuri, Kripasindhu. (2011b). An imperfect production process for time varying demand with inflation and time value of money–An EMQ model. *Expert Systems with Applications*, *38*(11), 13543-13548.

18. Sarker, Bhaba R, Jamal, AMM, & Mondal, Sanjay. (2008). Optimal batch sizing in a multi-stage production system with rework consideration. *European Journal of Operational Research*, *184*(3), 915-929.

19. Taft, EW. (1918). The most economical production lot. *Iron Age, 101*(18), 1410-1412.

20. Tseng, Yung-yu, Yue, Wen Long, & Taylor, Michael AP. (2005). *The role of transportation in logistics chain*.

21. Widyadana, Gede Agus, & Wee, Hui Ming. (2012). An economic production quantity model for deteriorating items with multiple production setups and rework. *International Journal of Production Economics*, *138*(1), 62-67.

Modeling and numerical simulation of chip formation in high speed machining of titanium alloy Ti6Al4V

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Abstract: This study develops simulation procedure to get extensive awareness into chip development technique for high speed machining of Ti6Al4V using PCD (Polycrystalline Diamond) cutting tool. The simulation of high speed machining is accomplished with the aid of finite element analysis (FEA), in which the Johnson-Cook (JC) damage evolution model with a displacement failure criterion is adopted. The cutting speeds are selected ranging from 200 m/min to 5,000 m/min, and un-deformed chip thickness is fixed as 0.35 mm. The variables investigated include the temperature of the workpiece and frequency of chips in addition to the cutting force and stress. The results show that both the Temperature and frequency have positive correlations with the cutting speed. An important regularity for the transformation of chip morphology from serrated to unit at a critical cutting speed has been achieved, and the critical value for Ti6Al4V is about 5000 m/min. The research also finds the decrease in cutting force and temperature when the cutting velocity increases, while its fluctuant frequency and amplitude increase sharply and the influences of JC fracture constants (the five constants in J-C fracture model) on chip formation are investigated based on the finite element method.

1 INTRODUCTION

With the recent development titanium compounds are exceptionally well known to use in the aviation, biomedical, automobile and petroleum enterprises as a result of their great quality to weight proportion and solid consumption resistance [1]. However, it is extremely hard to machine Ti6Al4V because of poor warm conductivity and high substance reactivity [2]. Siekmann (1955) identified that machining of titanium alloys is difficult, doesn't matter the technique used to transform this metal into chips. The awful machinability of Ti6Al4V has driven numerous substantial organizations, such as (General Electric and Rolls-Royce) to put a great deal more in making new strategies to diminish machining cost (Ezugwu and Wang. 1997). Due to the unique properties of Ti6Al4V, especially for their poor thermal property, the chips produced are serrated chips even when the cutting speed is very low.

Sun et al. [3] tentatively assessed the dry turning of chip development of Ti6Al4V under various cutting velocities, depth of cut and feed rates. The reason behind the segmented chip development process was high frequency of the cyclic power. This frequency was observed to be corresponding cutting velocity which was inverse to the feed rate. Cotterell and byrne [4] also performed the same investigation using image study of saved video timeline.

Umbrello [5] inspected the impact of cutting power, chip segmentation and chip morphology during conventional and rapid machining of Ti6Al4V in which three Johnson-Cook conditions with various arrangements of material constants were enacted. The good result can be accomplished for both (the primary cutting power and chip morphology) if the material parameters for the Johnson-Cook constitutive equation embraced are reasonable.

Hosseini and Kazeminezhad [6] implemented a new and advanced constitutive model in FE method to investigate the material behavior during intense deformation. The new model was entirely based on the physical components that can anticipate all phases of stream stress advancement and also can illustrate the effects of strain and strain rate on stream stress advancement of material during serious plastic deformation which can be utilized as a part of simulation of rapid machining.

Karpat [7] recommended different temperature-dependent stream softening settings which were evaluated by utilizing FE analysis. The outcomes were justified with the experimental results taken from the writing serves, stream softening started begin around 350-500°C consolidated with suitable softening parameters yields simulation results in good contract with the investigational measurements.

The biggest challenge now is to conduct simulation for material like titanium alloys widely used in aerospace industry. Calamaz, et al [8] made a finite element simulation to check the effects of cutting velocity, feed rates and cutting force in the development of segmented chip for titanium alloys.

Vijay Sekar, K.S and Kumar, M.P [10] made a simulation of titanium allow with the same models employed by [8] for flow stress model analyzing parameters like the chip morphology, stress, strain, temperature distribution, feed force and cutting force but the specimen was a tube and only the cutting speed was varied and [11] made a 3D thermo-mechanical simulation of milling process of Ti6Al4V alloy to analyze the stress distribution considering speed, feed and depth of cut.

The other authors used the speed not more than 3000 m/min which is very less as compared to the velocity used in this research. High speed will reduce the time, material cost, temperature and cutting force when cutting the titanium alloy. In this study we perform modeling and simulation of chip production of titanium alloy with various cutting velocities ranging from 200 m/min to 5000 m/min keeping in mind to examine the situation involved during chip segmentation. 2D numerical model is created then the chip morphology and serrated degree are analyzed through the finite element simulation with different Johnson-Cook fracture constants. In addition, material fracture energy is used to reduce the mesh dependency and accomplish material degradation during cutting process.

2 FINITE ELEMENT METHOD AND MODELING PROCEDURE

To enhance physical conception of fragmented chip formation and friction properties during the cutting of titanium alloy Ti6Al4V, the commercial software Abaqus/Explicit was used. Finite element analysis (FEA) is just a new but most useable method in engineering and mathematics. The method has huge application and extensive use in the thermal, structural and industrial analysis areas. The FE method is comprised 3 major phases: (1) pre-processing, (2) solution, and (3) post-processing. In this paper a two dimensional orthogonal cutting model was established as shown in fig 1. This model was built up by utilizing the (CPE4RT) planar quadrilateral continuum elements, which were reasonable for the coupled temperature-displacement/explicit analysis. Cutting tool is considered as rigid body and its rake and flank angles are 15° and 10° respectively. The cutting tool edge radius is 0.03mm which is designed to reduce the mesh distortion problem [12]. The cutting velocity V ranges from 200 to 5000 m/min and is parallel to the workpiece as shown in fig 1.

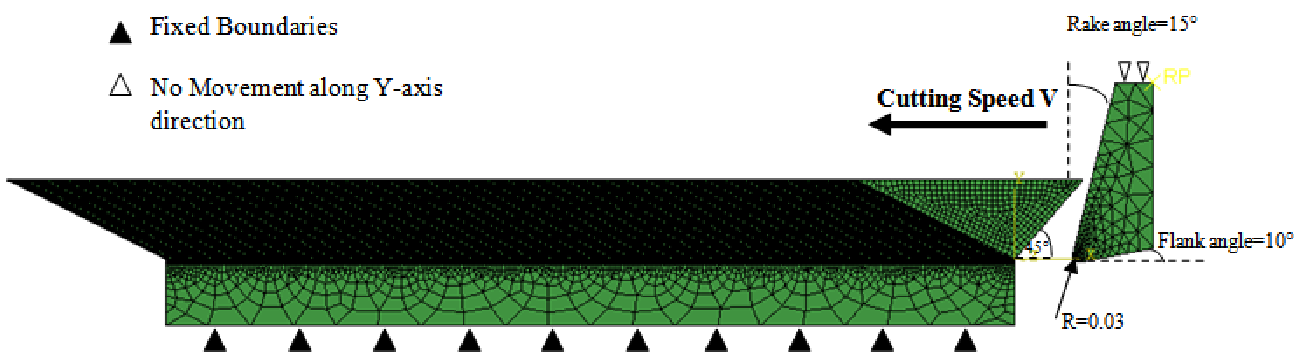

Figure 1. Finite element model for orthogonal cutting including mesh properties

The workpiece is fixed in the bottom for any movement during the cutting process. The thickness of zone A and zone B (uncut chip) was set to 0.35 mm during entire study and 0.1 mm for comparison. To optimize the better outcomes, workpiece geometry is partitioned into three distinct zones. In every zone the mesh has different qualities. The zone A will be a layer which will be evacuated by cutting and zone B, the middle layer of 0.005mm thick. The Zone A and Zone B parts relates to the machined surface as shown in fig 2. The purpose of this mesh setting is to encourage the segmented chip during machining of titanium alloys [13].

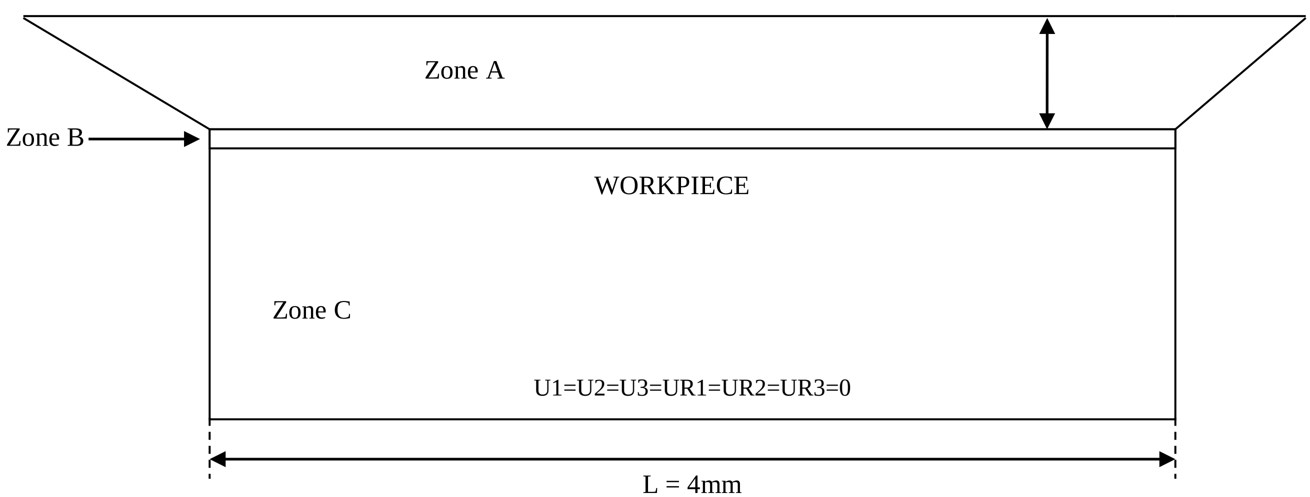

Figure 2. Finite Element model including boundary conditions

2.1 Constitutive model material

The constitutive material model of Ti6Al4V follows the JC model as expressed in eq. (1) [14].

$$\sigma = \left[A + B\bar{\varepsilon}^{n}\right]\left[1 + Cln\left(\frac{\dot{\bar{\varepsilon}}}{\dot{\bar{\varepsilon}}_0}\right)\right]\left[1 - \left(\frac{T-T_r}{T_m-T_r}\right)^{m}\right] \quad (1)$$

This provides the acceptable explanation of the ways of metals and alloys since it considers a temperature dependent visco-plasticity, vast strains and high strain rates. The Johnson-Cook material parameters of the workpiece of Ti6Al4V can be found in table 1 [15], and the constants for J-C model for Ti6Al4V is given in table: 2 [16].

Table1**.** Johnson Cook parameters of Ti6Al4V [15]

A (MPa)	B (MPa)	n	C	m
950	331	0.387	1.1	0.02

2.2 Chip separation criterion

For various programming and materials, the constitutive model way with element damage is different. According to the classical cumulative damage law, the fracture model is established and expressed by eq. (2), in which the JC fracture model has been developed [17].

$$w = \sum \frac{\Delta\bar{\varepsilon}}{\bar{\varepsilon}_f} \quad (2)$$

Where $\Delta\bar{\varepsilon}$ is the increment of equivalent plastic strain during an integration cycle and $\Delta\bar{\varepsilon}_f$ is the equivalent strain to the fracture under the conditions of strain rate temperature, pressure and equivalent stress. The general expression for the JC fracture strain is shown in eq. (3) [17].

$$\bar{\varepsilon}_f = \left[D_1 + D_2 exp\left(D_3\frac{P}{\bar{\sigma}}\right)\right]\left[1 + D_4 ln\frac{\dot{\bar{\varepsilon}}}{\dot{\bar{\varepsilon}}_0}\right]\left[1 + D_5\frac{T-T_r}{T_m-T_r}\right] \quad (3)$$

Where P is the average of three normal stresses. The ratio $\frac{P}{\bar{\sigma}}$ is reffered to as sress triaxiality. The parametersD_1, D_2, D_3, D_4, and D_5 are experimental data from (table 2).

Table 2. The constants for Johnson Cook material model for Ti6Al4V [16]

D1	D2	D3	D4	D5
-0.09	0.25	-0.5	0.014	3.87

To simulate the damage evolution during high speed machining, an energy failure criterion is used in this research [18].

3. FINITE ELEMENT SIMULATION RESULT

The chip development morphologies with high cutting speeds ranging from 200 to 5000 m/min is shown in fig 3, in which the distributions of equivalent plastic strain (PEEQ) can also be seen. As the cutting velocity increases, the chip serration is increased until the chip morphology evolving to unit at the cutting speed of 5,000 m/min. It can be seen that the highest strain in the PEEQ distributions decreases from 5.920 to 3.102 with the increase of cutting speed from 200 to 5000 m/min. From fig.3. it can also be noticed that at the speed of 200 m/min the plastic strain is more serious, as the speed increases the material becomes more brittle and cause the discontinuous chips. The mechanism to this result is that the material property changes from plastic to brittle under higher cutting speed [19]. This mechanism also explains why the chip evolves from continuous to serrate until it is fractured completely.

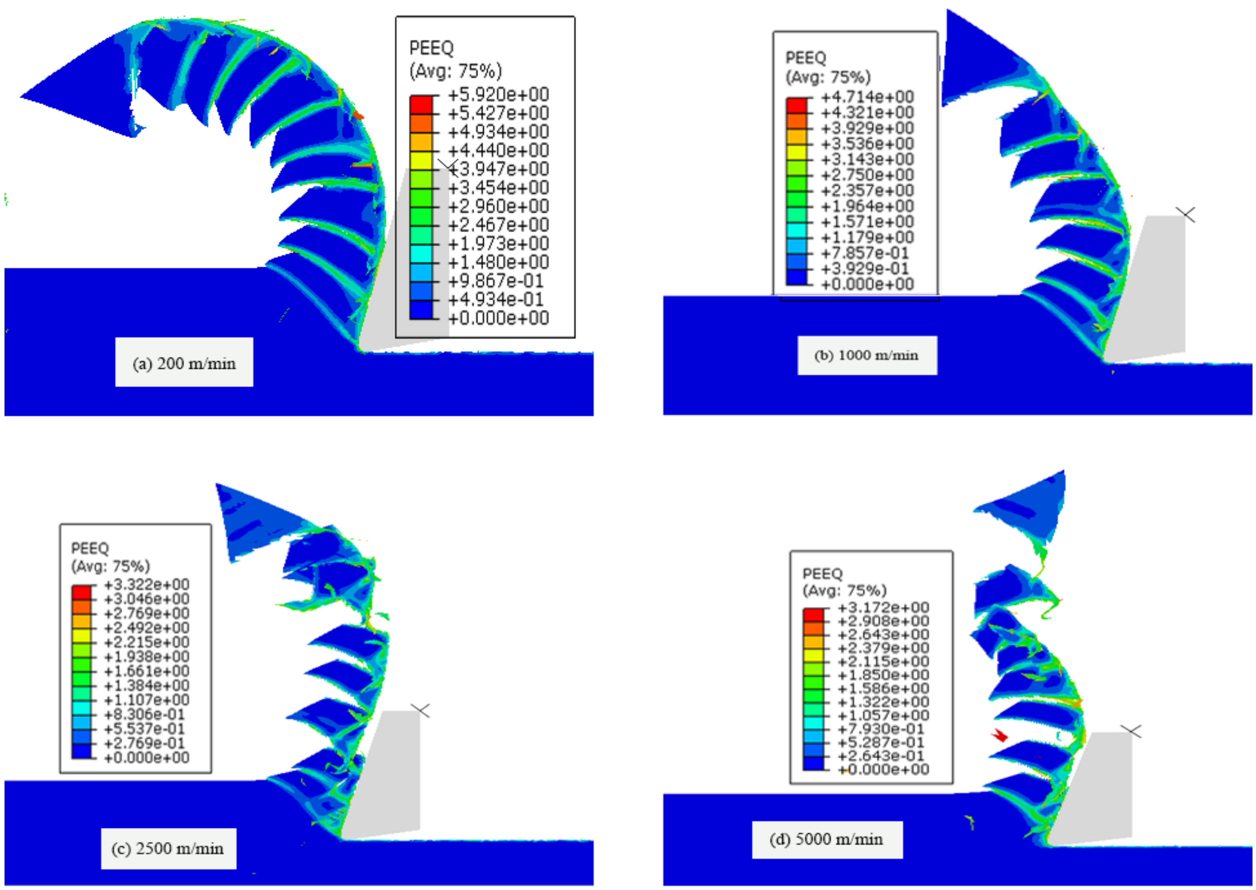

Figure 3. Variation in chip segments under different cutting speeds

Fig.4 shows the speed and temperature graph, which explains that increasing of the cutting speed from 200 to 5000 m/min cause the decrease in temperature from 1173 °C to 1045 °C due to the segmented chip at maximum speed. It can be seen that the fluctuation occurs due to the cyclic generation of the shear band in the serrated chips during high speed machining.

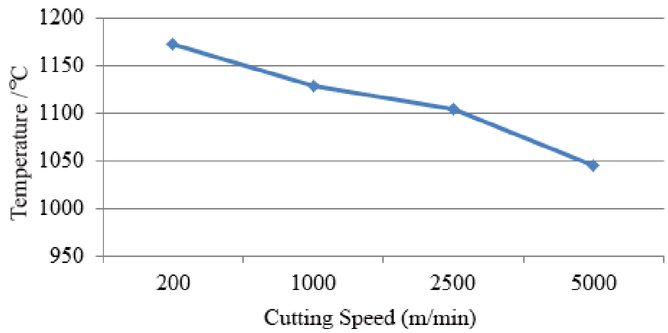

Figure 4. Cutting Temperature during high speed cutting on different cutting velocities

The average cutting force variation under different cutting velocities has been analyzed as shown in fig.5. It can be deduced that the cutting force decreases with the increase of cutting speed. It is a good advantage of decreasing the cutting force in high speed machining when the cutting speed is high.

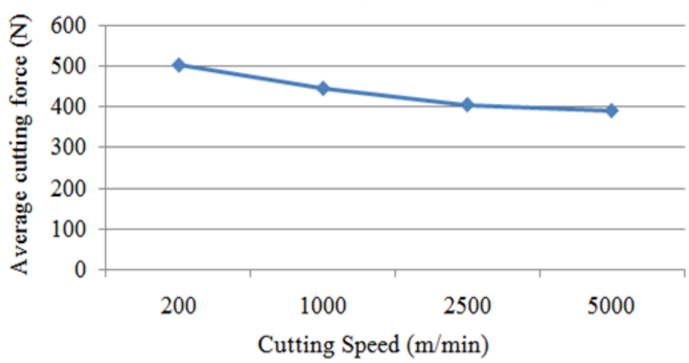

Fig.5. Average cutting force under various cutting speeds

3.1 comparison with other researchers

The numerical results obtained from simulation in this research and compared with experimental results gathered from [20]. Fig.6 shows that the experimental cutting force is higher than the simulation results. Wang [20] used the cutting speed up to 3000 m/min and un-deformed chip thickness 0.1 mm. To validate the result, simulation were designed based on 0.1 mm un-deformed chip thickness and speed up to 3000 m/min. In this research the maximum cutting speed of 5000 m/min is used to observe the cutting force. By comparing both results up to 3000 m/min. It is observed that the experimental cutting force is higher than that of simulation cutting force, the main reason is that the cutting tool has some radius on its edge in the simulation process where as the sharp edge tip cutting tool were used in the experiment.

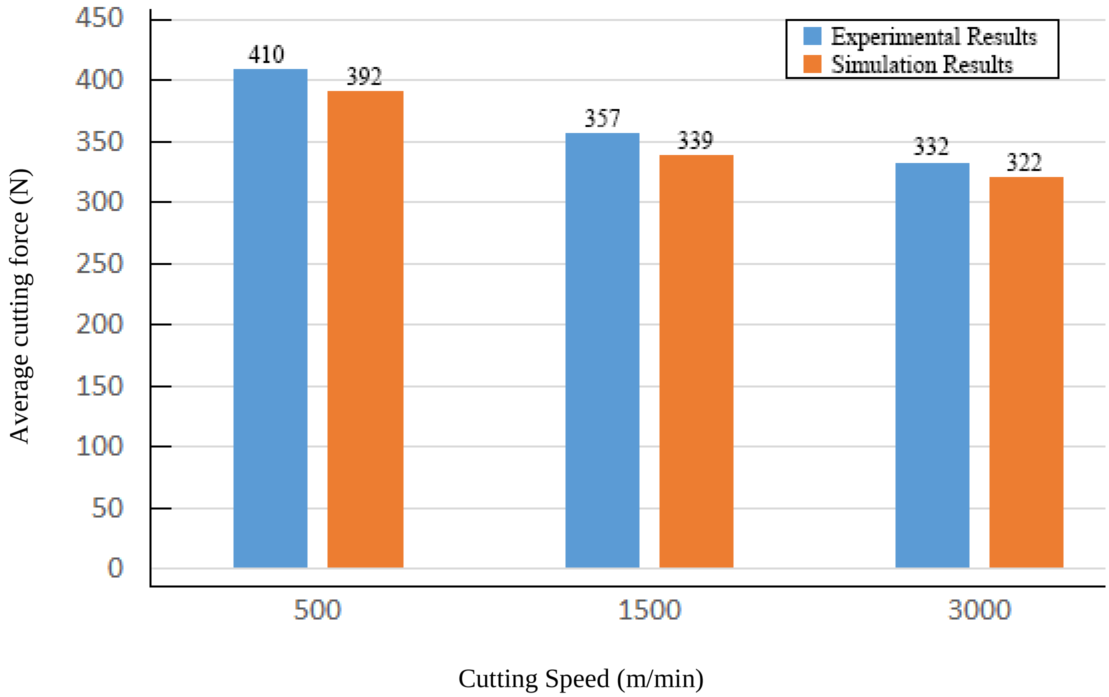

Figure 6, Comparison cutting force under different cutting speeds [20]

4. CONCLUSION

It has been seen that the machining is an important and complex process still in development; the machining simulation provides better understanding and help the industries and universities to find a proper state of the phenomena involved. Among all the morphology of chip and the effect of cutting parameters were observed. Some concluding’s are:

The increasing of cutting speed cause the chip serrated degree increases until it tends to one in which the chip is become fragmented. For the orthogonal cutting process of titanium alloys the critical turning point of chip from serrated to segment is near 5000 m/min.

The serrated chip frequency has positive connection with the cutting speed. When the chip morphology becomes unity, the serrated frequency could not be used to describe the geometric characteristic of chip.

References

[1] Arrazolaa PJ, Garaya A, Iriarte LM, Armendiaa M, Maryab S, Maitrec FL (2009) Machinability of titanium alloys (Ti6Al4V and Ti555.3). J master Process tech 209:2223-2230.

[2] Puerta Velasquez JD, Bolle B, Chevrier P, Geandier G, Tidu A (2007) Metallurigical study on chips obtained by high speed machining of a ti6AL-4V alloy. Mater Sci Eng A 452-453:469-474.

[3] Sun S, Brandt M, Dargusch MS. Characteristics of cutting forces and chip formation in machining of titanium alloys. Int J Mach Tools Manuf 2009:49:561-8.

[4] Cottrell M. Byrne G. Dynamics of Chip formation during orthogonal cutting of titanium alloy Ti-6Al-4V. CIRP Ann-Manuf Technol 2008:196:79-87.

[5] Sutter G, List G (2013) very high speed cutting of Ti-6Al-4V titanium alloy-change in morphology and mechanism of chip formation. Int J Mach Tools Manuf 66:37-43.

[6] Hosseini E, Kazeminezhad M (2011) Implementation of a constitutive model in finite element method for intense deformation. Mater Des 32:487-494.

[7] Karpat Y. Temperature dependent flow softening of titanium alloy Ti6Al4V: an investigation using finite element simulation of machining, J Mater Process Technol 2011:211:737-49.

[8] Calamaz. M.; Coupart, D.; Girot, F A new material model for 2D numerical simulation of serrated chip formation when machining titanium alloy Ti-6Al-4V. International Journal of Machine tools and manufacture, v.48, pp.275-288,

[9] Sima, M.; Ozel, T. Modified material constitutive models for serrated chip formation simulations and experimental validation in machining of titanium alloy Ti-6Al-4V, International Journal of Machine Tools and manufacture 50 (11) pp.943-960,2010

[10] Vijay Sekar, K.S.; Kumar, M.P. Finite element simulation of Ti6Al4V titanium alloy machining to assess material model parameters of the Johnson-Cook constitutive equation. Journal of Brazilian society of Mechanical Science & Engineering, v.23, n.2, 2011.

[11] Escamilla, I.; Zapata, O.; Gonzalez, B.; Gamez, N.; Guerrero, M. 3D finite element simulation of the milling process of a Ti6Al4V alloy. Simula Customer Conference. Providence, Rhode Island. USA. 2010.

[12] Subbiah S, Melkote SN (2008) Effect of finite edge radious on ductile fracture ahead of the cutting tool edge in micro-cutting of Al2024T3. Mater Sci Eng A 474:283-300.

[13] Hortig C, Svendsen B. Simulation of chip formation during high speed cutting J Mater Process. Technol 2007: 186:66-76.

[14] Johnson GR, Cook WH (1983) A constitutive model and data for metals subject to large strains, high strain rates and high temperatures. Proc. of the 7th international symposium on ballistics, the Hugeue, pp 31-48.

[15] G. Germain, A. Morel, T. Brahm-Bouchnak (2013) Identification of material constitutive laws representative of machining conditions for two titanium alloys: Ti6Al4V and Ti555-3.

[16] Johnson GR, Holmquist TJ (1989) test data and computational strengthen and fracture model constants for 23 materials subjected to large strain, high-strain rates, and high temperatures. Los Almos National Laboratory, LA-11463-MS.

[17] Johnson GR, Cook WH (1985) Fracture characteristics of three metals subjected to various strains, strain rates, temperatures and pressures. Eng Fract Mech 21:31-48.

[18] Hillerborg A, Modeer M, Petersson PE (1976) Analysis of crack formation and crack growth in concrete by means of fracture mechanics and finite elements. Cem Concr Res 6:773-781.

[19] Liu ZQ, su GS (2012) Characteristics of chip evolution with elevating cutting speed from low to very high. Int J Mach Tool Manuf 54-55:82-85.

[20] Bing Wang, Liu Zhanqiang (2014), Investigations on the chip formation mechanism and shear localization sensitivity of high-speed machining Ti6Al4V.

Assessment of Economic factors for sustainable construction industry

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Abstract: In developed countries construction industry contributes around 9.9 % to the GDP, where as in Pakistan it is around 2.4 %. Moreover, construction industry worldwide engages multiple industrial sectors and majority of the labor forces. Any positive or negative change directly or indirectly effect the whole economic fabric of a country. Sustainability, therefore becomes an important aspect to safeguard the current and future generation demands, requirements and other needs. It is therefore important to identify and assess the different factors associated with economic sustainability. A thorough literature review is conducted to identify different economic factors. A questionnaire based survey is conducted to evaluate the identified factors, and then the statistical measures are used to evaluate and rank these factors. The analysis shows that Raw material, Fuel, and Transportation costs are the most significant economic factors.

Keywords: *Sustainability; GDP (Gross Development Product); Economic Sustainability; Construction Industry.*

1. INTRODUCTION

Sustainability or Sustainable development has been commonly defined as “Economic and social development that meets the needs of the current generation without compromising the ability of future generations to meet their own needs" (Sultan 2005). Construction is large, dynamic, and complex sector that plays an important role in the country GDP. Construction workers and employers build roads, houses, work places etc.; and also repair and maintain our national physical infrastructure. Construction work can involve buildings of new structure, which may include subdividing land for sale as a buildings sites or preparation for new construction (Moavenzadeh and Rossow 1935).

Sustainable construction provides smarter buildings (optimize technological performance), improve internal environmental quality, and minimizing the economic impact throughout the life cycle of the building (Drexhage and Murphy 2010). So, the managers and engineers should focus on sustainable construction. In order to reduce the economic unsustainability of construction activities, one has to identify the root cause and develop an appropriate model applicable across the globe. To overcome the increasing concern of today's resource depletion and to address economic considerations of developing countries, like Pakistan, Analytical Hierarchical Process (AHP) can be applied for decision making in order to identify the factors affecting the sustainability of construction industry.

The aim of this research is to access the different construction industries and identify the significant factors that effects the economic sustainability. The factors are ranked on the basis of AHP Eigen values.

2. LITERATURE REVIEW

In recent years, different techniques such as, life cycle assessment techniques (LCA) in the assessment of sustainability (Gundes 2016), Modified Delphi method (Lau, Wandersman et al. 2016), Analytical Network Process (Hussain, Awasthi et al. 2016), Analytical Hierarchical Process (AHP) (Calabrese, Costa et al. 2016), are used for the analysis/evaluation of factors and selection of best alternatives. Gundes (2016) worked on two life cycle techniques namely Life Cycle Cost (LCC) & Life Cycle Assessment (LCA) in the assessment of sustainability. LCC with the help of cost analysis includes economic factors in the assessment of sustainability. Whereas LCA is used to evaluate the potential environmental impacts of a product/process during entre life cycle. The researcher tried to integrate the LCC and LCA techniques, but the need for a clear, systematic and standard methodology for integrating the economic, environmental and social impact assessments still remains unfulfilled. It measures only the environmental performance excellently, like the consumption of natural inputs and emissions to nature by production processes (Gundes 2016). Turnbull et al. (2016) used modified Delphi method to develop a list of non-emergent interventions commonly used in Intensive Care Units (ICUs), which requires a clear understanding of treatment's goals. Researchers conducted a three-round modified Delphi process via panel consisting's, of 6 physicians, 6 ICU nurses, 6 former ICU patients, and 6 family members. About Eight interventions are achieved i.e. Clinical and patient/family participants are the two significant factors were able to identify sensitive decisions that should trigger in decision making. Donohoe et al. (2012) said it is useful for specific, single-dimension question and fail to support when there are complex problems with multiple factors.

AHP is a structure technique for analysis of complex decisions and a multi criteria decision making method that was originally developed by Prof. Thomas L. Saaty in 1980. This method derive ratio scales from paired wise comparisons (Barczak, Batako et al. 2010). Recently, Liaghati et al. (2016) have worked on developing an ethics-based approach to indicators of sustainable agriculture using AHP. The developed hierarchical network has two levels for selection from among the three ethical approaches, which were developed based on the general tenets of utilitarian, rights, and virtue models. The findings indicated that criteria, i.e. resilience of agricultural systems, supportive policies and self-reliance, and equity, are the most important criteria for sustainable agriculture in Iran. Finally, he obtained two strategies for developing a macro ethics approach: namely informational strategies and structural strategies. AHP is multi-attribute approach that has been applied for formulating and analyzing unstructured problems in a variety of decision making situations ranging from simple personal decisions to complex (Liaghati 2016). This is the reason AHP is selected for this research.

According to Omair et al. (2015) there are basically three steps involved in this process: (1) to set an overall objective. (2) Define a criteria (indicators), on which alternatives are to be selected. (3) To pick an alternative, in which the best one is to be selected. One of the method used to solve AHP is called Square Matrix Method. Square Matrix Method is used for higher order matrices i.e. may be used for more than 15 factors. In this research we will go through square matrix method, because there are more than 15 factors identified Omair et al. (2015). Sustainable Construction requires a long term view, considering initial capital cost, against running costs of the structure. The major economic benefits of sustainable construction are to reduce operation and utility costs, maintenance costs, and an overall improvement in the buildings performance and efficiency (Ugwu et al. 2007). Different researchers have worked on sustainability. Table 1 summarizes the research work done by different researchers.

Table 1. Literature Reviews

S.No	Title	Aims/Objective	Method used	Inputs	Conclusion	Remarks
1	A review of construction companies' attitudes to sustainability (Myers 2005)	To determine attitudes to sustainability and in a large part these were gauged by the reporting of corporate social responsibility and Associated issues.	Using Integrated Management Systems (IMS), combining ISO 14001 (Environment), OHSAS 18001 (Health & Safety), and ISO 9001–2000 (Quality)	Annual reports of CSR	The conclusion is that even though the construction industry has its own sustainability agenda, Relatively few companies have changed their business paradigm.	Identification of sustainability factors
2	The construction industry in Yemen-towards economic sustainability (Sultan 2005)	To examine construction industries and industries contribution to nation's overall economy	To identify sustainability indicators and to select an indicator set, Delphi method	Experts (civil engineers, architects, consultants etc.), questionnaire survey	Discuss issues in Yemen construction industries and bring awareness of new era of sustainable development	Limited to Yemen construction industries,

3	Role of Construction Sector in Economic Growth: Empirical Evidence from Pakistan Economy (Khan 2008)	To examine the contribution of construction sector in Pak economy and identification of relationship with economic growth	1) Leontief's (1936) Input-Output Analysis 2) The new econometric Methodology developed by Engle and Granger, Unit root test	A time- series model, annual data (1950-2005), Monte Carlo Simulation	Granger Causality indicated that there is unidirectional relationship between construction industry and aggregate economy of Pakistan	To identify the major issues affecting the efficiency of construction sector and take corrective action to increase in economic growth
4	A methodology to identify sustainability indicators in construction projects in Spain (Fernandez et al. 2010)	To propose a methodology for selecting indicators, which will be developed by all stakeholders, thus reducing the subjectivity and uncertainties of the process	Techniques of project management, Pareto principle diagramming techniques i.e. Ishikawa diagrams, systems Diagrams	Experts, Compilation of information through interviews, Brainstorming, Analysis by checklists, questionnaires	Identify sustainability indicators and to select an indicator set.	Validating questionnaire and expert experience
5	Sustainable manufacturing: Modelling and optimization challenges at the product, process and system levels (Jayal et al. 2010)	An overview of recent trends and new concepts in the development of sustainable Products, processes and systems.	Scoring techniques, LIFE CYCLE ASSESSMENT TECHINIQUES (LCA), AHP	Processes, machines, cost factors, environmental, social, & economic factors	optimization techniques for sustainable manufacturing processes, focusing on dry, near-dry and cryogenic machining as examples, Are presented.	Limited to manufacturing industries, only show the presentation of techniques not the actual data
6	Sustainable development tool for Khyber Pakhtunkhwa's dimension stone industry (Omair et al. 2015)	Identification of relevant product, and indicators in terms of parameters using MS Excel for measuring sustainability of dimension stone industry	Statistical analysis, Framework development	Engineers, Experts, & Questionnaire	Significant parameters have been obtained on the basis of economic, societal and environmental factors in life cycle of dimension stone product.	LCC and LCA tools can be used for cost analysis using the identified parameters
7	Evaluation of Factors affecting the Quality of Construction Projects (Abas et al. 2015)	To identify the success and adverse factors that have significant effect on quality performance of construction projects of Pakistan.	A statistical analysis tool such as chi-square and weighted mean method (WMM) were used	Experts, Consultants, Questionnaire	Critical factors are identified. The critical factors identified are continuous improvement, joint working, communication, technical person availability, and procurement unit of the contractor.	Limited to quality of construction projects, can be used for sustainability analysis of construction projects
8	Identification and Evaluation of Risk Factors Affecting the Supply Chain Environment of Construction Industry of Khyber Pakhtunkhwa (KPK) (Khattak et al. 2015)	This research work addresses and highlights external factors affecting different performance indicators (Cost, Quality and Time).	Analytical Hierarchy Process (AHP) is used	Questionnaire based	In this research the effect of external factors on key performance indicator (Cost, Quality and Time) of the construction projects is assessed.	This can be extended to manufacturing industries, service industries etc.

As shown in Table 1, multi dimension research has been carried out to identify the factors associated with sustainability and construction. Sultan (2005) worked on economic sustainability of Yemen construction industry using Delphi method. Delphi Method was used to identify sustainability indicators & select an indicator set. Table 2 enlist the economic factors identified from literature review. A total of 23 factors are selected. The factors are extracted from the literature cited in Table 1.

Table 2. Identified Factors

S.No	Identified Factors	S.No	Identified Factors
A	Raw material cost	**M**	Electricity consumption
B	Operating cost	**N**	Heating Consumption
C	Capital cost	**O**	Energy consumption in processing a ton of raw material
D	Employee wages and benefits	**P**	Transportation cost
E	Payments to providers of capital	**Q**	Maintenance cost
F	Payments to government (taxes/month)	**R**	Total fuel consumption
G	Costs of managing risks/ opportunity	**S**	The procurement budget used for significant locations of operation
H	Employees hired on the minimum wages	**T**	Consumer injury cost
I	Minimum wage of employee/ month	**U**	Sustainable construction methods result in increased capital costs
J	Tax relief and tax credits given to your organization by the government	**V**	Awareness of government incentive schemes on sustainability
K	Extent to which development infrastructure investments are supported	**W**	Opinion that sustainable construction could be achieved without increased capital costs
L	Investments used in enhancing skills and knowledge among professional community/year		

Factors are verified from expert in a group discussion session. The selected factor as shown in Table 2 were shared with both academic and construction practioners. A total of five experts were consulted. The objective of the group discussion was to ensure that the selected factors are also applicable to Pakistan and especially KPK construction projects and firms. Since the inaugural international conference on sustainable construction, in Tampa, USA in 1994, sustainable “green” building has become a significant global issue. A large number of pioneering projects have proved that green buildings can provide a far more comfortable, healthy, living and working environment for their end users (Dobson, Sourani et al. 2013). Infrastructure projects have significant impact on a sustainable construction environment. Civil engineering infrastructure differs from other structures such as buildings for which there are sustainability assessment tools available (Ikediashi et al. 2016). Several researches has been initiated related to sustainability and environment in general. In South Africa, there have been some projects that focused on investigating different aspects of sustainability within the local context. Examples include socio-economic aspects at the planning stages (Talukhaba et al. 2005), health safety in construction (Haupt et al. 2005), and environment sustainability in affordable housing (Dalgliesh et al. 1997). Other researchers investigated the sustainable development of aviation transportation infrastructure at the African continental level (Rhoades 2004).

3. METHODOLOGY

The literature review and discussion with experts assisted in identifying the factors related to sustainability in construction industries. A review was conducted using literature on sustainability research and questionnaire-based survey for indicators validation. Figure 1 shows the methodology of the project (how the research objective is achieved).

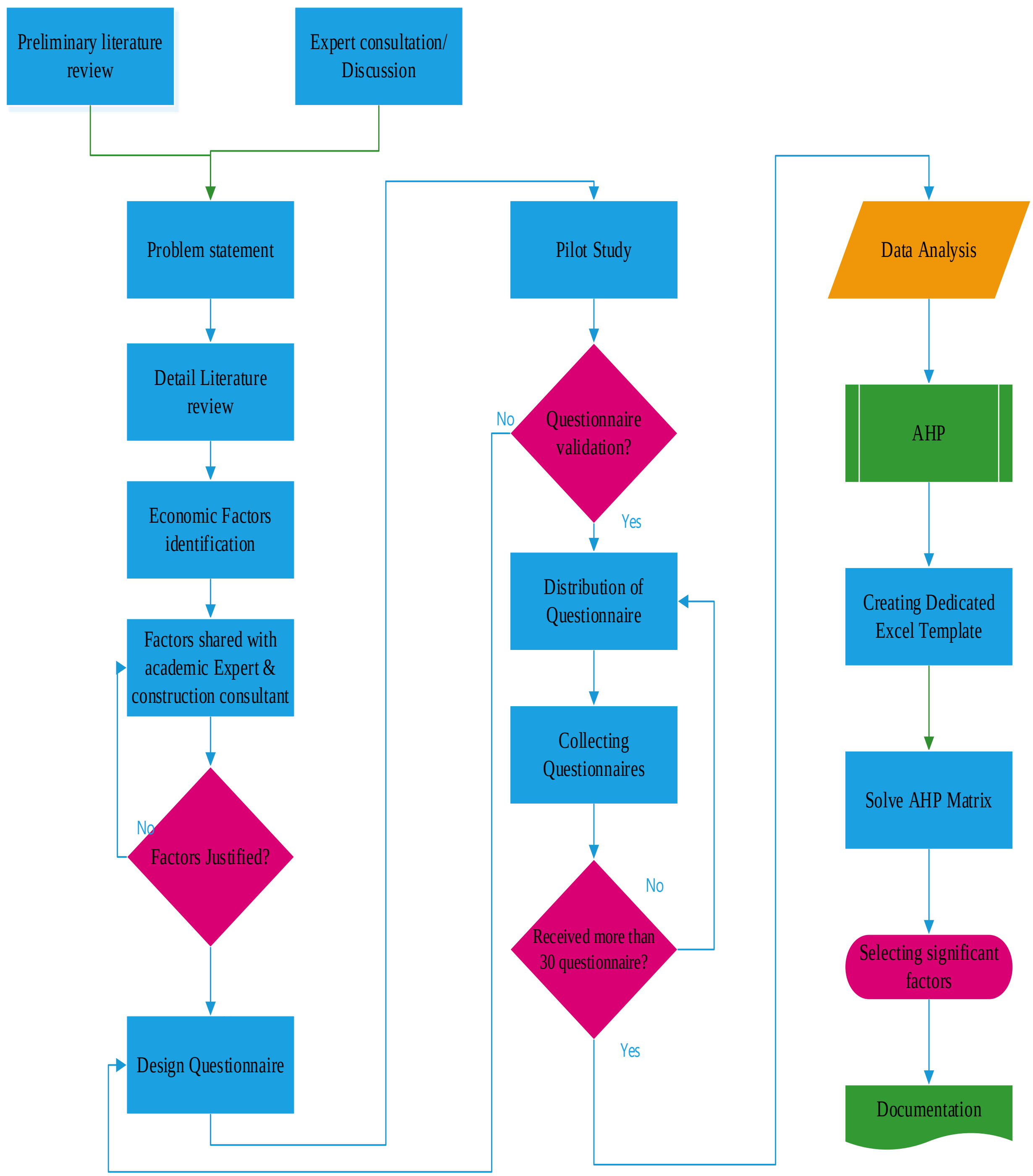

Figure 1. Methodology flowchart

Figure 1 shows the methodology used for this research. Different techniques and article associated with sustainable production were reviewed. After preliminary literature review, problem statement was defined. It was discussed and finalized in consultation with academic and construction experts. Around twenty-three (23) economic factors as shown in Table 2 were identified through a comprehensive literature review.

A pilot study was conducted by distributing the initial questionnaire to a panels of experts. The first panel, which consisted of experts in the field of contracting, was asked to verify and validate the questionnaire topics and its relevance to the research objective. The second panel, which consisted of two experts in the statistics, was asked to identify that the instrument used was valid statistically and that the questions was designed well enough to provide relations and tests among variables. Expert's comments and suggestions were gathered and evaluated carefully. At the end of this process, some minor changes, modifications and additions were incorporated to the questionnaire and the final questionnaire was designed. Then questionnaire was distributed and data analysis was performed when the number of received questionnaires reached 30.

Data analysis was done through Analytical hierarchical process (AHP) using Microsoft Excel. After solving AHP matrices significant economic factors were identified. The result compilation and documentation was done at the end. The designed questionnaire had two sections. The first section was related to information about the respondent profiles such as- name, designation, qualification, and address. The second section included important weights assigned to identified factors. Weights were on the scale of 0-5, whereas 0 shows not applicable (N/A), 1(very low), 2(low), 3(moderate), 4(high), and 5(very high).

Different respondents were selected from Pakistan Engineering Council (PEC) database. The top four categories as per PEC are Class A (CA), Class B (CB), Class1 (C1) and Class (C2). The questionnaire was shared with CA, CB, C1, and C2 category contractors. The designed questionnaire was shared with about 70 respondents. Also series of discussion sessions were arranged with project managers and site engineers, and executive's engineers of firms and the responses were noted during the session. Around 40 questionnaires were received out of which 10 were rejected due to lack of information. So the response ratio of the received questionnaires is 42.86%.

3.1. Conducting an Item Analysis for Data Validation

For validity and reliability, item analysis for the collected data is necessary. This is important because the data is collected independently from different organizations and different practitioners, so there may be chance of differences in their responses. For item analysis, Cronbach's alpha test was conducted using Minitab software. Table 3 shows the reliability of data, which is being collected. This statistic is an overall item correlation where the values range between 0 and 1. Value above 0.7 is considered to be acceptable (Gliem 2003). As the Cronbach's alpha value is greater than 0.7, so by definition data collected is highly reliable.

Table 3. Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized items	N of items
0.9833	0.9533	30

4. DATA ANALYSIS

The data collected is analysed by the method known as Analytical Hierarchical Process (AHP). This process is used to evaluate the factors and identifying the significant factors. Basically there are two techniques/methods used to solve AHP. First one is consistency ratio method and the second is square matrix method. Consistency ratio method is very common but it is applicable to 15x15 matrix only whereas square matrix method is used for higher order matrices. As there are 23 factors identified, so square matrix method is used to carry out the analysis.

4.1. Square matrix method

Square matrix method is used for analysis of more than 15 factors. The procedure to solve it by square matrix method is shown below;

Step 1: Factors in rows are being compared to the factors in columns. The values are inserted in the matrix like from to chart. The values are inserted in such a way that the column values are in numerator while row values are in denominator.

Step 2: Square the matrix obtained in step 1 and new resultant matrix will be obtained.

Step 3: Normalize the matrix by first row wise addition and then sum the values obtained column wise (total sum will be obtained). Then divide each value in column by the total sum, the values obtained will be normalized values.

Step 4: Again square the matrix obtained in step 2. Repeat the process described in step 3 for normalizing the values.

Step 5: Take difference between normalize values of step 2 and step 1. If the difference is 0 (zero) in each row, then stop the process. The normalized values obtained in last matrix will be the Eigen values of all the factors.

4.2. Procedure to Solve AHP on Excel

Applying the Square Matrix Method, the calculation for economic factors by using the above steps is shown below. There are 23 factors, so the matrix obtained will be of order 23x23.

In Table 4, Criteria in the row are being compared to the criteria in the column. The below table is MS Excel template for AHP based on step 1. The values are inserted in the matrix like "from to chart". The row values are in numerator while columns values are in denominator. The values in numerator and denominator are the mean values of the factors obtained from questionnaire.

Table 4. Pairwise Comparison (Input Matrix)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
A	1	1.114	1.067	1.309	1.076	1.351	1.38	1.84	1.46	1.443	1.427	1.549	1.114	1.427	1.04	1.024	1.175	1.008	1.814	1.512	1.124	1.716	1.46
B	0.897	1	0.958	1.175	0.966	1.213	1.239	1.652	1.31	1.296	1.281	1.39	1	1.281	0.934	0.919	1.055	0.905	1.628	1.357	1	1.54	1.31
C	0.937	1.044	1	1.227	1.009	1.266	1.293	1.724	1.368	1.353	1.337	1.452	1.044	1.337	0.975	0.96	1.101	0.945	1.7	1.417	1.053	1.608	1.368
D	0.763	0.851	0.815	1	0.822	1.032	1.054	1.405	1.115	1.102	1.09	1.183	0.851	1.09	0.794	0.782	0.898	0.77	1.385	1.155	0.858	1.311	1.115
E	0.929	1.035	0.991	1.217	1	1.255	1.282	1.71	1.356	1.341	1.326	1.439	1.035	1.326	0.967	0.952	1.092	0.936	1.685	1.405	1.044	1.594	1.356
F	0.74	0.824	0.79	0.969	0.797	1	1.022	1.362	1.08	1.068	1.056	1.146	0.824	1.056	0.77	0.758	0.87	0.746	1.342	1.119	0.832	1.27	1.08
G	0.724	0.807	0.773	0.949	0.78	0.979	1	1.333	1.058	1.046	1.034	1.122	0.807	1.034	0.754	0.742	0.851	0.73	1.314	1.095	0.814	1.243	1.058
H	0.543	0.605	0.58	0.711	0.585	0.734	0.75	1	0.793	0.784	0.775	0.842	0.605	0.775	0.565	0.556	0.638	0.548	0.985	0.821	0.611	0.932	0.793
I	0.685	0.763	0.731	0.897	0.737	0.926	0.946	1.26	1	0.989	0.977	1.061	0.763	0.977	0.713	0.702	0.805	0.69	1.243	1.036	0.77	1.176	1
J	0.692	0.772	0.739	0.907	0.746	0.936	0.956	1.275	1.011	1	0.989	1.073	0.772	0.989	0.721	0.71	0.814	0.698	1.257	1.048	0.779	1.189	1.011
K	0.7	0.781	0.748	0.918	0.754	0.947	0.967	1.29	1.023	1.012	1	1.086	0.781	1	0.729	0.718	0.824	0.706	1.271	1.06	0.788	1.203	1.023
L	0.645	0.719	0.689	0.845	0.695	0.872	0.891	1.188	0.942	0.932	0.921	1	0.719	0.921	0.672	0.661	0.759	0.651	1.171	0.976	0.726	1.108	0.942
M	0.897	1	0.958	1.175	0.966	1.213	1.239	1.652	1.31	1.296	1.281	1.39	1	1.281	0.934	0.919	1.055	0.905	1.628	1.357	1.009	1.54	1.31
N	0.7	0.781	0.748	0.918	0.754	0.947	0.967	1.29	1.023	1.012	1	1.086	0.781	1	0.729	0.718	0.824	0.706	1.271	1.06	0.788	1.203	1.023
O	0.96	1.07	1.025	1.258	1.034	1.298	1.326	1.768	1.402	1.387	1.371	1.488	1.07	1.371	1	0.984	1.129	0.968	1.743	1.453	1.08	1.649	1.402
P	0.976	1.088	1.042	1.278	1.051	1.319	1.348	1.797	1.425	1.409	1.393	1.512	1.088	1.393	1.016	1	1.148	0.984	1.771	1.476	1.097	1.675	1.425
Q	0.85	0.947	0.907	1.114	0.915	1.149	1.174	1.565	1.241	1.227	1.213	1.317	0.947	1.213	0.885	0.871	1	0.857	1.543	1.286	0.956	1.459	1.241
R	0.992	1.105	1.059	1.299	1.068	1.341	1.369	1.826	1.448	1.432	1.416	1.537	1.105	1.416	1.032	1.016	1.166	1	1.8	1.5	1.115	1.703	1.448
S	0.551	0.614	0.588	0.722	0.593	0.745	0.761	1.014	0.804	0.795	0.786	0.854	0.614	0.786	0.574	0.564	0.648	0.555	1	0.833	0.619	0.946	0.804
T	0.661	0.737	0.706	0.866	0.712	0.894	0.913	1.217	0.966	0.955	0.944	1.025	0.737	0.944	0.689	0.677	0.778	0.667	1.2	1	0.743	1.135	0.966
U	0.889	0.991	0.95	1.165	0.958	1.202	1.228	1.637	1.299	1.284	1.27	1.378	0.991	1.27	0.926	0.911	1.046	0.897	1.615	1.345	1	1.527	1.299
V	0.582	0.649	0.622	0.763	0.627	0.787	0.804	1.072	0.851	0.841	0.831	0.903	0.649	0.831	0.607	0.597	0.685	0.587	1.057	0.881	0.655	1	0.851
W	0.685	0.763	0.731	0.897	0.737	0.926	0.946	1.26	0.987	0.989	0.977	1.061	0.763	0.977	0.713	0.702	0.806	0.69	1.243	1.036	0.77	1.176	1

Table 4 shows the pairwise comparison matrix obtains from mean value of the factors and compared with each other. For example, factor A "Raw material cost" has a mean value of 4.2333 and Factor B "Operating Cost" has a mean value of 4.2000. So the ratio is 1.114. The same method is applied to all the factors.

In the next step squaring of above Table 4 is done then normalization is performed. After normalization the stopping criteria is checked by calculating the difference between normalized values of both iterations. The difference is zero and the resultant values as shown in Table 5 are the Eigen values of the economic factors.

Table 5. Weighted Preference Matrix for Economic factors

S.No.	Economic Factors	Eigen values

1	Raw material cost	0.055527
2	Total fuel consumption	0.055094
3	Transportation cost	0.054215
4	Energy consumption in processing	0.05335
5	Capital cost	0.052038
6	Payments to providers of capital	0.051592
7	Electricity consumption	0.049847
8	Operating cost	0.049847
9	Sustainable construction increased costs	0.049414
10	Maintenance cost	0.047224
11	Employee wages and benefits	0.042409
12	Payments to government (taxes/month)	0.041098
13	Costs of managing risks/ opportunity	0.040232
14	Heating Consumption	0.03892
15	What extent is the development infrastructure investments are supported	0.03892
16	Tax relief and tax credits given to your organization by the government	0.038474
17	Minimum wage of employee/ month	0.038041
18	Sustainable construction could be achieved without increased capital costs	0.038041
19	Consumer injury cost	0.03673
20	Investments used in enhancing skills and knowledge per year	0.035851
21	Awareness of government incentive schemes on sustainability	0.032361
22	The procurement budget used for significant locations of operation	0.030604
23	Employees hired on the minimum wages	0.030171

Table 5 shows the final AHP priority values in terms of Eigen values. The factors are arranged in descending order. The normalized principle Eigen vector is also called priority vectors or weighted preference matrix (Teknomo 2006). By priority/ Eigen values, it means the relative weights among the things/factors that we compare. As shown in Table 5 case raw material cost got the highest ranking with the Eigen value of 0.055527, total fuel consumption is ranked 2nd with the Eigen value of 0.055094, transportation cost is ranked 3rd with the Eigen value of 0.054215.

5. RESULTS AND DISCUSSION

As shown in Table 5, Raw material cost with a value 0.0555 is ranked first, Total fuel consumption with a value of 0.0520 is ranked second, Transportation cost with a value of 0.0542 is ranked third, Energy consumption in processing a ton of raw material with a value of 0.0533 is ranked fourth, Capital cost with a value of 0.0520 is ranked fifth, Payments to providers of capital with a value 0.0515 is ranked sixth, Operating cost with a value of 0.0498 is ranked seventh, Electricity consumption with a value of 0.0498 is ranked eighth, Sustainable construction methods result in increased capital costs with a value of 0.0494 is ranked ninth, Maintenance cost with a value of 0.0472 is ranked tenth respectively.

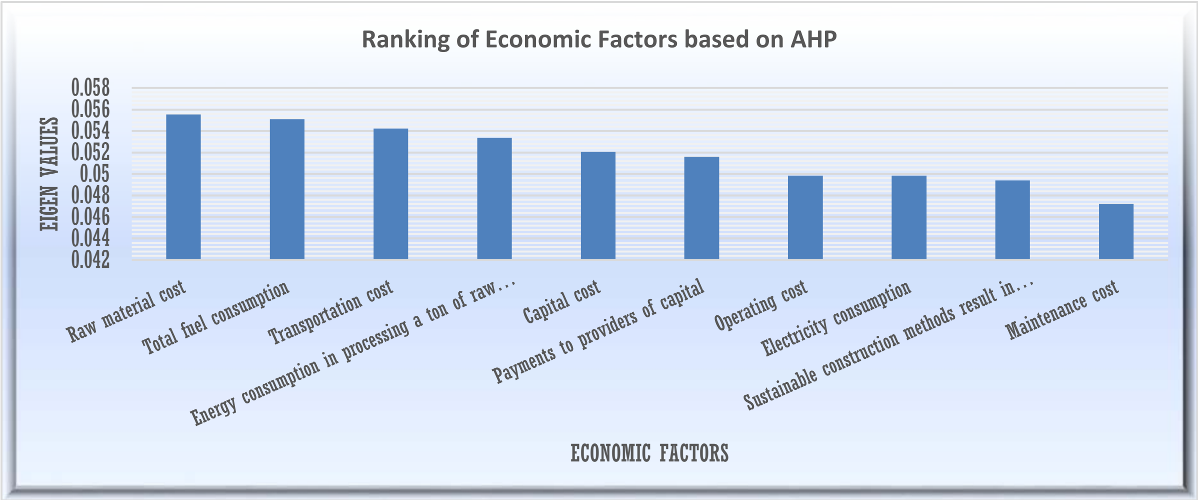

Figure 2. Top 10 Economic Factors Selected Based on AHP

The bar graph shown in Figure 2 summarizes the results for economic indicators with respect to AHP. In this Figure relative importance of the factors are discussed. Raw materials represent a major expense in construction, so timely and proper purchase policy and rules will open opportunities for reducing costs. As construction projects involves the use of different equipment and machinery, the Total fuel consumption with a value of 0.055094 was reported to second most significant factor. Transportation cost got the value of 0.054214 and is ranked third. Robust supply chain is one of the most important aspects of construction projects. It also plays a vital role in economic sustainability. This can be reduced if the construction organization has proper vendor selection mechanism. High amount of energy is required to process different types of raw materials. Energy consumption is ranked fourth. The project managers should not over process the raw materials and should avoid unnecessary processing.

Capital cost got a value of 0.052038 and is ranked fifth. Capital costs are fixed, one-time expenses incurred on the purchase of land, buildings, construction, and equipment. Project managers should not purchase unnecessary equipment etc. A payment to providers of capital got a value of 0.051592 and is ranked sixth. It can affect the construction projects economically. Sometime the government or other shareholders give loan to company for the projects. The yearly interest and dividends paid to providers of capital should be properly planned. Operating cost got the value of 0.049847 and is ranked seventh. Operating cost is incurred only when the equipment is operated. The operating cost of the equipment is influenced by various parameters namely number of operating hours, location of job site, operating conditions, category of equipment etc. Proper data logging can eliminate the redundant movements. Electricity consumption got the mean value of 0.049847 and ranked eightieth. Some companies look for indigenous solutions by having generators or small turbine system. This may increase the operating cost of the overall project as well. Construction practioners are of the view that sustainability will increase the capital cost. The factor sustainable construction increased capital cost got the value of 0.049414 and is ranked ninth. Sustainability safeguards future generations' interests. But if managers focus on the controlling of unnecessary capital cost then it will be flexible enough to do sustainable development. Maintenance cost got the value of 0.047224 and is ranked tenth. It has a vital role in the construction processes economically. Machines may slow down due to long hour operations. Total productivity maintenance may be handful to keep the machines up for most of the time. The factor employees hired on the minimum wages is the least significant factor. With a value of 0.030171, it is ranked last. In construction projects large no. of employees are hired below the minimum wages. This factor has less effect economically on construction projects but can be significant if government imposes penalties. Also social aspect of the employees should also be safeguarded.

6. CONCLUSION

Construction industrialists due to advancements in technology and techniques need to be economically competitive in market. In this research paper, we have identified the factors that affect the sustainability in construction industries economically. The significant factors identified in descending order are Raw material cost, Total fuel consumption, Transportation cost, Energy consumption in processing a ton of raw material, Capital cost, Payments to providers of capital, operating cost, Electricity consumption, Sustainable construction methods result in increased capital costs, and Maintenance cost. These factors are for any type construction including road, building, and bridges construction. The outcomes findings are distributed to the recognized construction specialists and supervisors. They can easily see the results as well as the information relevant to their industry. The EXCEL tool can help them to determine the factors they have to focus upon for enhancement of durability. They have to take initiative for ISO certification. Government should focus on improving laws related to sustainable construction.

REFERENCES

1. Abas, M., S. Khattak, I. Hussain, S. Maqsood and I. Ahmad (2015). "Evaluation of Factors affecting the Quality of Construction Projects." Journal of University of Engineering and Technology, 20 (II) (S), pp. 115-120 ISSN: 2313-7770.

2. Barczak, L., A. Batako and M. Morgan (2010). "A study of plane surface grinding under minimum quantity lubrication (MQL) conditions." International Journal of Machine Tools and Manufacture 50(11): 977-985.

3. Calabrese, A., R. Costa, N. Levialdi and T. Menichini (2016). "A fuzzy Analytic Hierarchy Process method to support materiality assessment in sustainability reporting." Journal of Cleaner Production 121: 248-264.

4. Dalgliesh, C., P. Bowen and R. Hill (1997). "Environmental sustainability in the delivery of affordable housing in South Africa." Engineering, Construction and Architectural Management 4(1): 23-39.

5. Dobson, D. W., A. Sourani, B. Sertyesilisik and A. Tunstall (2013). "Sustainable construction: analysis of its costs and benefits." American Journal of Civil Engineering and Architecture 1(2): 32-38.

6. Donohoe, H., M. Stellefson and B. Tennant (2012). "Advantages and limitations of the e-Delphi technique: Implications for health education researchers." American Journal of Health Education 43(1): 38-46.

7. Drexhage, J. and D. Murphy (2010). "Sustainable development: from Brundtland to Rio 2012. Background paper prepared for consideration by the High Level Panel on Global Sustainability at its first meeting 19 September 2010."

8. Fernández-Sánchez, G. and F. Rodríguez-López (2010)."A methodology to identify sustainability indicators in construction project management—Application to infrastructure projects in Spain."Ecological Indicators 10(6):1193-1201.

9. Gliem, R. R. and J. A. Gliem (2003). Calculating, interpreting, and reporting Cronbach's alpha reliability coefficient for Likert-type scales, Midwest Research-to-Practice Conference in Adult, Continuing, and Community Education.

10. Gundes, S. (2016). "The Use of Life Cycle Techniques in the Assessment of Sustainability." Procedia-Social and Behavioral Sciences 216: 916-922.

11. Haupt, T. C., J. Smallwood and N. Chileshe (2005). Aspects of HIV and Aids intervention strategies within the South African construction industry. Proceedings of CIBW99 working commission fourth triennial conference—rethinking and revitalizing construction safety, health and quality.

12. Hussain, M., A. Awasthi and M. K. Tiwari (2016). "Interpretive structural modeling-analytic network process integrated framework for evaluating sustainable supply chain management alternatives." Applied Mathematical Modelling 40(5): 3671-3687.

13. Ikediashi, D. I., A. C. Ogwueleka and T. Haupt (2016). "Assessing the use of ICT systems and their impact on construction project performance in the Nigerian construction industry." Journal of Engineering, Design and Technology 14(2).

14. Jayal, A., F. Badurdeen, O. Dillon and I. Jawahir (2010). "Sustainable manufacturing: Modeling and optimization challenges at the product, process and system levels." CIRP Journal of Manufacturing Science and Technology 2(3): 144-152.

15. Khan, R. A. (2008). Role of construction sector in economic growth: Empirical evidence from Pakistan economy. Proceedings of the First International Conference on Construction in Developing Countries (ICCIDC), Karachi,

Pakistan.

16. Khattak, S., M. Abas, S. Maqsood, M. Omair, R. Nawaz and I. U. Haq (2015). "Identification and Evaluation of Risk Factors Affecting the Supply Chain Environment of Construction Industry of Khyber Pukhtunkhwa (KPK)." University of Engineering and Technology (UET) Taxila, Pakistan 20(SI): 6.

17. Lau, E. Y., A. H. Wandersman and R. R. Pate (2016). "Factors influencing implementation of youth physical activity interventions: an expert perspective." Translational Journal of the American College of Sports Medicine 1(7): 60-70.

18. Moavenzadeh, F. and J. A. K. Rossow (1935). "BIBLIOGRAPHIC INPUT SHEET." Proceedings of the MoT.T. Symposium on Strategies for A.I.D. 3.

19. Myers, D. (2005). "A review of construction companies' attitudes to sustainability." Construction Management and Economics 23(8): 781-785.

20. Omair, M., S. Noor, I. Hussain, S. Maqsood, S. Khattak, R. Akhtar and I. U. Haq (2015). "Sustainable development tool for Khyber Pakhtunkhwa’s dimension stone industry." Technical journal, University of Engineering and Technology, Taxila 20: 160-165.

21. Rhoades, D. L. (2004). "Sustainable development in African civil aviation: problems and policies." International Journal of Technology, Policy and Management 4(1): 28-43.

22. Sultan, B. M. (2005). The construction industry in Yemen: Towards economic sustainability, Queensland University of Technology.

23. Talukhaba, A., A. Ngowi and K. Letlape (2005). Implementation of socioeconomic sustainability in construction projects at the planning stage in developing countries. Proceedings, CIBW99 working commission fourth triennial conference—rethinking and revitalizing construction safety, health and quality.

24. Teknomo, K. (2006). "Analytic hierarchy process (AHP) tutorial." Retrieved on January 11: 2011.

25. Turnbull, A. E., S. K. Sahetya and D. M. Needham (2016). "Aligning critical care interventions with patient goals: A modified Delphi study." Heart & Lung: The Journal of Acute and Critical Care 45(6): 517-524.

26. Ugwu, O. and T. Haupt (2007). "Key performance indicators and assessment methods for infrastructure sustainability—a South African construction industry perspective." Building and Environment 42(2): 665-680.

27. Veisi, H., H. Liaghati and A. Alipour (2016). "Developing an ethics-based approach to indicators of sustainable agriculture using analytic hierarchy process (AHP)." Ecological Indicators 60: 644-654.

RISK ASSESSMENT FOR CONSTRUCTION AND INTERDEPENDENT INDUSTRIES

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Abstract: Natural disasters such as earthquakes have the potential to cause physical disruption to an infrastructure system and is one of the most frequently occurring natural disasters in Pakistan. This paper discusses the losses due to earthquakes in North West province of Pakistan named Khyber Pakhtunkhwa (KPK). Dynamic Inoperability Input Output Model (DIIM) is used to estimate the losses. DIIM is based on Leontief input output model. One of the consequence is workforce reduction, which results in low production. This paper relates workforce directly to production therefore its reduction become critical. The losses depend upon the intensity of an earthquake. Construction industry is also interrelated with other industries, therefore, other industries will also be affected by an earthquake. This paper uses the interdependency matrix to estimate the losses occur due to interrelationship of other industries. The extended methodology is capable of identifying critical workforce availability on the basis of inoperability. Inoperability measures the normalized loss of each sector as a proportion of its total production output and is known as economic loss, which measures the monetary worth of the reduced production of a sector. Economic losses estimation provides a platform for contingency plans.

Keywords: Risk assessment, Construction, DIIM, Interdependency, KPK

1. INTRODUCTION

In construction industry, any type of disaster can lead to a big loss. Many tools are available to minimize its effect but still it needs improvement in order to take full control. Natural disasters are one of the most disruptive risks. Large intensity natural disasters can cause huge losses to an organization. The objective of this paper is to prepare a framework that could minimize the losses occurring from a natural disaster as well as to assess the risk by reactive approach to estimate the economic loss of a specific industry. These economic losses occur due to inoperability by absenteeism.

In Pakistan, earthquake and flood are frequent natural disasters. According to ((NDMA) 2011), $6 million of losses occurs due to earthquake in Pakistan. According to the report published by ((NDMA) 2011), the most affected area by the earthquake in Pakistan is Khyber Pakhtunkhwa (KP). Besides human losses, earthquake also disrupts the industries as well. This paper scope is limited to the analysis of KPK based construction projects.

Construction industry involves sub-industries such as cement, furniture, stone, bricks and marble industry etc. Every sub-industry has its supplies, demands and customers on the basis of interdependency. These sub industries also have supplies and demand from other sectors such as an agriculture and manufacturing etc. In this paper the demands of all the sub-industries from other sectors/industries has taken combined and named "demand of construction industry". The monetary value of these demands is determined. The supplies of all the sub-industries from other sectors/industries have taken combined and named as "supplies of the construction industry". The supplies and demands of construction industry from other seven industries/sectors of KPK are also analyzed.

This paper assumes constant production. Additionally, the concept of bottleneck is ignored. The demand can be varied by considering the other factors. It is applicable in the areas where workforce is taken as the key factor in the production of demand. The earthquake causes absenteeism of the workforce and is related to the intensity of the earthquake. The more the intensity is, the more disruptions will be occurring and large workforce will be absent. The number of employees working in construction industry might vary from time by time but this paper assumes a fix value.

2. LITERATURE REVIEW

Construction industry involved more risks as compared to other industries (Zou, Zhang et al. 2006). Various factors can lead a project towards risk. The working environment and complexity may change any time due to many stakeholders (Zou, Zhang et al. 2006, Meng 2010). Construction projects involve large amount of money which increases the chance of losses. The more money is invested, the more efficient should be the risk management. Different approaches, methods, techniques, and models are used to handle the risks but its hard to eliminate risks (Odimabo and Oduoza 2013). The approaches could be proactive or reactive but will only reduce risk or its effects ((WSU) 2015).

Literature is full of such techniques that are used for risk assessment. These techniques are helpful in reducing the effects of risks. One of the most common techniques is HAZOP method which means Hazard and Operability. It is a qualitative method in which a team of experts identifies the hazards and risks which causes the industry to be inoperable and have human injury (Qureshi and Shakeel 2013). Many other method such as Fault Tree Analysis (FTA) could also be used(Lee, Grosh et al. 1985, Ericson and Ll 1999). Construction industry risks can also be analyzed on the basis of these methods. Furthermore, one most common method is to list all the hazard and risks, analyze those risks on the basis of probability and consequences and identify the most severe risk(s). Once these risks are identified, then contingency plans are prepared to reduce their impact (Williams 2004). After 2010, more research paper are published as (Rezakhani 2012) classified the risks into external, legal and internal. (Zhou, Goh et al. 2015) identified the 19 risks in life cycle of the project. Risks can affect the economy of any organization and country directly or indirectly. Different approaches for risk assessment are available. The approaches may be qualitative or quantitative such as Program Evaluation Review Technique (PERT) analysis, Critical Path Method (CPM), and Factor rating etc. These approaches are project specific.

Leontief Input Output Model and Dynamic Inoperability Input Output Model (DIIM) can be used to assess the risks and manage it for a whole industrial sector(Akhtar and Santos 2013). The basis of these models is interdependencies among sectors. This case study investigates the implementation of data in the input output based model (DIIM)(Akhtar 2014).
The risk assessment got focus recently as it is one of the major causes of economic slowdown. The three barriers which affect the implementation of risk assessment and management practices are awareness of risk management processes, lack of experience, and lack of information (Chileshe and Kikwasi 2014).

Identification of risks is one of the important processes. Risk can be transferred, minimized and shared but can't be eliminated completely (Odimabo and Oduoza 2013). Industries use different approaches to reduce its effect. Those risks which occur frequently all over the world are categorized by Global Risk Management Survey (GRMS). In this survey, the top ten risks which occur globally are identified. In Pakistan, Natural Disaster Management Authority (NDMA) publishes reports about risks which occur more frequently. It can be used to identify critical risks occurring in Pakistan. In general, risk management team used NDMA report information for assessing the risks. An appropriate model is required to assess the risk on the basis of this information.

Leontief Wesley developed a model and got the Nobel Prize for it. Leontief, founder of modern Input-Output analysis, stated that the main objective of input-output is to describe economic reality as closely as possible(Sargento 2014). In the model, it is assumed that the full output of an industry is dependent upon the intermediate and final consumption of the industry. Intermediate consumption is of those products and commodities which are produced by industry and uses the same product itself to produce the final demand (Akhtar and Santos 2013). Final demand is also dependent upon the part and products supplied by other industries which are interdependent. Final demand is end product shipped to the customer. The input output model is shown in equation (1) (Akhtar and Santos 2013).

$$X = AX + C \quad (1)$$

Where X is the total output of an industry, AX is the intermediate demand of the industry and C is the final demand by customer. So the two inputs to the model are intermediate and final demand while its output will be the whole production of the industry considering the interdependency. Now when an industry is subjected to an earthquake then this model is used to estimate the initial inoperability of an industry i.e. how many percent of total demand or production will be lost by an industry. The model can be rewritten as shown in equation (2) (Akhtar and Santos 2013).

$$X = A`X + C` \quad (2)$$

Where X represent the inoperability, A`X represent the reduction in intermediate demand while C` represent the normalized reduction in final demand.

(Lian and Haimes 2006) worked on a model that was the extension of the IIM model. IIM model was used for static time determination of cascading effects. It is an extension to inoperability model which is based on Leontief input output model. The model is used to identify the time by time inoperability of an industry after an earthquake. This model shows the best estimate of the losses in order to take decision about the future planning of industry. The model is represented in equation (3) (Akhtar 2014).

$$q(t+1) = q(t) + K[A`q(t) + c`(t) – q(t)] \quad (3)$$

Where q(t+1) represent the inoperability of an industry at time t+1, K is the resilience vector which indicates the recovery rate of an industry, A`q(t) is the normalized reduction in the intermediate consumption at time (t) and c`(t) is the normalized reduction in the final demand of an industry at time (t). The resilience vector shows the rate that how the industry is recovering from its initial inoperability to normal position. The formula for K is shown in equation (4) (Akhtar 2014).

$$Ki = \ln[qi(0)/qi(T)] / Ti(1-a`ii) \quad (4)$$

Where

qi(0) = Initial inoperability of industry/sector i.
qi(T) = Desired inoperability level of industry/sector i.
T = Time required for full recovery
aii = The diagonal value of Aregional matrix (From equation (5))

For calculations, T is assumed to be 3 days, which means workforce can recover in 3 days after a small intensity earthquake. Aregional matrix is formula is shown in equation (5) (Akhtar 2014).

$$Aregion = diag(LQi)*Anation \quad (5)$$

Where

Aregion = Interdependency matrix for region (KPK)
Diag(LQi) = Location Quotient (LQ) of industry/sector i, multiplied with the diagonal of a nation.

Anation = Interdependency matrix of a nation (Pakistan)

Location quotients relate the smaller area with larger one such as the comparison of KPK industries income with all Pakistan industries income. It usually measures the region industrial specialization relative to nation. It can be calculated via equation (6) (Bess and Ambargis 2011).

$$LQi = \min [(LAPIi\ region/\sum iLAPIi\ region)/\ (LAPIi\ nation/\sum i\ LAPIi),1 \quad (6)$$

Where

LAPIi region = Local Area Personal Income of sector i of region (KPK)

LAPIi nation = Local Area Personal Income of sector i of nation (Pakistan)

Location quotient can be found from several websites but if not available then it can be calculated by formula. Aregion shows the matrix that includes the interdependency values of the region. Usually, the technical coefficient matrix is given for the nation which simply shows the input output of an industry of the whole country. Location quotient of each industry can be determined via equation (6). Location quotients of the desired region are multiplied with technical coefficient matrix of nation. The resulting matrix is used as interdependency matrix for that region.

The workforce presents in every sector need to be noted for risk assessment procedure. The number of workers present and absent after an earthquake can affect the results. Workforce unavailability in the aftermath of an earthquake can degrade the productivity of industry with in economic region (Sargento 2014). Workforce availability and mobility is critical in disruptive event likes an earthquake, as most of the industry sectors are workforce dependent and workforce disruptions will cause direct economic loss to industries (Akhtar and Santos 2013).

Final demand consists of goods and services purchased by final users and can be expressed in terms of gross output, earnings, or employment (Solutions 2014). The outputs of an industry might be private consumption, government consumption, investment and exports, but they are used as final demand in DIIM model. A fundamental field within input-output analyses is a measurement of the scale of production induced at each sector by generation of a certain final demand (Sargento 2014).

After collecting the data, the first step is to find the initial inoperability which can be determined by putting the values in equation (1). Workforce involvement in fulfilling the final demand is identified by equation (7)

$$\text{Demand/person} = \text{final demand/no. of employment in the industry} \quad (7)$$

The numbers of absent employees are then multiplied with equation (6) so the demand of an industry that can be fulfilled after an earthquake. For finding the final inoperability level, and to identify the resilience coefficient, the workforce level is taken at 95%. Putting the reduced demand in equation (2) It will become

$$\text{Reduced demand} = \text{final demand} - \text{demand fulfilled after disaster/final demand} \quad (8)$$

The intermediate demand is assumed to be undisrupted. It will be hundred percent. After calculating initial and final inoperability, the K value is determined by equation (4) which shows the recovery rate. The dynamic inoperability for the rest of the periods is calculated by dynamic inoperability input output model as shown in equation (3).

3. METHODOLOGY

Construction organizations invest too much money. It must recover the investment in calculated recovery period. The recovery period is usually out of vision and no one knows what might happen. The problem is that there are much more probabilities of occurrence of event that can push you back. These events are the risks, which might be financial, legal, management, market, policy or political or natural disasters. It can affect the production drastically. Earthquake is one of these natural disasters causing not only the economic loss but can lead to safety issue as well.

Flowchart as shown in Figure 1 represents the whole procedure of the project. All the major steps should take are written in the box in flowchart. The data required to complete these major steps are written in parallelogram i.e. parallelogram represent the minute steps of the project. Literature review is a process on continuous basis. It should take as an alternative process. It is written in box with rounded corners as shown in Figure 1.

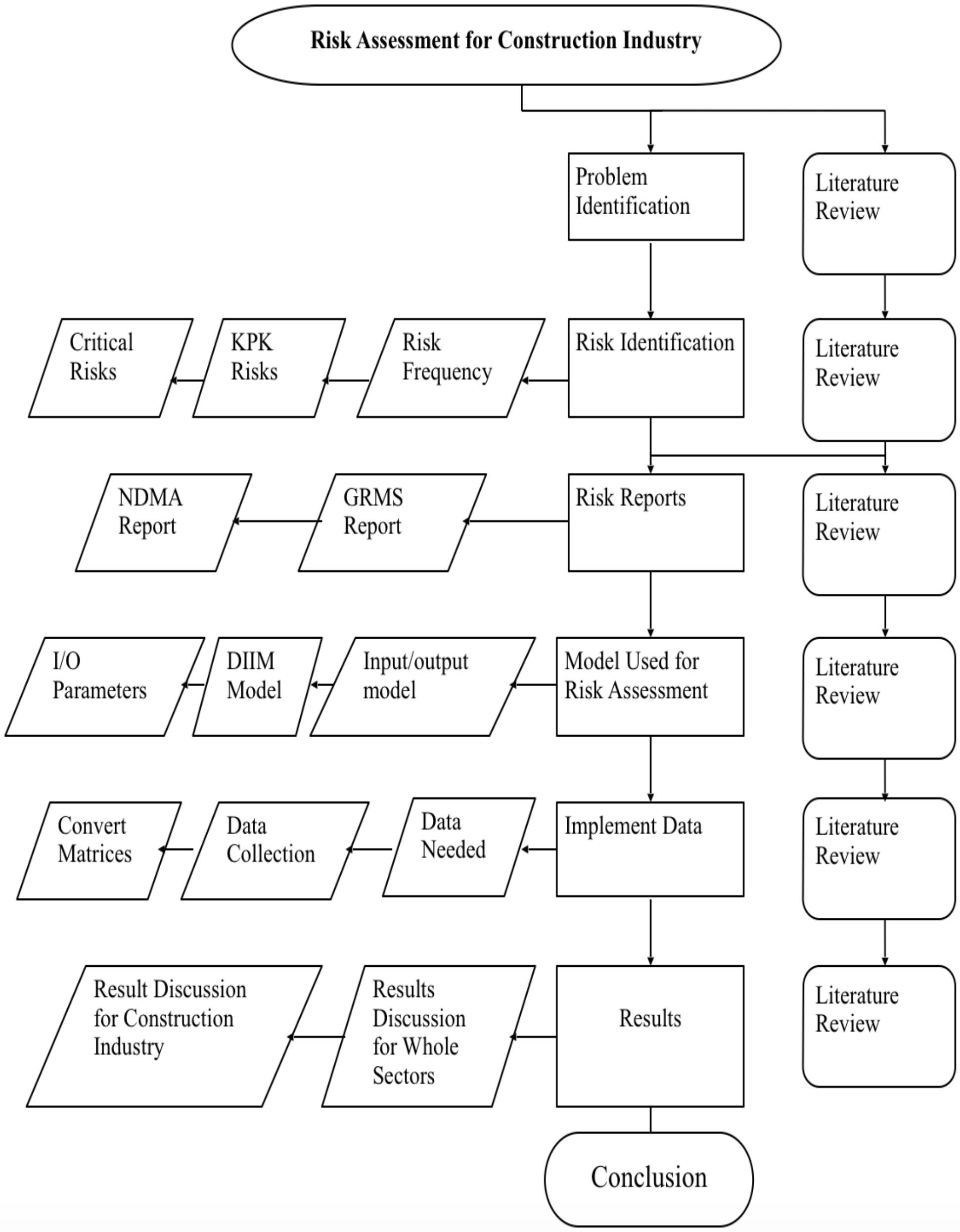

Figure 1 Flowchart of Case study

3. DATA COLLECTION, ANALYSIS AND TABLES

Global Risk Management Survey for the year of 2011, 2013 and 2016, categorized the most common risks occurring in the world (Solutions 2014). It is a survey for identification of critical risks occurring all over the world. This survey revealed the most disruptive risks which occurred in the year of 2011, 2013 and 2016. They ranked the risks and named the report as "Global Risk Management Survey for the year of 2011, 2013 and 2016". The top risk is economic slowdown and the last is Cash flow/liquidity risk. The economic slowdown occurs due to different events happened suddenly. The key sectors always play an important role in the GDP and economic situation of the country. Risk analysis is necessary to reduce the economic slowdown.

While analyzing the risk in Pakistan, it is important to analyze factors and risks which cause the economic slowdown. The statistics of this report revealed the most frequent and most disruptive disaster in Pakistan ((NDMA) 2011). The report is shown in Table 1.

Table 1. NDMA report about natural disasters

S.No.	Disaster type	In millions					
		People homeless	People killed	People injured	People affected	Total affected	Total damage($)
1	Flood	8.928	0.012	0.001	38.669	47.589	2746
2	Earthquake	2.854	0.143	0.088	1.294	4.236	5019
3	Drought	-	0.0001	-	2.269	2.269	247
4	Famine	-	-	-	0.300	0.300	-
5	Epidemic	-	0.000	0.000	0.016	0.016	-
6	Wind storm	0.023	0.012	0.001	1.057	1.081	4
7	Landslides	0.003	0.000	0.000	0.000	0.003	-
8	Extreme temperature	-	0.001	0.000	0.000	0.001	-
9	Total	11.807	0.168	0.009	43.607	55.505	8016
10	Flood 2010	1.744	0.002	0.003	20.185	20.185	1000
11	Flood 2011	1.500	0.001	0.001	9.200	-	0.247

3.1 Input Output Tables

Input output tables are published yearly by every country. Bureau of analysis always publish it for US. Usually the economist of the country publishes it. These tables show the flow of commodity between industries. The input of one industry is also the output of another industry, which reflects the interdependency of industries on each other. The monetary value of input goods of each industry is shown in tables. The flow of commodities throughout the country is represented in the nation input output table and for a specific region is also given ((WB) 2005). It is also known as technical coefficient matrix. For Pakistan, 34 industries input output are given

The Leontief inverse matrix is also known is industry-by-industry total requirement table. This is given in (I-A)-1 form. It can be simplified into technical coefficient matrix (A) by eliminating the inverse. This A matrix is then called technical coefficient matrix. The industry-by-industry total requirement table is separate for region (KPK) and nation (Pakistan). The Leontief inverse table or industry-by-industry total requirement table for the region (KPK) is shown in Table 2.

Table 2. Industry by Industry Total Requirement Table

Industries	Description	1	2	…	34
1	Agriculture, hunting, forestry, and fishing	1.0653	0.0005	…	0.0000
2	Mining and quarrying	0.0162	1.1348	…	0.0000
:	: :	:	:	…	:
34	Private households with employed person	0.0000	0.0000	…	0.0000
		1.2840	1.2064	…	0.0000

Now as it is given earlier that code 1 and 2 is used for “agriculture, hunting, forestry, and fishing sector” and “mining and quarrying sector” respectively. Now the pivot value of 2nd row and 1st column of the Table 2 is 0.0162. It can be interpreted as if $1 increase occurs in the demand of “agriculture, hunting, forestry, and fishing sector” then there will be $0.0162 increase in the production of “Mining and quarrying sector” due to interrelationship.

The column sum represents the output multiplier. For example, the output multiplier for column 1 is 1.2840 as shown in Table 2. It means that if there is $1 increase in “Agriculture, hunting, forestry, and fishing sector” then there will be $1.2840 change in other sectors.

3.2 Location Quotients

After determining the “A” matrix, it is important to determine the Aregional matrix as discussed in literature review. The formula (5) for Aregional matrix is explained in section 2. Aregion is determined to show the degree of interdependency between region (KPK) and nation (Pakistan).

LQ of KPK industries are available in World Bank reports ((WB) 2005). If not available, it can be calculated from equation (3). Table 3 shows the location quotient taken from World Bank.

Table 3. Location quotients for different sectors of KPK

Industries	Agriculture	Manufacturing	Construction	Public administration	Communication	Financial
KPK	0.2	1.4	1.4	2.7	2.2	2.1

The values in the Table 3 can be interpreted as for construction industry the location quotient for KPK is 1.4. It’s above 1 which means that KPK construction industry has a significant role in the economy of the country. Location quotients is used to find the regional interdependencies used when an industry is subjected to earthquake. LQ is the location quotient for each industry which is diagonally multiplied with technical coefficient matrix of nation to get interdependency matrix A` as shown in Table 4.

Table 4. Interdependency matrix of region for K values

Industries	1	2	3	4	5	6
Agriculture (1)	0.012	0.057	0.020	0.004	0.000	0.000
Manufacturing (2)	0.000	0.002	0.001	0.001	0.000	0.000
Construction (3)	0.003	0.000	0.002	0.068	0.022	0.007
Public administration (4)	0.000	0.001	0.000	0.002	0.000	0.005
Communication (5)	0.000	0.004	0.010	0.009	0.079	0.019
Financial (6)	0.003	0.031	0.023	0.027	0.028	0.226

The diagonal values of the Table 4 are used as “aii” for determining the K values.

3.3 Employment in Industries

This paper is based on workforce absenteeism in the aftermath of an earthquake. The demand is directly related with employees present. World Bank survey report identified the key industry sectors employment ((WB) 2005). The employment in the different industry sectors of KPK are given in Table 5. It shows the employment in each sector of KPK e.g. workforce required for construction industry is 52024.

Table 5. Employment in Industry Sectors of KPK

Industries	Agriculture	Manufacturing	Construction	Public administration	Communication	Financial
Employment	51099	9670	52024	15000	9000	8744

3.4 Final Demand

Final demand is used by the customer. Final demand refers to the end product. In order to find the inoperability, final demand is used as an input to the DIIM model. The final demand must be in dollars i.e. the monetary value of the goods that needed to be produced annually. The GDP of each industry sector give by the World Band for KPK economic report are shown in Table 3.6 ((WB) 2005).

Table 6. Key Industry Sectors GDP

Industries	Agriculture	Manufacturing	Construction	Public administration	Communication	Financial
Final demand (million dollars)	945.02	753.88	170.95	512.25	180.00	114.65

For construction industry of KPK, the final demand is 170.95 million dollars per year. This is the monetary value of the goods to be produced in construction industry of KPK.

4. ANALYSIS OF DATA

The data collected as discussed in previous sections is used in Input Output Model and DIIM model. The calculations are discussed in this section.

4.1 Total Output of Construction Industry of KPK

The total output of industries before subjected to an earthquake is given in Table 7. The intermediate demand is mentioned in Table 4 while final demand is given in Table 5. The total output is calculated by with the help of equation (1).

AX is calculated by adding the column of the respective industry. The intermediate demand for construction industry of KPK is shown on the intersection of 3rd last row and 3rd column of Table 7. The value is 0.055478. The final demand is shown at the intersection of 2nd last row and 3rd column. The value is 170.95. The total output of the industry is calculated by equation (4).

Output (X) of construction industry = 0.055478+170.95 = 171.0055

Calculation of all the industries is summarized in Table 3.7. All the other sectors are also some output per year which is shown in Table 7.

Table 7. Total Output of Industries

Industries	Agriculture	Manufacturing	Construction	Public administration	Communication	Financial
Agriculture	0.058000	0.056800	0.019800	0.003900	0.000020	0.000030
Manufacturing	0.000490	0.001820	0.000970	0.000620	0.000001	0.000160
Construction	0.014300	0.000200	0.002300	0.068000	0.021800	0.006800
Public administration	0.000093	0.000510	0.000008	0.001500	0.000092	0.004800
Communication	0.000026	0.003800	0.009600	0.008600	0.078500	0.018800
Financial	0.016000	0.030700	0.022800	0.027100	0.028100	0.226000
AX(Intermediate demand)	0.088909	0.09383	0.055478	0.10972	0.128513	0.25659
C (Final demand)	945.02	753.88	170.95	512.25	180.00	114.65
X = ax + c	945.1089	753.9738	171.0055	512.3597	180.1285	114.9066

For construction industry the total output is $171.0055 million as shown in last row of Table 7. The intermediate and final demand is added to get the total demand of 171.0055 million dollars. Intermediate demand is used by industry itself instead of customer. Intermediate demand is not the finish product but used in production of final product.

4.2 Calculating the Initial and Final Inoperability

Now when an industry is subjected to an earthquake the workforce is reduced due to damages in infrastructure or injuries of the workers. The initial and final inoperability for calculating the recovery coefficient K is given in Table 9. The initial workforce is assumed to be 40% absent and full recovery workforce is assumed to be at 95 %. The present employment value is multiplied with demand/person and then put the values in I-O model. The calculations are given below:

Calculation for inoperability economic losses is given below while inoperability in percentages is calculated by dividing the economic loss on the total output of an industry. It can be written as "Economic loss/Total output "of an industry.

Demand/person in the industry = Demand/employment (9)

For construction industry, demand/person = 171.0055/52024 = 0.00328 million dollars/person
For initial inoperability the 40% workforce is absent = 0.4(employment of each industry).
For construction industry when 40% workforce is absent, then present employment
= 0.4*52024 = 30659
Demand fulfilled by present workers = 30659*0.00328 = 102.60 million dollars
The initial loss of construction industry (qi(0)) = 171.0055-102.60 = 68.40 million dollars
To calculate the final demand, the desired workforce is at 95%. So the calculation is:
95% employment for construction industry = 0.95*52024 = 49422
Demand fulfilled by present workers = 49422*0.00328 = 162.4552
Loss at 95% of workforce (qi(T) = 171.0055-162.4552 = 8.55 million dollars

Table 8. Initial and final inoperability for industries

Inoperability	Agriculture	Manufacturing	Construction	Public administration	Communication	Financial
Demand/person (million dollars)	0.0184941	0.077962	0.003286	0.034151	0.020002	0.013119
Initial q(0)	378.04356	301.5895	68.40219	204.9439	72.05141	45.96264
Final q(T)	47.255445	37.69869	8.550274	25.61799	9.006426	5.74533

It is assumed that percentage of present workforce for all industries is same therefore the values for all sectors are identical. Initially the sectors will be 40% inoperable and the desired value is 5%. Now the resilience vector K can easily be determined with the help of equation (10).

K = ln[qi(0)/qi(T)] / Ti(1-a`ii) (10)

As the values of qi(0) and qi(T) is given in Table 3.8. T is the recovery period assumed 3 days and aii is the diagonal value of construction industry in the Table 4.6. The K value for construction industry can be calculated as shown below:
K (For construction industry) = ln[68.40219/8.550274]/3(1-0.0116) = 0.68
Table 9 represents the k values for other industries calculated by equation (10)

Table 9. K values for Industries

Industries	Agricultural	Manufacturing	Construction	Public Administration	Communication	Financial
K values	0.6851067	0.653776	0.679423	0.690444	0.693133	0.693126

The larger K value shows fast recovery of an industry. All the industries have relatively same recovery rate.

4.3 Calculation of Economic Losses for Construction Industry of KPK

Now all the values required for dynamic inoperability input output model (DIIM) are determined. As the initial inoperability q(0) has already determined for all industries in Table 4.11, the inoperability of first period q(1), second period q(2) and third period q(3) can be calculated by putting the values in DIIM model. Calculation of construction industry is shown below:

(DIIM) : q(t+1) = q(t) + K[A`q(t) + c`(t) – q(t)]…….(11)

DIIM model as shown in equation (11) is used to determine the dynamic inoperability. q(t) shows the inoperability of the previous period, K shows the resilience of each industry, A`q(t) is the intermediate demand after an earthquake and c`(t) is the reduced demand after an earthquake. q(0) is given for all industries in Table 10, K-value of all industries is given in Table 9, where as A` values is given in Table 2. q(1) and q(2) of construction industry is calculated below:

20% workforce recovered so demand fulfilled = (0.8*52024) * 0.003286 = 136.80 million dollars
So c`(t) at next plan is = 171.0055-136.80 = 34.20
q (1) = 68.40219+0.679423[68.40219(0.023+0.001+0.002+0.000+0.010+0.020) +34.20 - 68.40219] = 47.74 million dollars

For q (2), when workforce recovered 90% then demand fulfilled = (0.90*52025) * 0.003286 = 153.90
Implementing the values in DIIM model the inoperability of all the industries in each period up to period 3 are calculated in Microsoft Excel. Table 10 gives the inoperability of each sector in each time period.

Table 10. Inoperability of industry sectors in each period

Industries	q(0)	q(1)	q(2)	q(3)
Agriculture	378.0435	253.1489	82.8674	27.1381
Manufacturing	301.5895	221.5041	90.3432	36.8536
Construction	68.4021	47.7434	17.173	6.1865
Public Administration	204.9439	149.7184	57.7572	22.2890
Communication	72.0514	53.4988	21.2518	8.4491
Financial	45.9626	38.2081	18.5896	9.0454

5. RESULTS, DISCUSSION AND CONCLUSION

The inoperability economic loss calculated in previous section leads to result discussion. The result required to estimate the losses of construction industry are discussed in this chapter. Figure 2 shows the gradual decrease of inoperability of construction industry and others.

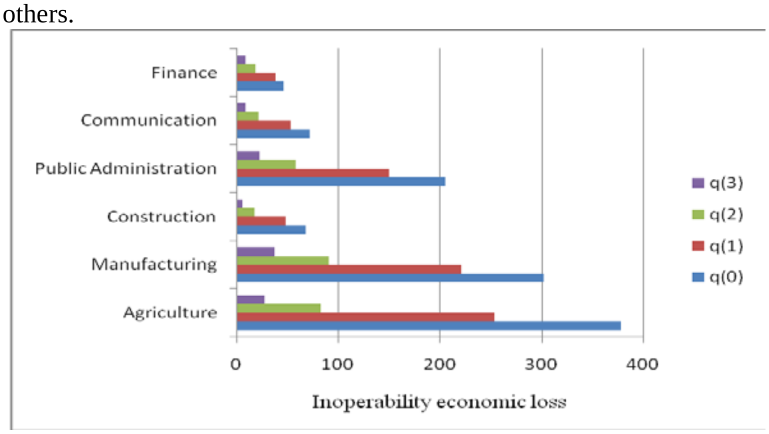

Figure 2. Inoperability of industries at various time periods

The absenteeism of workforce in initial phase of the earthquake for all the industries is 40%. The inoperability economic losses are shown in figure 4.1. At initial phase q (0), the economic losses of all the industries are higher. It is due to the high ratio of workforce absenteeism at initial stage. Inoperability economic losses decreased gradually in q (1), q (2) and q (3). The gradual decrease in all the industries is due to the recovery of workforce in the sectors. The inoperability has determined at 40%, 20%, 10% and 5% of workforce absenteeism. At initial phase q (0), the workforce absenteeism is 40% so the economic losses are higher for all industries as this gradual decrease is occurring in all the industries including construction industry, therefore it can be estimated that workforce absenteeism is significant factor in overcoming the economic losses. Fast recovery of workforce results less economic losses.

Comparison of construction industry with other industries is discussed in this section. The results of agriculture industry are compared with construction industry in Table 11. It shows that the total output of construction industry is smaller than agriculture industry i.e. agriculture industry produces more goods than construction industries. The industry with large production needs more employment. Therefore, agriculture industry is more of workforce dependent. The initial loss of agriculture industry is more than construction industry due to workforce dependency. Average economic loss of construction industry is less than agriculture industry. It is concluded from the table that industry with larger output will affect more in disasters.

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Table 11. Comparison of agriculture sector with construction sector

Parameters	Construction Industry	Agriculture Industry
Total output (million dollars)	171.0055	945.1089
Initial loss (million dollars)	68.40219	378.04356
Average loss (million dollars)	34.87631	185.2995

6. CONCLUSION

In this research we use different reports published by different organization to identify the critical risks for construction industry of KPK. The reports reveal that KPK is the most affected province of Pakistan by natural disasters especially by earthquakes. Generally, earthquake destroys the infrastructure or injures the people, therefore it become difficult for the workforce to reach industries. This paper estimates the economic losses of construction industry of KPK and five other sectors of KPK which occurs due to workforce absenteeism. The results show those inoperability economic losses of construction industry and other sectors decreases gradually with time. This gradual decrease in losses occurs due to gradual increase in workforce of each sector. As the whole workforce is recovered, the economic losses become negligible. It shows that fast recovery of workforce is important to reduce the impact of an earthquake.

7. BIBLIOGRAPHY

1. (NDMA), N. D. M. A. (2011). NDMA Pakistan Annual Report**:** 2-6.
2. (WB), W. B. (2005). Pakistan-Northwest Frontier Province (NWFP) economic report : accelerating growth and improving public service delivery in the NWFP - the way forward. Washington, DC, World Bank.
3. (WSU), W. S. U. (2015). Hazard Identification, Risk Assessment and Control Procedure.
4. Akhtar, R. (2014). Risk-Based Input-Output Modeling and Uncertainty Analysis of Hurricane Impacts on Interdependent Regional Workforce Systems, THE GEORGE WASHINGTON UNIVERSITY.
5. Akhtar, R. and J. R. Santos (2013). Risk analysis of hurricane disruptions on workforce and interdependent regional sectors. Systems and Information Engineering Design Symposium (SIEDS), 2013 IEEE, IEEE.
6. Bess, R. and Z. O. Ambargis (2011). Input-output models for impact analysis: Suggestions for practitioners using RIMS II multipliers. 50th Southern Regional Science Association Conference, New Orleans, Louisiana.
7. Chileshe, N. and G. J. Kikwasi (2014). "Risk assessment and management practices (RAMP) within the Tanzania construction industry: Implementation barriers and advocated solutions." International Journal of Construction Management **14**(4): 239-254.
8. Ericson, C. A. and C. Ll (1999). Fault tree analysis. System Safety Conference, Orlando, Florida.
9. Lee, W.-S., D. L. Grosh, F. A. Tillman and C. H. Lie (1985). "Fault Tree Analysis, Methods, and Applications A Review." IEEE transactions on reliability **34**(3): 194-203.
10. Lian, C. and Y. Y. Haimes (2006). "Managing the risk of terrorism to interdependent infrastructure systems through the dynamic inoperability input–output model." Systems Engineering **9**(3): 241-258.
11. Meng, X. (2010). "Assessment framework for construction supply chain relationships: Development and evaluation." International Journal of Project Management **28**(7): 695-707.
12. Odimabo, O. O. and C. F. Oduoza (2013). "Risk Assessment Framework for Building Construction Projects' in Developing Countries." International Journal of Construction Engineering and Management **2**(5): 143-154.
13. Qureshi, M. A. and S. Shakeel (2013). Risk Assessment and HAZOP Study of Oil and Gas Sector**:** 151-153.
14. Rezakhani, P. (2012). "Classifying key risk factors in construction projects." Buletinul Institutului Politehnic din lasi. Sectia Constructii, Arhitectura **58**(2): 27.
15. Sargento, A. L. M. (2014). Introducing input-output analysis at the regional level: basic notions and specific issues. Regional Economics Applications Laboratory, Discussion Paper, University of Illinois REAL 09-T-4. http:// www. real. illinois. edu/ d-paper/ 09/ 09-t-4. pdf. Accessed 17 May.
16. Solutions, A. R. (2014). Global Risk Management Survey.
17. Williams, L. (2004). Risk Assessment**:** 4.
18. Zhou, Z., Y. M. Goh and Q. Li (2015). "Overview and analysis of safety management studies in the construction industry." Safety Science **72**: 337-350.
19. Zou, P. X. W., G. Zhang and J.-Y. Wang (2006). Identifying key risks in construction projects: life cycle and stakeholder perspectives. Pacific Rim Real Estate Society Conference.

PRODUCTIVITY ENHANCEMENT IN TOBACCO COMPANY THROUGH TOTAL PRODUCTIVE MAINTENANCE

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Abstract: The purpose of this paper is to increase the availability and maximize the overall effectiveness of existing equipment of Tobacco Company through total productive maintenance (TPM), and create an effective TPM model for productivity enhancement. There are mainly two phases to productivity enhancement through TPM implementation plan. Measurement is the first phase that cycle includes data collection, evaluating OEE and assessment of six big losses. In measurement phase, the present overall equipment efficiency of cigarette making department (CMD) is evaluated at 56.44% which is below the world class OEE that is 85%; initial OEE provides a baseline for the assessment of future improvement. In recondition and improvement phase, equipment and workplace has been brought to its original position using 5S and autonomous maintenance. Post OEE is calculated at 60.31% that is comparatively much improved. To carry on improvement, TPM model has been proposed for future research.

1. INTRODUCTION

Total productive maintenance (TPM) is a maintenance philosophy that requires complete workforce participation in order to achieve perfect production. The idea is to involve the operators in maintaining their own equipment, and highlighting preventive maintenance will help to minimize breakdowns, stops and defects. The traditional approach to TPM was developed in the 1960s and consists of 5S as a foundation and eight supporting activities. These activities are sometimes referred as pillars of TPM that are mainly focused on autonomous, planned, and quality maintenance techniques for preparing equipment for consistent and stable production Vorne (2011). TPM is widely applicable and implemented because of the maintenance issues and challenges in today's technologically advanced industries. It is a Japanese equipment maintenance ideology that permit facility to improve manufacturing performance with the involvement of all the employees to bring organization goals to perfection. Total means the complete workforce, from top management to the worker operating the machine; Productive means every activity is waste free, just according to the customer demands or it can exceed the customers' expectations if continuous improvement concept is carried on in real sense; Maintenance is keeping equipment in good working and productive condition. Research design and approach, data collection, interviews, direct observations and questionnaires are carried out for TPM implementation (Mwanzaa & Mbohwaa, 2015).

TPM depends upon three major concepts: maximizing equipment effectiveness; autonomous maintenance by workers. Overall equipment efficiency (OEE) is core metric for TPM that features downtime along with other production losses which cuts down throughput. OEE will never consider planned downtime, insufficient material input, deficiency of labor Ljungberg (1998). OEE is needed to know the existing efficiency of bottleneck station, and for that it takes into consideration availability losses, performance losses, and quality losses. Data is collected using stopwatch, sampling study, interviewing workers, videotaping Narses (2004). This metric has become widely accepted as a quantitative tool essential for measurement of productivity in manufacturing operations; the overall goal of TPM is to raise the overall equipment effectiveness (Samuel et al., 2002; Wakjira & Singh, 2012).

TPM has eight pillars: 5S, jishu hozen, kobetsu kaizen, planned maintenance, quality maintenance, education & training, office TPM, safety health and environment control; but 5s is the foundation program for it (Prashanth et al., 2016). TPM implementation stages include: awareness about TPM in an organization; training is to be provided according to the type of improvement needed; building committee for each department and setting up TPM; bottleneck station is evaluated and target is set; a small get-together; eight activities are implemented one by one (Wakjira & Singh, 2012).

JISHU HOZEN is the Japanese name for autonomous maintenance. Operators are motivated and geared towards performing small maintenance tasks, thus it helps to utilize the skilled maintenance people time for critical tasks and technical repairs. Operators are completely authorized and responsible for keeping equipment in good operating condition to prevent it from deteriorating (Badiger et al., 1999). Autonomous maintenance requires team work and coordination to perform maintenance tasks on equipment. Jishu Hozen acts as basis for other maintenance activities by making the basic conditions for a machine's operation. Various tentative standards for cleaning, inspection and lubrication are set for all machines. Fuguaies are noticed in all machines after setting up of standards for all machines, fuguaies are the abnormalities in the machine, that are captured during initial cleanup (Goyal & Jindal, 2015).

Autonomous maintenance consists of preventive, predictive and breakdown maintenance activities which are performed by workers on daily basis. Regular inspection is performed that consists of looking, feeling, listening, smelling, and testing (Kulkarni & Dabade, 2013). Autonomous maintenance (AM) can be done by operators rather than expert maintenance technicians Talva (2016). Training includes how best basic maintenance activities can be performed by operators, and as result of productive training of few months, workers should be able to scan and detect issues within equipment before breakdown occurs (Dogra et al., 2011) Steps that are followed for autonomous maintenance includes involvement and participation, empowerment of workers, communication, attitude, skill development, ownership of machine, team work development, motivation and recognition, providing safety everyone (Kulkarni & Dabade, 2013).

5S, a straightforward, but effective, lean manufacturing methodology. The 5S pillars, Sort (Seiri), Set in Order (Seiton), Shine (Seiso), Standardize (Seiketsu), and Sustain (Shitsuke), offer a methodology for coordinating, cleaning, developing, and sustaining an effective work environment. A typical 5S implementation would lead to substantial reductions in the size of space needed for current operations (Shinde & Shende, 2014). The 5S philosophy focuses on simplification of the work environment, productive workplace organization, and reduction of waste while enhancing safety and quality. It enables the enhancement of efficiency and productivity. The 5S technique is a structured plan to systematically accomplish total organization cleanliness and standardization at work (Vipulkumar & Thakkar, 2014). It's relatively easy to carry out, and requires minimal further resources (Ennin & Obi, 2012). 5s Permits you to regulate the workplace visually. Skilled employees with designated tasks can go and put into action knowledge through training (Falkowski & Kitowski, 2012).

A Check Mark process has been performed based on 5S check lists and the outcomes analyzed to confirm great changes like increasing effectiveness in production and quality, increases safety workplace (Vipulkumar & Thakkar, 2014). Boeing uses 5S as a tool for safety process enhancement (Rosas et al., 2010). It could be useful to display on-screen, in the company cafeteria, some marketing material with examples of a regular workstation. The next important step is to establish duties and the information circulation among employees of various levels. (Falkowski & Kitowski, 2012).

Others commenced measurement OEE from bottleneck station, but in this research OEE for entire plant is calculated, and for the first time TPM is put in place for Tobacco company.

2. METHODOLOGY

The company has been experiencing different breakdowns in machines for the very long time. It is extremely challenging to control breakdowns when on the other side production must be elevated. Breakdown includes: mechanical, spares, electrical, and power shutdown breakdowns. All these breakdowns can be controlled and eradicated by means of TPM application in addition to OEE, by emphasizing six big losses. A team of few employees and researchers are set to go for the eradication of breakdowns and production improvement through TPM. Plant manager has authorized the team to develop a methodology roadmap to find the most problematic department of the factory that contains comparatively much higher numbers of breakdowns, and enhance the productivity through reduction of losses.

The very first step is to research for the pilot area that is most problematic and targetable for improvement. Once the pilot area is selected, next step is to go for data collection through different techniques of motion study. When data is collected; team goes for the overall equipment efficiency calculation. The data is analyzed using excel and act as baseline for future improvement. On the basis of that data; TPM implementation dimensions are set to go; once TPM is implemented successfully; similar to the previous data collection, data is collected again and verified.

TPM is also a continuous improvement philosophy, sometime workplace and equipment contains much higher issues and losses that need high level improvement. And enhancement achieved through previous TPM implementation might not be satisfactory then further TPM practices are established and plan is redesigned for further improvement. Data is again collected, OEE is calculated for the new data and comparison between the very first calculated OEE is once again performed with the very latest one. And if it is at acceptable level, it is then validated and recommendations are given for further advancement in TPM plan. The whole methodology roadmap is shown in the Figure 1.

2.1 Research

Research for most problematic and easy to improve area is started from leaf department; it has been carried through the green leaf threshing and primary production departments, studied operations being performed in both the departments, it has bit higher issues in comparison to leaf department. Cigarette making department is the last department to be evaluated for issues, it contains much higher machine breakdowns in comparison to all the aforementioned departments that are studied in depth.

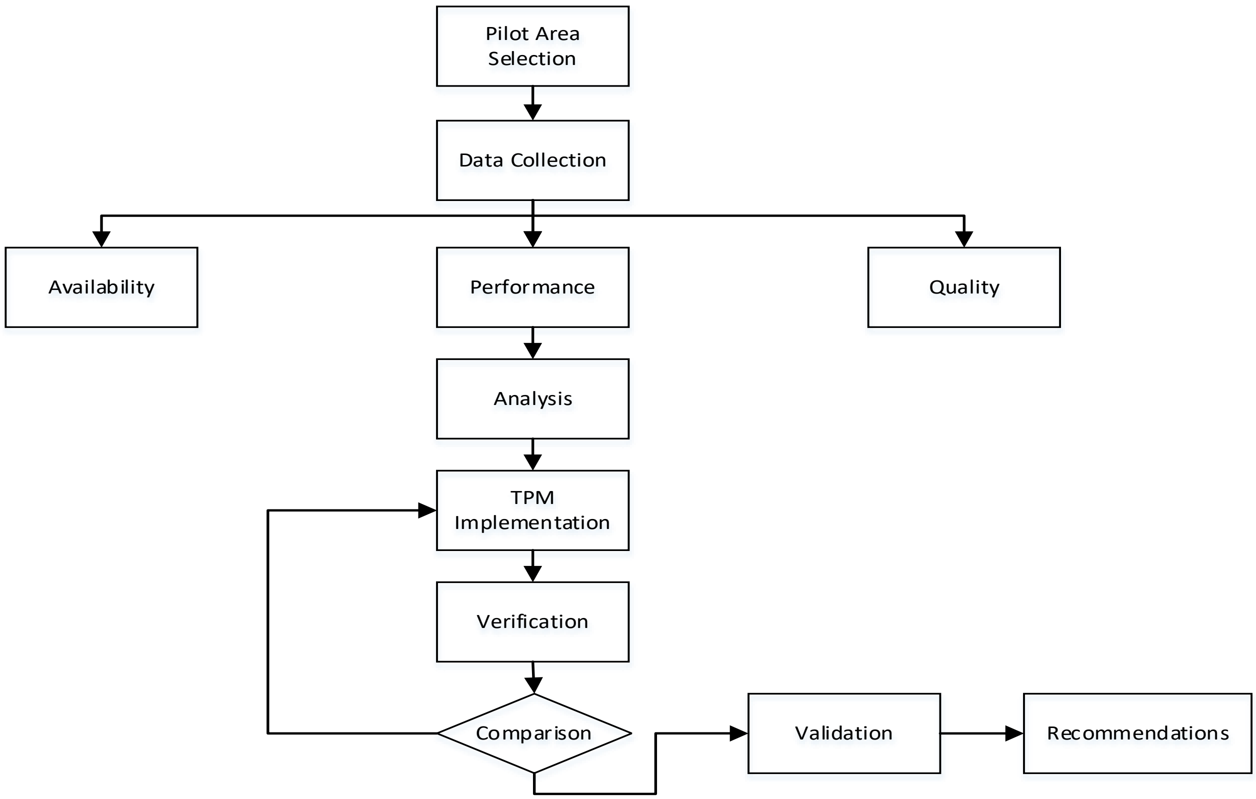

Figure 1. Methodology Roadmap

2.2 Measurement Phase

CMD is selected as the main pilot area that needs to be advanced in terms of improvement. There are 14 machines in total that are required to be targeted for enhancement through TPM.

2.2.1 <u>Data Collection</u>

Very first, different breakdowns are identified; i.e. mechanical, electrical, spares, and power shutdown. These are the breakdowns causing problem in the way of improved productivity and needs to be eradicated to bring the plant for an effective condition.

For data collection regarding each machine is performed with time study technique, with the help of team prescribed for TPM implementation task under the supervision of plant manager and its team. Breakdowns are measured in terms of time (minutes). Fourteen days' breakdowns data in total for each machine is shown in Table 1.

Table 1. Breakdowns

M/C BRD	MK8-1	MK8-2	MK8-3	MK8-4	MK8-5	MK8-6	MK8-7	MK8-8	MK8-9	MK8-10	MK9-1	MK9-2
Mech.	995	1340	895	1605	575	1275	1555	880	1175	1050	2470	2390
Elec.						60					420	240
Spares												
Pwr S.D	170	170	170	170	170	170	170	170	170	170	340	340

2.2.2 Data Analysis

Data collection has been come to an end, now it should be analyzed to know the existing OEE of each machine and then entire plant. Excel is used as analysis tool because of dozen calculation to reduce human load and save time.

For data collection regarding each machine is performed with time study technique, with the help of team prescribed for TPM implementation task under the supervision of plant manager and its team. Breakdowns are measured in terms of time (minutes).

$$Availability = \frac{Operating\ \ time}{Planned\ \ production\ \ time} \tag{1}$$

$$Performance = \frac{Total\ \ Pieces}{\dfrac{Operating\ \ Time}{Ideal\ \ Run\ Rate}} \tag{2}$$

$$Quality = \frac{Good\ \ Pieces}{Total\ \ Pieces} \tag{3}$$

$$OEE = Availability \times Performance \times Quality \tag{4}$$

World class overall equipment efficiency (OEE) must be 85%; in which availability, performance, quality is 90.0%, 95.0%, and 99.9% respectively. OEE of any equipment close to 85% is considered to be really effective, or it can be used as baseline and target to gain improvement in manufacturing and productivity enhancement.

Table 2. Initial OEE Calculation

Machines	Availability	Performance	Quality	OEE
MK8-1	0.873917749	0.74	0.928571429	0.600506339
MK8-2	0.836580087	0.741	0.928571429	0.575626855
MK8-3	0.88474026	0.701	0.928571429	0.575902713
MK8-4	0.807900433	0.695	0.928571429	0.521384315
MK8-5	0.919372294	0.7145	0.928571429	0.609970683
MK8-6	0.837121212	0.681	0.928571429	0.529359578
MK8-7	0.813311688	0.69	0.928571429	0.521100417
MK8-8	0.886363636	0.72	0.928571429	0.592597403
MK8-9	0.854437229	0.7145	0.928571429	0.566888586
MK8-10	0.867965368	0.713	0.928571429	0.574655071
MK9-1	0.82521645	0.658	0.928571429	0.504207251
MK9-2	0.919642857	0.707	0.928571429	0.603745536
Entire Plant	0.860547439	0.70625	0.928571429	0.564350084

First Availability, performance, quality, and OEE for each machine has been calculated respectively; but in this case entire plant is required to be calculated rather than stuck in bottleneck station because whole plant need to be improved within given resources and constraints. The availability, performance, quality, and OEE for entire plant is 86.05%, 70.62%, 92.85%, and 56.43% respectively. The entire plant OEE is needs to be enhanced to get better use of operating time.

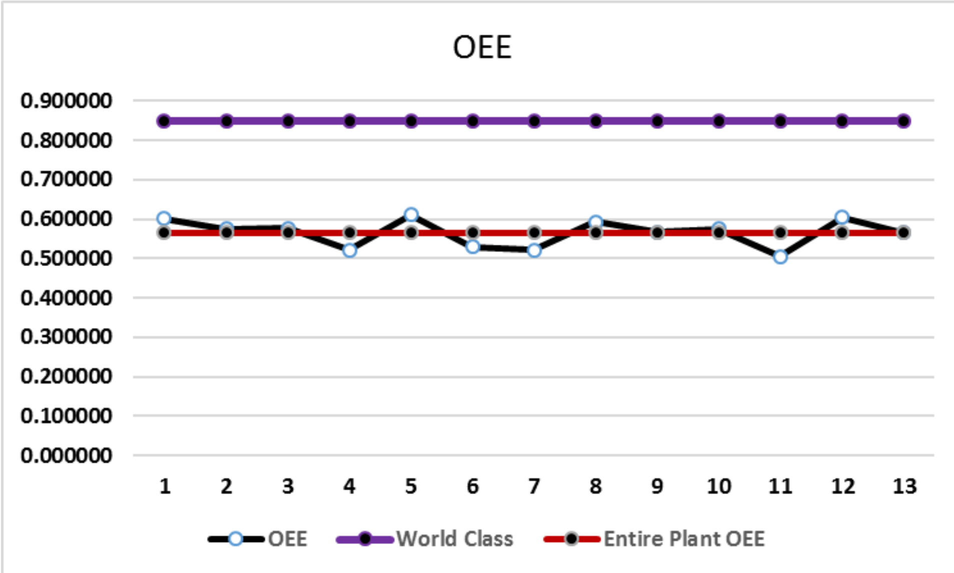

Figure 2. OEE Analysis

2.3 Recondition and Improvement Phase

In order to get the plant back to its original and improved condition, TPM tools must be executed to gain company objectives. In this research, tools applied are 5s followed by the autonomous maintenance; this setup a model for continuous improvement (Kaizen).

2.3.1 TPM: <u>5s Implementation</u>

5s implementation starts with sorting followed by systematize, shine, standardize, sustain and sometime safety is included in American way. This complete set of 5s will really bring plant to its productive condition and will setup a culture of TPM.

Sorting has been applied to remove and dispose unnecessary items. Unnecessary items are identified and these measures have been taken: unnecessary clutters are removed; all tools, gauges, materials are classified and then stored.

In order to apply aforementioned measures a technique of red tagging is applied. This technique can be performed by following steps:

- Red labels are provided to each and every operator and asked to go through every item at the workplace.
- Along with the item need, the operator is assigned with the responsibility that in how much quantity that each item is utilized at workplace.
- The items which are not needed are assigned red tags.
- Red tag area has been specified at workplace and all the red tag items are kept there.
- Along with the red tag items, there are specific items about which an immediate decision cannot be taken; such unconfirmed items are also kept with the red tag items for one week.
- The items should be reevaluated at the end of every week and all the needed items should be returned back.

Table 3. Priority of Items

Priority	Frequency of use	Storage	Items
Low	Less than one year/Once per year	Store away from the work place	

Average	Monthly or weekly usage	Store together but offline	Tongue piece, garniture tape, suction tape
High	Daily usage	At work place	Tipping paper bobbin, Cigarette paper bobbin, plane knife, seams

In order to apply aforementioned measures, a technique of red tagging is applied. This technique can be performed by following steps:

Systematize (set in order) is the second step in 5s implementation. An order is given to items mostly used during work, that would minimize the mental stress that is caused because of searching required item. After the successful implementation of sort, all the left items are arranged in systematic way. Proper layout for tools and equipment is organized there at workplace. Each tool has been assigned a proper location on the basis of its nature and frequency of use with proper labeling, marking, bordering and shadow boards for each tool and ensured that everything is close to its point of use.

Shine is the third step in 5s, but it is carried out from the very start of implementation and continues along the execution of other activities, entire plant is subjected towards cleanliness campaign. Causes of dirt and grime are identify the and proper action has been taken for its removal. whole workplace is divided into different zones and workers are assigned responsibilities cleaning respective workplace. Inspection for various; problems, defects, safety issues, variation, and non-standard conditions; is performed throughout cleaning. Besides, the workplace divided in different zones, it is also separated into white-tag and yellow-tag areas, the responsibility of cleaning the area is given to cleaning team with white-tag, operator of machine can also be the part of cleaning team. The responsibility of cleaning the area having yellow tags will be assign to maintenance team because of its complexity and technicality.

Standardize tactics has helped to Maintain the proper standard of maintenance system that is generated for the above 3S and developed the standard procedures, schedule and practices for the work. Made a checklist for each S and a regular audit is carried out by using these checklists to ensure the level of housekeeping.

Sustain is also carried out throughout whole implementation. By means of this an encouraging atmosphere is established to think about 5s, this atmosphere is made by providing the 5S proper training and awareness seminars for staff. Awareness posters are pasted on the walls at different locations.

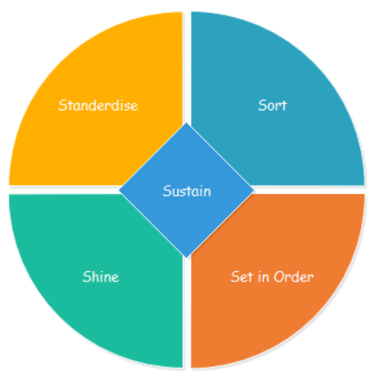

Figure 3. 5s

2.3.1 Autonomous Maintenance

Autonomous maintenance (AM) is one of the most important pillars of total productive maintenance in which operators are given with extra responsibilities for maintenance of small tasks. Machine operator have spent some time with maintenance team and have got necessary training regarding routine maintenance. Following steps are followed to implement autonomous maintenance.

- Operator properly clean and inspects the workplace for the workers to perform task efficiently, a daily checklist is made for routine maintenance inspection that will minimize the major problems of rod breaking, tobacco jam.
- Tag is used at problematic area that conveys the message to responsible person for resolving the issue. White tag is used at the place where the problem can be control by an operator and red tag is used at the place where the problem is complicated and can only be handle by maintenance team.
- Cleaning and routine maintenance standards are made that formulate the work standards which helps in maintaining, cleaning, lubrication with minimum time and efforts by plane knife, circular knife, ruler drums can be maintained productive for long term.

- Training sessions have been conducted that focuses on the standards of inspection in which the minor defects are fixed like tongue piece issue, plan knife fault issue.
- Workplace is standardized for product quality. This standardization is done with benchmarking phenomena for WIP, initial inventory and also for machines tools and their spare parts.
- For further enhancement of the process and removal of weaknesses from existing process meetings of jury should be arranged weekly or monthly to keep the process updated.

2.4 Improvement Check

In order to check the TPM success, OEE for each and entire plant is again evaluated shown in Table 3.

Table 3. Post OEE Calculation

Machines	Availability	Performance	Quality	OEE
MK8-1	0.895022	0.743	0.928571	0.617501
MK8-2	0.868506	0.7415	0.928571	0.597998
MK8-3	0.902056	0.71	0.928571	0.594713
MK8-4	0.89632	0.7	0.928571	0.582608
MK8-5	0.925866	0.7145	0.928571	0.614279
MK8-6	0.882035	0.7045	0.928571	0.577008
MK8-7	0.88171	0.7055	0.928571	0.577614
MK8-8	0.892641	0.725	0.928571	0.600938
MK8-9	0.906061	0.7345	0.928571	0.617966
MK8-10	0.878788	0.743	0.928571	0.606301
MK9-1	0.899351	0.725	0.928571	0.605456
MK9-2	0.939367	0.74	0.928571	0.645479
Entire Plant	0.89731	0.723875	0.928571	0.603145

3. RESULTS

After successful implementation of TPM, data for post OEE is gathered and then evaluated using excel as shown in Figure 6.

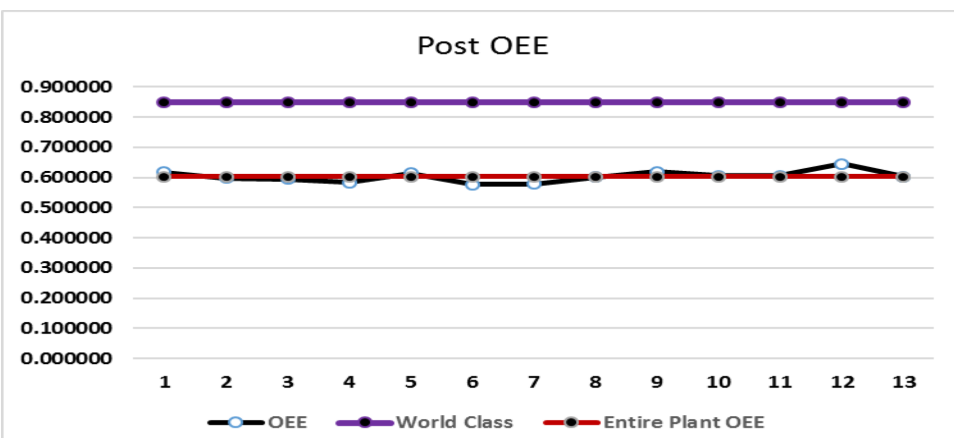

Figure 4. Post OEE

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3.1 Comparison

Comparison between initial and post availability, performance, quality, and OEE is done here to show improved output as a result of TPM and to indicate the success of TPM model. On the other side, initial and post implementation breakdowns are also compared.

3.1.1 OEE

Comparison between initial and post OEE is done here to show improved output as a result of TPM and to indicate the success of TPM model. On the other side, initial and post implementation breakdowns are also compared.

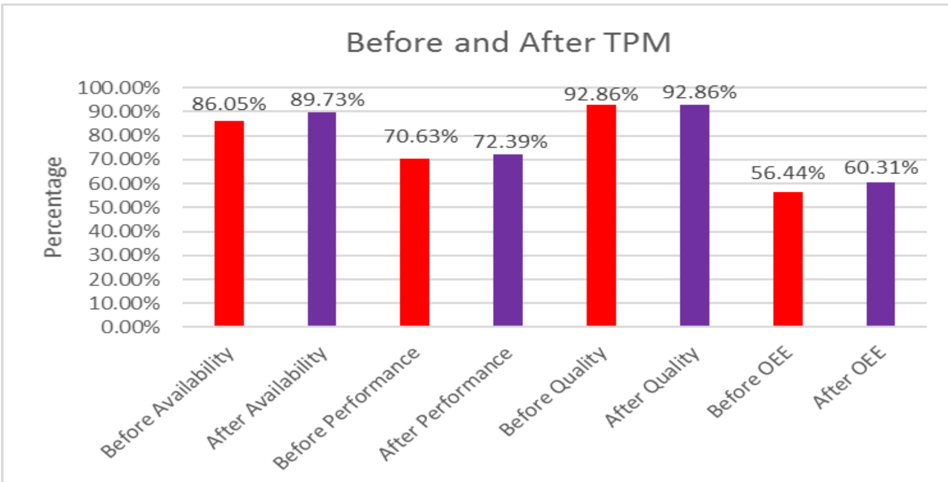
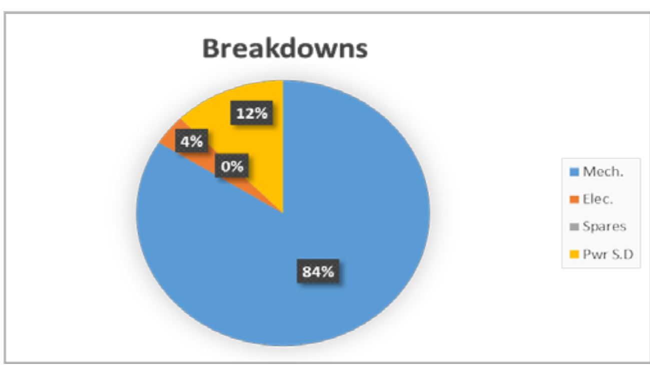


Figure 5. OEE Comparison

According to Figure 5, OEE before implementation of OEE is 56.44%, while OEE after TPM implementation is 60.31%, there is significant change because of 5s and autonomous maintenance.

3.1.1 Breakdowns



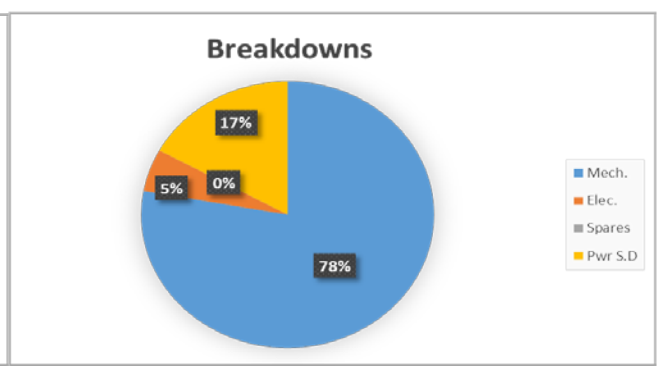


Figure 6. Before TPM Breakdowns

Figure 7. After TPM Breakdowns

Before TPM implementation, mechanical breakdowns were 84%, that are reduced to 78% after success of TPM.

4. DISCUSSION

Availability, performance, and quality losses were due to huge breakdowns. There had not been existed any routine maintenance system before implication of successful TPM program. Prolonged downtime, failure of equipment, low production all of these problems are because of poor maintenance system. Workers had not been exposed to any training and skill learning program before that and they even did not know about maintenance because they were not authorized to play part in maintaining the equipment.

The results show that availability was 86.05%, i.e. due to downtime. Performance is 70.63% that is lower due to slow cycles because machines were running all the time without maintenance system. Material waste and prolong running of machines are the reasons of low quality. After implementation of TPM, OEE has been increased to 60.31%. The methodology that has been applied can be used as model, and this can be improved with the utilization of other TPM pillars because it always allows gap for continuous improvement.

4.1 Proposed Model

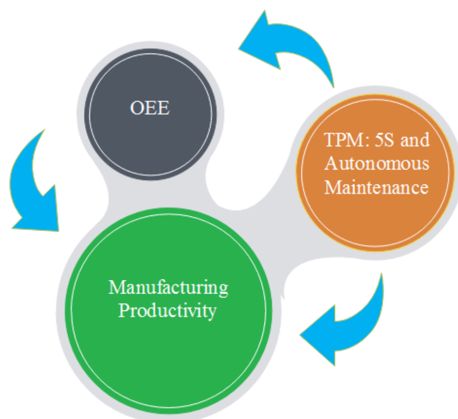


Figure 8. Proposed TPM Model for Continuous Improvement (Sahu et al., 2015).

According to Figure 8, manufacturing productivity will be enhanced if 5s and autonomous maintenance are applied successfully and as a result OEE will be increased, when OEE increases, productivity will be improved.

5. CONCLUSION

It is very first time that TPM has been implemented in tobacco company. Several loopholes in maintenance system are identified, and removed through TPM. The objective of this research is to expose company to TPM and its pillars for very first time in the history of company for productivity enhancement and that is finally achieved. OEE of the existing system has been evaluated and compared to the world class OEE. To improve productivity, it is essential to improve overall equipment efficiency (OEE) by reducing six big losses. TPM model is proposed for future improvement and hopefully it will act as basis if someone wish to successfully implement TPM.

5. REFERENCES

1. Badiger, A. S., Gandhinathan, R., Gaitonde, V. N., & Jangaler, R. S. (1999). Implementation of Kaizen and Poka-yoke to Enhance Overall Equipment Performance - A case study. In ResearchGate, pp. 24-28.

2. Dogra, M., Sharma, V. S., Sachdeva, A. and Dureja, J. S. (2011). TPM-A Key Strategy For Productivity Improvement in Process Industry. Journal of Engineering Science and Technology. Vol. 6, pp. 2-13.

3. Ennin, Y. C., & Obi, D. (2012). 5s: Good Housekeeping Techniques For Enhancing Productivity, Quality And Safety At The Workplace. International Trade Centre, Geneva, Switzerland.

4. Falkowski, P., & Kitowski, P. (2012). The 5S methodology as a tool for improving organization of production. In PhD Interdisciplinary Journal, p. 127.

5. Goyal, R., & Jindal, D. S. (2015). A Systematic Approach towards Implementation of TPM in an Automobile Industry. In International Journal of Emerging Research in Management &Technology, Vol. 4, pp. 14-16.

6. Kulkarni, A., & Dabade B. M. (2013). Investigation of Human Aspect in Total Productive Maintenance (TPM): Literature Review. In International Journal of Engineering Research and Development, Vol. 5, pp. 27-26.

7. LeanProduction: Vorne. (2011), Retrieved December 3, 2016, from http://leanproduction.com/tpm.html

8. Ljungberg, Õ. (1998). Measurement of overall equipment effectiveness as a basis for TPM activities. In International Journal of Operations & Production Management, Vol. 18 Iss 5, pp. 495 - 498.

9. MobilityWork: MobilityWork Blog. Talva, M. A. (2016). Autonomous Maintenance: The 5 Steps to Successful Implementation. Retrieved from http://tinyurl.com/h5j74f4.

10. Mwanzaa, B. G., & Mbohwaa, C. (2015). Design of a total productive maintenance model for effective implementation. Procedia Manufacturing 4, IESS, pp. 261-263.

11. Narses, A. (2004). Case study: Production and OEE improvement for an 800 tons stamping press. Product and process development, Concurrent Engineering Master Thesis Programme Innovation and Product Design, Mälardalen University, pp. 16-28.

12. Prashanth, M. P., Ramachandra, C. G., Srinivas, T. R., & Raghavendra, M. J. (2016). Effect of Total Productive Maintenance (TPM) Implementation in Manufacturing and Service Industries – A Review. National Conference on Advances in Mechanical Engineering Science, pp. 346-347.

13. Rosas, J. H., Alidaee, B., Moreno, C. J., & Urbina, J. (2010). Quality improvement supported by the 5S, an empirical case study of Mexican organisations. In International Journal of Production Research, Vol. 48, pp. 4-15.

14. Sahu, S., Patidar, L., & Soni, P. K. (2015). 5S Transfusion to OEE for Enhancing Manufacturing Productivity. In International Research Journal of Engineering and Technology (IRJET), p. 1214.

15. Samuel, H. H., John, P.D., Shi, J., & Qi, S. (2002). Manufacturing system modeling for productivity improvement. Journal of Manufacturing Systems, 21(4), pp. 249-260.

16. Shinde, D. B., & Shende, P. N. (2014). Improvement of Plant Layout by using 5S technique-An industrial case study. In International Journal of Modern Engineering Research, Vol. 04, pp. 141-145.

17. Vipulkumar, C., & Thakkar, P. H. (2014). A Case Study: 5s Implementation in Ceramics Manufacturing Company. In Bonfring International Journal of Industrial Engineering and Management Science, Vol. 4, pp. 132-134.

18. Wakjira, M. W., & Singh, A. P. (2012). Total Productive Maintenance: A Case Study in Manufacturing Industry. Global Journal of researches in engineering Industrial engineering, Vol. 12, pp. 1-9.

INVENTORY ANALYSIS OF CONSTRUCTION PROJECT

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Abstract: Construction Industry involves multi echelon supply chain. With so many stake holders involved, the inventory management becomes a critical aspect of construction project management. Construction industry faces a lot of problem due to poor inventory management, these projects over run the time and the allocated budget. ABC analysis is one of the preliminary inventory assessment methods but it is still alien to Pakistan construction environment. The paper will focus on the importance and economic benefit of inventory management for construction practitioners.

Keywords: Inventory, Construction, Multi-Item

1. INTRODUCTION

The term inventory refers to the goods or material used by firm for production or sale. Inventory control refers to coordinating availability, controlling, utilization and procuring of materials. Inventory control is the course along activities with the purpose of getting to the right inventory in the right place at the right time and in the right quantity and it is directly connection to the production functions of any organization. The project develops an inventory management for the construction project. The need for the project is to present the problems, facing by the companies in material requirements and to provide proper material management. For this, assessment of problems in construction firms, in term of inventory management will be evaluated through different market survey using questionnaire, interview, and literature review. For data analysis, Quantitative analysis includes inventory model like (ABC) will be applied on acquired data. Also Qualitative analysis, which includes (S-curve), will be used to differentiate between planned and actual consumption of materials.

Material management is an essential management tool which will be improving the productivity of a construction industry. The management of material is related to all the periods in the construction site and also throughout the construction phase. A poor management can impact on overall construction site, time, cost and quality. Construction management is the overall planning, sourcing, purchasing, moving, storing, coordinating and controlling the project form starting to the end. The objective is to produce a functionally and financially feasible project. The construction industry is consistent with five major sector, such as residential, environment, heavy civil, industrial and commercial.

2. Literature Review

(Kanimozhi and Latha 2014) research was related to material management. The literature review clearly indicated that material management is one of the critical aspect of construction industry (Akintoye, McIntosh et al. 2000, Zou, Zhang et al. 2007). One of the most reason for cost over run is poor material management(M. Abas 2016). According to (Zou 2012) proper inventory mechanism leads to reduces the over all cost. Proper order cycle, quantity stocks, lead time and safety stock needs to be calculated for inventory cost minimization.

Poor planning and material management decreases labor productivity (Patil and Pataskar 2013). As sufficient stock is necessary for achieving project performance parameters, ABC and EOQ analysis is performed to overcome the problem of stock out.

(Madhavi, Mathew et al. 2013) emphasized on the problems related to improper material procurement process. Construction project cost may vary depending on material, manpower, subcontractor, overhead cost and other general issues. Material procurement is the variance major contributor to cost variance. (S.Sindhu 2014) used ABC analysis to classify the different types of inventory items. The data was collected via questionnaire and was analyzed through Statistical Package for Social Sciences (SPSS).

Material management is the critical component of construction industry (Soni, Pitroda et al. 2016). Proper material management enhances not only the labor productivity but also the equipment's/machines output. Timely material flow minimizes the redundant tasks and minimizes the overall procurement cost (Soni, Pitroda et al. 2016). Around 50-60 percent of project cost may be allocated for inventory (Kasim, Liwan et al. 2012) . Good project managers should be concerned with maintaining optimum investment level for inventory as well(Kasim, Liwan et al. 2012, Pande and Sabihuddin 2015).

(Himanshu Mahant 2013) defined ABC Analysis as a technique for inventory management which enables top management to place the effort where the result will be the highest. Under this method highest value of inventory is kept in category A; lowest value of inventory is kept in category C and medium value of inventory is kept in category B. The monetary percentages of each individual category are mentioned in bullets below:

- "A" Category – 5% to 10% of the items represent 70% to 75% of the money value.
- "B" Category – 15% to 20% of the items represent 15% to 20% of the money value.
- "C" Category – The remaining number of the items represent 5% to 10% of the money value.

(Patil and Pataskar 2013, Pande and Sabihuddin 2015), emphasized on qualitative analysis to analyze the planned and actual materials consumption in the construction projects. It forms S shape followed by deviation which is produced by the cumulative expenditure of parameter (cost) against time.

The literature review concludes that in a construction project usually that the actual cost of project exceeds the estimated cost. One of the factors associated with it is improper inventory control. Construction projects involves multi item. Each item has its own significance. Cost and time of a project can be controlled by having proper inventory control system. This research will highlight the most significant inventory items through ABC analysis. Additionally, this paper compared planned and actual cost of material through the s-curve analysis and applied the inventory control technique to minimize the stock out problem and total cost of inventory.

3. METHODOLOGY

Once the problem was identified, the next step was to collect the data. For data collection fields visits were arranged. One of project related to bridge construction was selected. The data was gathered from the inventory books and physical verification of the items was also performed. The raw data was then transformed into required information. Figure 1 gives the overall methodology adopted for this research. After data collection, with the help of Microsoft Excel, the ABC analysis was performed.

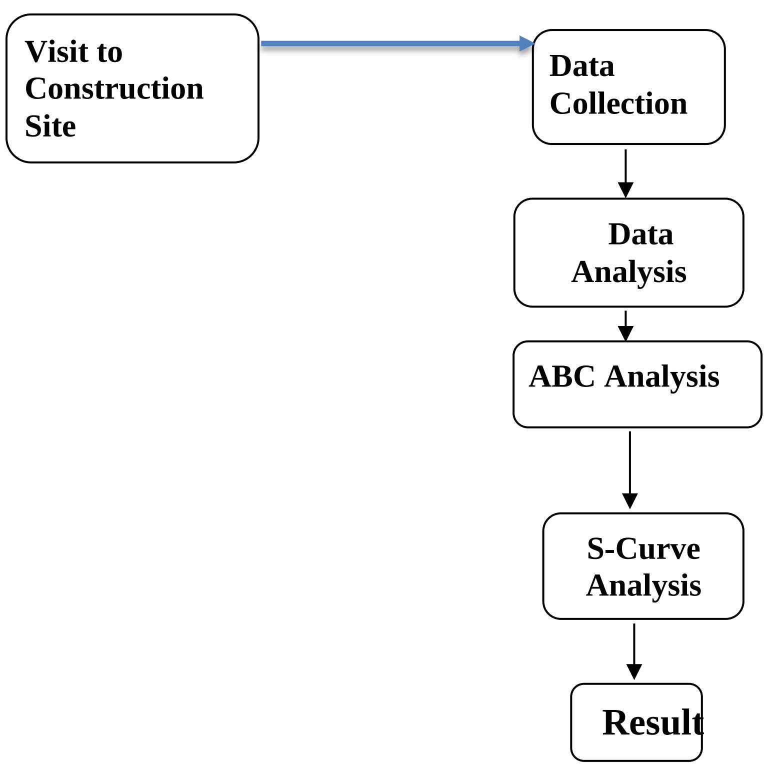

Figure 1. Methodology Flow Chart

4. DATA COLLECTION AND ANALYSIS

On site data was collected for a bridge project. Column 1 of Table 1 shows the items names where as the column 2 represents the annual demand of the respective item. Column 3 represents the annual percentage of the respective item where as the unit cost is mentioned in column 4. The respective item annual cost is mentioned in column 5 of Table 1. For ABC analysis, annual cost, annual usage percentage and annual usage cumulative percentage are the deciding factors. These factors are shown in column 6,7, and 8 of Table 1 respectively.
The items are classified on the basis of steps mentioned below:

I. Classify items and find its use in units and unit price.
II. Find the total value for every item by taking the product of expected units by its unit price.
III. Rank the item accordance to the highest total value.
IV. Calculate the percentages of number of units of each item to total units of all items and the ratio of total value of each item to total value of all items.
V. Add together the items on basis of their relative value to form A, B and C categories.

Table 1 Collected Data

S.No	Items	Annual Demand	Annual Percentage	Unite Price	Annual Cost	Annual Usage Percentage	Annual Usage Cumulative Percentage
1	**Cement**	67416	3.4932	535	36067560	19.2803	19.2803
2	**Steel 25mm**	471	0.0244	72150	33982650	18.1658	37.4462
3	**Steel 16mm**	350	0.0181	72150	25252500	13.4990	50.9452
4	**Steel 10mm**	220	0.0114	72150	15873000	8.4851	59.4303
5	**Batching plant 2 size(0.5meter**	45	0.0023	307000	13815000	7.3850	66.8153
6	**Shingle**	1089759	56.4663	11.25	12259788.8	6.5536	73.3689
7	**Steel 20mm**	156	0.0081	72150	11255400	6.0167	79.3856
8	**Crush 10--20mm**	243364	12.6100	45	10951380	5.8542	85.2398
9	**Sand**	221095	11.4561	21	4642995	2.4820	87.7218
10	**Aggregate**	100000	5.1815	34	3400000	1.8175	89.5393
11	**Excavator 3**	46800	2.4250	72	3369600	1.8013	91.3405
12	**Wooden Batten**	5000	0.2591	400	2000000	1.0691	92.4096
13	**Heavy Loader**	12	0.0006	150000	1800000	0.9622	93.3719
14	**Concrete Pump 2**	24960	1.2933	72	1797120	0.9607	94.3325
15	**Mixture 4**	24960	1.2933	72	1797120	0.9607	95.2932
16	**Plié—Sheet**	850	0.0440	1950	1657500	0.8860	96.1792
17	**Crush 20--25mm**	35909	1.8606	42	1508178	0.8062	96.9855
18	**Roller 2—4**	12	0.0006	80000	960000	0.5132	97.4986

19	**Joints**	9430	0.4886	101	952430	0.5091	98.0078
20	**Dumper—6**	12480	0.6467	72	898560	0.4803	98.4881
21	**Stone—Dust**	30000	1.5545	24	720000	0.3849	98.8730
22	**Tractor**	12	0.0006	40000	480000	0.2566	99.1296
23	**Water Tank 2—3**	6240	0.3233	72	449280	0.2402	99.3697
24	**Scaffolding pipe**	4461	0.2311	80	356880	0.1908	99.5605
25	**Crush 25--38mm**	5889	0.3051	42	247338	0.1322	99.6927
26	**Grader**	12	0.0006	200000	240000	0.1283	99.8210
27	**Steel 32mm**	24	0.0012	7700	184800	0.0988	99.9198
28	**Crane --2**		0.0000	150000	150000	0.0802	100.0000
	Total	**1929927**			**187069080**		

For detailed data analysis, item wise s-curve analysis for individual item is also performed. Table 2 shows the S-Curve data for Cement item. Column 1 of Table 2 shows the the number of months, column 2 shows the actual cost of cement per month whereas column 3 shows the planned cost (Bill of Order Quantity).

Table 2. S-Curve Analysis for Cement

No.	Actual Cost	Planned Cost
0	0	0
1	1498000	73295
2	569775	488455
3	1433800	151405
4	1765500	143915
5	1091400	485245
6	1124035	529650
7	1275975	51360
8	1123500	58850
9	1203750	346145

5. Results and Discussion

A total of 28 items were analyzed. Six (6) items as shown in Table 3 are categorized in Class A, 8 items are categorized in Class B where as fourteen items are categorized in Class C.

Cement and steel of all sizes except of 20 mm and 35 mm are categorized in Class A. As reported the contractors are also worried about cement and steel consumption. Both elements are of significant nature. There disruption not only causes delay but as shown in Table 3, the cost percentage is also on the higher side. Moreover, Shingle which is also one of the major raw material used in construction processes is also in category A.

Along with 20 mm steel, sand, aggregate, excavator etc.; are categorized in Class B. Though their significance cannot be questioned, the project might be delayed by due to them but the cost significance is on the lower side as compared to Class A items. The rest of the items are categorized in Class C.

Table 3. ABC Analysis

S.No	Items	Annual Cost	Annual Usage Percentage	Annual Usage Cumulative Percentage	Category
1	**Cement**	36067560	19.2803	19.2803	A
2	**Steel 25mm**	33982650	18.1658	37.4462	A
3	**Steel 16mm**	25252500	13.4990	50.9452	A
4	**Steel 10mm**	15873000	8.4851	59.4303	A
5	**Batching plant 2 size (0.5meter)**	13815000	7.3850	66.8153	A
6	**Shingle**	12259788.8	6.5536	73.3689	A
7	**Steel 20mm**	11255400	6.0167	79.3856	B
8	**Crush 10--20mm**	10951380	5.8542	85.2398	B
9	**Sand**	4642995	2.4820	87.7218	B
10	**Aggregate**	3400000	1.8175	89.5393	B
11	**Excavator 3**	3369600	1.8013	91.3405	B
12	**Wooden Batten**	2000000	1.0691	92.4096	B
13	**Heavy Loader**	1800000	0.9622	93.3719	B
14	**Concrete Pump 2**	1797120	0.9607	94.3325	B
15	**Mixture 4**	1797120	0.9607	95.2932	C
16	**Plié—Sheet**	1657500	0.8860	96.1792	C
17	**Crush 20--25mm**	1508178	0.8062	96.9855	C
18	**Roller 2—4**	960000	0.5132	97.4986	C
19	**Joints**	952430	0.5091	98.0078	C
20	**Dumper—6**	898560	0.4803	98.4881	C
21	**Stone—Dust**	720000	0.3849	98.8730	C
22	**Tractor**	480000	0.2566	99.1296	C
23	**Water Tank 2—3**	449280	0.2402	99.3697	C
24	**Scaffolding pipe**	356880	0.1908	99.5605	C
25	**Crush 25--38mm**	247338	0.1322	99.6927	C
26	**Grader**	240000	0.1283	99.8210	C

27	**Steel 32mm**	184800	0.0988	99.9198	C
28	**Crane --2**	150000	0.0802	100.0000	C

The graph shown in Figure 2 the comparison between Planned and Actual cost of cement consumption. The Actual cost was calculated from the unit of cement bag used on site, while the planned cost occurs from BOQ of materials. From the graph it is clear that there is too much increase in actual cement consumption due to demand fluctuation. The analysis recognizes that material management is important aspect of construction projects.

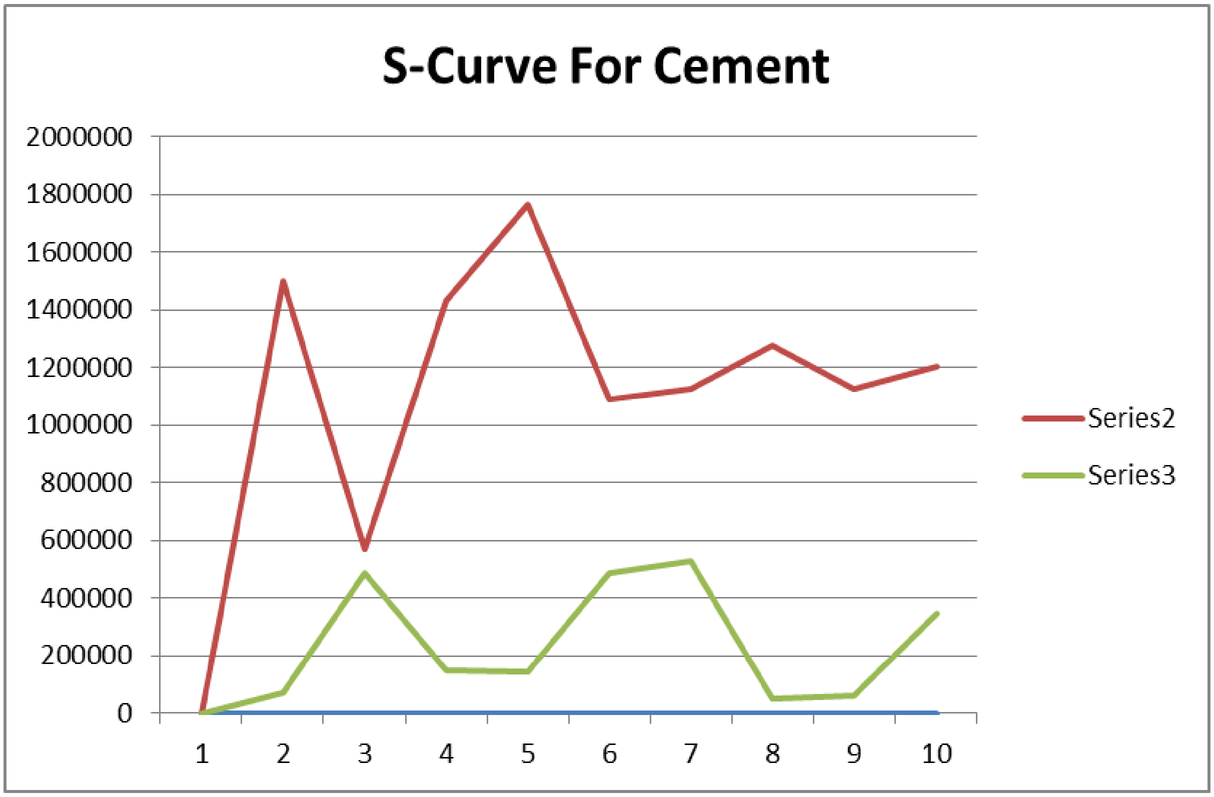

Figure 2. S-Curves for Cement

6. Conclusion

Around 50-60 percent of the project cost is associated with inventory. Improper material management leads to cost overrun as well increases time delays. ABC classification is an important technique to categorize the inventory in three different classes depending on their significance. Cement and steel are the most significant inventory items and should be procured properly. Sand etc.; is in class B where as stone etc.; are categorized in Class C.

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7. Bibliography

1. Akintoye, A., G. McIntosh and E. Fitzgerald (2000). "A survey of supply chain collaboration and management in the UK construction industry." European Journal of Purchasing & Supply Management **6**(3–4): 159-168.
2. Himanshu Mahant, P. S. S. C., Mr. Abhishek Yadav (2013). "INVENTORY MANAGEMENT BY IMPLEMENTATION OF ABC ANALYSIS UPON MEDIUM SCALE INDUSTRY." International Journal of Scientific Research **2**(8): 162-165.
3. Kanimozhi, G. and P. Latha (2014). "Material Management in Construction Industry." Indian Journal of Applied research **4**(4): 6-9.
4. Kasim, N., S. R. Liwan, A. Shamsuddin, R. Zainal and N. Che Kamaruddin (2012). "Improving on-site materials tracking for inventory management in construction projects."
5. M. Abas, S. B. K., R. Akhtar, I. Ahmad, M. Ullah, I. U. Haq (2016). "Identification of Factors Affecting Cost Performance of Construction Projects." Technical Journal, University of Engineering and Technology (UET) Taxila, Pakistan **21**(1): 104-109.
6. Madhavi, T. P., S. V. Mathew and R. Sasidharan (2013). "Material Management in Construction- A Case Study." International Journal of Research in Engineering and Technology(IC-RICE Conference Issue, Nov-2013).
7. Pande, A. A. and S. Sabihuddin (2015). "Study of Material Management Techniques on Construction Project."
8. Patil, A. R. and S. V. Pataskar (2013). "Analyzing Material Management Techniques on Construction Project." International Journal of Engineering and Innovative Technology (IJEIT), ISSN: 2277-3754.
9. S.Sindhu, D. K. N., V.Krishnamoorthy (2014). "Performance Analysis of Inventory Management System in Construction Industries in India." International Journal of Innovative Research in Science, Engineering and Technology **3**(4): 11488-11493.
10. Soni, H., J. Pitroda and J. J. Bhavshar (2016). "ANALYZING INVENTORY MATERIAL MANAGEMENT CONTROL TECHNIQUE ON RESIDENTIAL CONSTRUCTION PROJECT." **2**(3).
11. Zou, A. J. (2012). Optimization Research of Construction Inventory Management on Site Based on Inventory Theory. Applied Mechanics and Materials, Trans Tech Publ.
12. Zou, P. X. W., G. Zhang and J. Wang (2007). "Understanding the key risks in construction projects in China." International Journal of Project Management **25**(6): 601-614.

Project Management Effects on a Construction Organization

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Abstract: This paper evaluates the effect of project management on the performance of construction firm in Swat. Construction projects are mostly evaluated in terms of cost, quality and time. Once a construction project starts, certain aspects can easily deviate or go astray. This deviation can be overspending, a schedule slippage departure from the objective or scope. To overcome these factors available project management tool, need to be analyzed for taking corrective action to get the project back on track, or at least minimize the deviation. Project control process can helps track and manage the scope, cost and schedule for a construction project. This will establish a baseline which will act as a benchmark.

Keywords: Project Management, Construction, Khyber Pakhtunkhwa

1. INTRODUCTION

Human accomplishment in Construction can be traced back to the builders of pyramids, the architects of ancient cities and the mason and craftsmen of the Great Wall of China. (Woods and Woods 2000). Project management is critical for the success of a project. It contributes around 50 percent of the over all work. Project management is defined as accomplishment of project through application and integration of process initiation, planning, execution, monitoring, controlling and closing (Morris and Jamieson 2005). The aim of the project management is to integrate these functions and satisfy the stakeholders (Morris and Jamieson 2005).

Construction organization involves multiple stake holders, this leads to increase in complexity as well (Meng 2010, Meng 2012). Project management becomes essential throughout the life cycle of the project to achieve key performance indicators (Morris and Jamieson 2005). According to (Atkinson 1999), a project is dynamic and changes during life cycle from one stage to another.

A project could be viewed as a system, which is dynamic and ever changing from one stage to another in a life cycle (Atkinson, 1999). (Harvey 1999) consider project to have specific starting and ending date, objectives, budget and resources. (Spinner 1997) defines project as a unique set of series of tasks or activities.

Currently projects are more complex and and the risks involved are also much higher (S.B.Khattak 2015). In project management the cultural, and logistic barriers are also considered (Atkinson 1999).

2. LITERATURE REVIEW

Many researchers have studied the causes and effects of project delay in a construction industry. The literature review is categorized into two parts. The first one relates to the causes of delay whereas the second part focuses on the delay's affect.

2.1 Studies on causes of delay:

(Mansfield, Ugwu et al. 1994) worked on the identification of factors related to delay and cost over run. The study was primarily related Nigerian construction industries. A questionnaire survey was used for data collection. The study identified that finance and payment arrangements, poor contract management, shortages in material, and inaccurate estimation etc.; are the most significant factors.

(Assaf, Al-Hammad et al. 1995) studied the delays related to construction projects of Saudi Arabia. The findings were that approval of drawings, payments, and design changes delays the project significantly. A total of 56 delay causes was identified. The study emphasizes quick decision making by all the stakeholders can significantly reduces the delays.

(Chan and Kumaraswamy 1997) analyzed the reasons of delays in Hong Kong construction projects. The results indicate that poor project management, including risk assessment and slow decision making process are the significant contributors to delays. The study was related to role of parties (i.e. client, consultant or contractors) and also to the types of projects.

(Al-Momani 2000) quantitatively analyzed construction delays in Jordan. Factors such as user changes, site conditions and economic conditions were his main findings. Similarly (Odeh and Battaineh 2002) analyzed the delays from contractors and consultant perspective. The results show that the practitioners agreed that owner interference, slow decision making and improper planning delays the project significantly.

2.2 Studies on effects of delay:

Construction projects are usually evaluated in terms of cost, time and quality (Meng 2010, Khattak, Abas et al. 2015).(Aibinu and Jagboro 2002) focused on the effects of delays in Nigerian construction industry. A set of questions was shared with different stakeholders. The study highlighted that delays causes time and cost overrun, dispute, and litigations.

(Manavazhi and Adhikari 2002) paper is related to delays in highway projects in Nepal. A data of total 22 different project was collected via survey. The study identified the factors associated with the time delays and also their effects. Organizational weakness, government regulations and transportation delays were critical. Their major effect was cost overrun. (Williams 2003) used casual mapping and system dynamic approach to study the impacts of delays.

The literature review concludes that multiple factors are associated with the time delays. The factors significance varies from region to region. However improper project management (project planning) is considered significant by all the researchers. Time and cost overrun is the major the effect of delays. This paper will focus on the project management approach of evaluating and comparing the planned and actual time of a project.

3. METHODOLOGY

The very first and basic step is to collect the data of overall construction project. Highlight all the activities involve in the project, and make Gantt chart from those activities. Secondly the sub activities of major activities are observed and a flow chart will be drawn. After that collect the day wise activities and progress of the project and observed that either the project is on track or some activities or factors show deviation from the actual plan. The reasons and effects of that deviation should be noted. Finally draw a network diagram of all these activities and calculate the critical path. The overall project time, cost and scope depends on the activities that lie on the critical path. So these activities should be carefully checked repeatedly.

4. DATA COLLECTION AND ANALYSIS

Column 2 of Table 1 Shows the major activities of the project. The project work order is dated March 05, 2015. The Table 1 enlist the planned activities along with its duration and starting time. The contractor planned each activity independently. The column 1 of Table 1 shows the order of activities to be performed. A total of 33 major activities are involved. The project was planned to be completed by June 24, 2016. The data was collected from on site visits and the major activities were also verified from the Bill of Quantity (BOQ) as well.

Table 1. Major activities of the project

S. No	Activity	Starting Date	Days to complete
1	Mobilization	6-Mar-15	2
2	Topographic survey	9-Mar-15	2
3	Plot Preparation	12-Mar-15	2
4	Excavations	15-Mar-15	60
5	PCC	15-May-15	15
6	RCC	31-May-15	25
7	Brickwork and foundation	26-June-15	6

8	Plain Beam	2-July-15	13
9	Back Filling	15-July-15	5
10	Ground Floor Column And Slab	24-Jul-15	91
11	First Floor Column And Slab	24-Sep-15	92
12	Ground Floor Masonry	24-Oct-15	90
13	First Floor Masonry	24-Dec-15	89
14	Plaster Ground Floor(Internal And External)	24-Oct-15	62
15	Plaster First Floor(Internal and External)	24-Jan-16	61
16	Flooring Ground Floor	24-Nov-15	59
17	Flooring First Floor	24-Feb-16	61
18	Ceramic Tiles G.Floor	24-Dec-15	28
19	Ceramic Tiles F.Floor	24-Mar-16	31
20	Painting G.Floor and External	24-Jan-16	61
21	Painting F.Floor And External	24-Mar-16	61
22	Door Frame G.Floor	24-Dec-15	28
23	Door Frame F.Floor	24-Feb-16	30
24	Windows G.Floor	24-Nov-15	59
25	Windows F.Floor	24-Jan-16	61
26	Doors Ground And First Floor	24-Dec-15	150
27	Electrical Conducting Ground Floor	24-Aug-15	152
28	Electrical Conducting First Floor	24-Oct-15	151
29	Plumbing Piping Ground Floor	24-Oct-15	92
30	Plumbing Piping First Floor	24-Dec-15	89
31	Electrical Accessories G. & First Floor	24-Feb-16	122
32	Plumbing Accessories G.& First Floor	24-Mar-16	123
33	Site Clearance and Demobilization from site	24-Jun-16	61

The contractor as per the experience planned the activities as shown in Table 2. However due to reasons as discussed in next section, the project first 9 activities took much more time than the planned.

Table 2: Actual Days for first 9 Activities

S.No	**Activity**	**Starting Date**	**Planned Days**	**Actual Days**

1	Mobilization	6-Mar-15	2	2
2	Topographic survey	9-Mar-15	2	180
3	Plot Preparation	12-Mar-15	2	30
4	Excavations	15-Mar-15	60	240
5	PCC	15-May-15	15	20
6	RCC	31-May-15	25	40
7	Brickwork and foundation	26-June-15	6	15
8	Plain Beam	2-July-15	13	20
9	Back Filling	15-July-15	5	20
Total (Days)			130	567
Delay (Days)			437	
Delay (Months)			14.5666666666667	

Currently the project is at 10th activity and is still lagging behind the planned schedule. The number of days as planned for activity 10 is also increased from 91 to 125 and still counting. Table 3 shows one significant delay after activity 9. Such delay is unforeseen but significantly effect the overall performance parameters of the project.

Table 3 Actual and New Plan

S.No	Activity	Starting Date	Days	Actual
1	Mobilization	6-Mar-15	2	2
2	Topographic survey	9-Mar-15	2	180
3	Plot Preparation	9-Aug-15	2	30
4	Excavations	8-Sept-15	60	240
5	PCC	4-April-16	15	20
6	RCC	24-Apr-16	25	40
7	Brickwork and foundation	03-May-16	6	15
8	Plain Beam	19-May-16	13	20
9	Back Filling	08-June-16	5	20
Delay of 60 Days due to Non-Payment				
10	Ground Floor Column And Slab	1-Sep-16	91	125
11	First Floor Column And Slab	1-Nov-16	92	-
12	Ground Floor Masonry	1-Dec-16	90	-

13	First Floor Masonry	1-Feb-17	89	-
14	Plaster Ground Floor(Internal And External)	1-Dec-16	62	-
15	Plaster First Floor(Internal and External)	1-Mar-17	61	-
16	Flooring Ground Floor	1-Jan-17	59	-
17	Flooring First Floor	1-Apr-17	61	-
18	Ceramic Tiles G.Floor	1-Feb-17	28	-
19	Ceramic Tiles F.Floor	1-May-17	31	-
20	Painting G.Floor and External	1-Mar-17	61	-
21	Painting F.Floor And External	1-May-17	61	-
22	Door Frame G.Floor	1-Feb-17	28	-
23	Door Frame F.Floor	1-Apr-17	30	-
24	Windows G.Floor	1-Jan-17	59	-
25	Windows F.Floor	1-Mar-17	61	-
26	Doors Ground And First Floor	1-Feb-17	150	-
27	Electrical Conducting Ground Floor	1-Oct-16	152	-
28	Electrical Conducting First Floor	1-Dec-16	151	-
29	Plumbing Piping Ground Floor	1-Dec-16	92	-
30	Plumbing Piping First Floor	1-Feb-17	89	-
31	Electrical Accessories G. & First Floor	1-Apr-17	122	-
32	Plumbing Accessories G.& First Floor	1-May-17	123	-
33	Site Clearance and Demobilization from site	1-Aug-17	61	-

5. Results and Discussion:

The last column of Table 4 shows the causes of delay. As discussed in literature review, poor project management can significantly effect the time delays. As shown in Table 4, Topographic survey was planned to take 2 days but actually it took 180 days. The reason was that the survey conducted by the consultant and contractor didn’t match. The consultant in its document reported the site to have soft rocks where as the contractor’s claim was that it is hard rock. The consultant failed to establish the facts. The third party arbitration took more than 5 months to satisfy both the consultant and contractors. This poor decision making on part of stake holders delayed the project by 6 months.
As seen in Table 1, some of the activities are to be performed simultaneously, with this delay the first 9 activities were than scheduled to be periodic. The delay in activity 3 which is “Plot Preparation” is the result of improper information flow. With no proper coordination about the decision regarding the topographic survey, the contractors failed to complete the activity as planned.
Excavation was planned to take 60 days. The rocks as per the contract documents was reported to be soft. The project manager as per area calculations and machines available planned it for 60 days. But on ground the rock was hard and it took more than 7 months to clear the area.

Table 4 Delay Reasons

S.No	Activity	Starting Date	Planned Days	Actual Days	Delay Reason
1	Mobilization	6-Mar-15	2	2	-
2	Topographic survey	9-Mar-15	2	180	Wrong Survey
3	Plot Preparation	12-Mar-15	2	30	Slow Decision
4	Excavations	15-Mar-15	60	240	Hard Rocks instead of Soft Rocks
5	PCC	15-May-15	15	20	Skilled Labor Absence
6	RCC	31-May-15	25	40	Skilled Labor Absence
7	Brickwork and foundation	26-June-15	6	15	Skilled Labor Absence
8	Plain Beam	2-July-15	13	20	Wrong Amount Calculations
9	Back Filling	15-July-15	5	20	Wrong Calculations
Unforeseen Delay				60	Non-Payment
Total (Days)			130	567	0
Delay (Days)			437		
Delay (Months)			14.5666666666667		

The other activities such as Plain Beam had wrong area calculations, where as Back Filling was much more as mentioned in the BOQ. Skill labor absence caused the PCC, RCC and Brick work activities to be delayed by more than a month. The uncertain site situation caused the skilled labor to leave the site and search for other opportunities. As the contractor was not in position to keep the labor without utilizing their services. The poor decision making resulted in skilled labor loos. The contractor opted to used unskilled labor but the amount of rework was very much. So the manager had to wait for skilled labor to reach the site.

As the client was unable to make the payments, as per the contractors claim. The contractors willfully stopped the project by 60 days. Once the payment was settled the project was again started.

6. CONCLUSION

This paper related delay factors reported in literature review related to other countries. The same factors some how are responsible for time delays in Pakistan construction industries. All the stakeholders need to onboard, Blame game or running away from accepting mistakes delays the project. As delays results in cost overrun. The national exchequer has to pay more to the contractors and consultant for the services. The penalty and proper information flow needs to be implemented at all levels. Before awarding project, the Financial record of both the clients and contractors needs to be verified. Such unforeseen delays can become routine and will significantly effect the overall project performance.

7. REFERENCES

1.

1. Aibinu, A. A. and G. O. Jagboro (2002). "The effects of construction delays on project delivery in Nigerian construction industry." International journal of project management **20**(8): 593-599.

2. Al-Momani, A. H. (2000). "Construction delay: a quantitative analysis." International journal of project management **18**(1): 51-59.

3. Assaf, S., A. Al‐ Hammad and M. Al‐ Shihah (1995). "The effect of faulty construction on building maintenance: The results of a survey of 90 contractors, 30 architectural/engineering firms and 20 owners from the eastern province of Saudi Arabia identified 35 defect factors during the construction stage." Building research and information **23**(3): 175-181.

4. Atkinson, R. (1999). "Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria." International journal of project management **17**(6): 337-342.

5. Chan, D. W. M. and M. M. Kumaraswamy (1997). "A comparative study of causes of time overruns in Hong Kong construction projects." International Journal of project management **15**(1): 55-63.

6. Harvey, M. (1999). Project Management, the Nature and Context of Project Management, Strategy and Project Management, Financial Time Prentice Hall.

7. Khattak, S., M. Abas, S. Maqsood, M. Omair, R. Nawaz and I. U. Haq (2015). "Identification and Evaluation of Risk Factors Affecting the Supply Chain Environment of Construction Industry of Khyber Pukhtunkhwa (KPK)." University of Engineering and Technology (UET) Taxila, Pakistan **20**(SI): 6.

8. Manavazhi, M. R. and D. K. Adhikari (2002). "Material and equipment procurement delays in highway projects in Nepal." International Journal of Project Management **20**(8): 627-632.

9. Mansfield, N. R., O. O. Ugwu and T. Doran (1994). "Causes of delay and cost overruns in Nigerian construction projects." International journal of project Management **12**(4): 254-260.

10. Meng, X. (2010). "Assessment framework for construction supply chain relationships: Development and evaluation." International Journal of Project Management **28**(7): 695-707.

11. Meng, X. (2012). "The effect of relationship management on project performance in construction." International journal of project management **30**(2): 188-198.

12. Morris, P. and A. Jamieson (2005). "Moving from corporate strategy to project strategy." Project Management Journal **36**(4): 5-18.

13. Odeh, A. M. and H. T. Battaineh (2002). "Causes of construction delay: traditional contracts." International journal of project management **20**(1): 67-73.

14. S.B.Khattak, M. A., S. Maqsood, M.Omair, R. Nawaz , I.Ul Haq (2015). "Identification and Evaluation of Risk Factors Affecting the Supply Chain Environment of Construction Industry of Khyber Pukhtunkhawa (KPK)." Journal of University of Engineering & Technology (UET) Taxila, Pakistan **20**(II (S)): 185-190.

15. Spinner, M. (1997). Project management: principles and practices, Prentice Hall.

16. Williams, T. (2003). "Assessing extension of time delays on major projects." International Journal of Project Management **21**(1): 19-26.

17. Woods, M. and M. B. Woods (2000). Ancient Construction: From Tents to Towers, Twenty-First Century Books.

Assessment of site specific wind potential, energy generation and sensitivity analysis

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Abstract: Pakistan is energy deficient country, whose energy needs solely fulfilled by oil and gas resources. To produce energy by and large with oil and gas is expensive business for developing countries like Pakistan. The objective of this feasibility study is to find out new potential site for setting up wind farm. The methodology covers the detailed investigation of wind climate characteristics by using Weibull, k *and* c parameters and standard deviation. After wind assessment, three different wind turbines are compared so as to get the maximum energy output at the height 30m is materialized. In last, economic assessment of the each three of wind turbines is carried out. The site specific sensitivity analysis is also carried out. In this context, feasibility study of south coastal area of Karachi is carried out which demonstrate that the site has potential to install utility wind turbines. The wind assessment and financial aspect also calculated which showed potential results. The site specific sensitivity analysis has been carried out in terms of tangential force. This type of sensitivity analysis of site has not been performed yet before in any investigation study. The results of sensitivity analysis would become the basis for the site specific design optimization of the wind turbines.

Keywords: Wind analysis, Weibull parameters k and c, Wind power density, Energy production, Capacity factor, Economic analysis, Sensitivity analysis

1. INTRODUCTION

Pakistan is energy deficit country whose energy needs are solely fulfilled by oil and gas. The oil imports rise 3.8% per year after 1991 up to now. Similarly the demand rise again in the year 2015 with 4.4%. The average price of oil in 2001 was $23/barrel and within the same year the price of oil shoots up rapidly to $50.05/barrel. This is almost 115% rise of price in short span of time. According to national economic review that due to energy shortages the country lost 4.5% of the GDP in the last years. It resulted in to closure of factories, paralyzing the industrial production and exacerbating the unemployment.

There is another important reason to cope with the energy crisis is the worst financial position of the country. The current demand of electricity is 19000MW per day whereas the supply is 10500MW per day. The supply and demand gap is 8500MW per day. This gap can be overcome by wind energy. According to National renewable laboratories that Pakistan has $61{,}650\ m^2$ appropriate land for the installation of wind turbines. It accounts for the 8% of total land i.e.$770{,}875m^2$. The coastal belt of Sindh and Baluchistan has been termed as the wind corridor of the country[1].

2. LITERATURE REVIEW

Kalidellis described the past and current perspectives of fossil fuels and wind energy to fulfill energy needs [2]. Mostafaeipour et al conducted feasibility studies for generation of wind energy at different regions including shahrbabak city of Kaman province, Yazd province and Binalood city of Iran at different heights refer [3-5]. Keyhani et al investigated wind climate for energy production at Tehran, the capital city of the Iran refer [6]. S.kwon investigated wind uncertainty effects on energy production of the kwangyang bay [7].

Mohammadi et al estimated wind potential of Zarinah and used standard deviation and find out the accurate wind power density refer [8]. Mir hosseini et al conducted study of five towns of saman province of Iran and studied wind data for energy production refer [9]. Dhamouni et al investigated the wind variation at different heights for potential production based upon 1.5MW wind turbine at Borj-Cedria of Tunisia [10] Li et al assessed the wind energy potential of waterloo Canada [11]. Lashin et al analyzed the wind energy production of Port Said of Egypt [12]. Himri et al conducted the study of the tindouf of Algeria based on eight years of wind speed data [13].

Durisic et al conducted the study of wind energy at the South Banat region of the Serbia and concluded that the site is suitable for the large wind farm[14]. T.B.M.J.Ouarda et al evaluated the wind speed with reference to probability density function and used suitable pdf to minimize the wind power estimation error [15]. Alabadi et al conducted the wind potential of yanbu of Saudi Arabia and suggested the site has potential for the small wind turbines[16].

3. SITE SPECIFIC FEATURES

Karachi is a major economic activity generating city of Pakistan. Karachi is also falls on the coast line of Arabian Sea that is 1060km long connects two provinces namely Baluchistan and Sindh. The salient features of site are enumerated in table 1.

Table 1 Site specific features of south coastal area Karachi

Station Parameters	Unit	Features
Latitude	deg N	24° 52' 02.025"
Longitude	deg E	66° 51'41.983"
Wind Frequency	m/s	78.5/28.5m
Mean Wind speed at 30m	m/s	5.199
Wind Direction	m/s	0 -360°
Average Temperature	C°	24°
Surface Roughness	Sa	0.0024
Surface Roughness Class	Sa	0.5
Pressure	m bar	900 - 1100
Terrain	-	Flat Land
Obstacles	-	Nil
Relative Humidity	%	0 -100
Air Density	kg/m³	1.188

4. METHODOLOOGY

4.1. Wind Shear

Wind shear is the rate of change of velocity or direction of wind speed. The wind shear of the specific site has been calculated by the following equation;

$$\alpha = \frac{\ln(V_2)-\ln(V_1)}{\ln(Z_2)-\ln(Z_1)} \quad (1)$$

$V_1 refers\ to\ wind\ speed\ at\ the\ height\ Z_1$,$V_2\ refers\ to\ the\ wind\ speed\ at\ the\ height\ Z_2$ and

$\alpha\ wind\ shear\ coefficient$

4.2. Air Density

The air density is expressed as under

$$p = \frac{P}{R \times T}(Kg/m^3) \quad (2)$$

$p\ is\ the\ air\ pressure\ (Pa\ or\ N/m^2)\ R = the\ specific\ gas\ constant\ for\ air (287J/kg\ )$

$T = air\ temperature\ in\ kelvin(c + 273°)$

4.3. Weibull Probability Distribution Function

The Weibull $f(v)$ probability distribution function is written as;

$$f(v) = \left(\frac{k}{C}\right)\left(\frac{V}{C}\right)^{k-1} \exp\left(-\frac{V}{C}\right)^k \quad (3)$$

Here V refers to wind speed, k refers to Weibull shapeless parameter, c refers to Weibull scale parameter having similar dimension of V. The mean wind speed can be calculated as;

$$V_{mean} = \frac{1}{N}\sum_{i=1}^{N} V_i \quad (4)$$

The standard deviation can be calculated as;

$$\sigma^2 = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(V_i - V_{avg})^2} \quad (5)$$

The wind power can be calculated as;

$$P = \frac{1}{2}(air\ density)(swept\ area)(wind\ seed)^3 \quad (6)$$

Betz limit is denoted by Cp and can be expressed as;

$$P = \frac{1}{2}(air\ density)(betz\ constant)(swept\ area)(wind\ seed)^3 \quad (7)$$

The WPD can be calculated with the Weibull density function as;

$$WPD = \frac{P}{A_T} = \frac{1}{2} pC_{p^3}\Gamma\ (1 + \frac{3}{\mathrm{k}}) \quad (8)$$

Weibull distribution function for achieving the wind energy

$$E = T\int \left(\frac{k}{C}\right)\left(\frac{V}{C}\right)^{K-1} exp\left(-\frac{V}{C}\right).p(v)d(v) \quad (9)$$

4.4. Capacity Factor

Capacity factor of wind turbine calculated as;

$$cf = \frac{A_{Power}\ of\ wind\ turbine}{R_{power} of\ wind\ turbine} \quad (10)$$

5. ECONOMIC ANALYSIS

Let I can be termed as an initial investment whereas C_{om} referred as operation and maintenance cost which is known as $n\%$ of the primary investment. T is termed as the life time of the wind turbine. The discounted costs of operation and maintenance for the life time t of wind turbine for the initial year can be calculated by

$$PC_{om_{1-t}} = I\left[\left[\frac{(1+i_r)^t-1}{i_r(1+i_r)}\right]\right] \tag{11}$$

The net present worth can be calculated as

$$PW_{1-t} = I\ \left[I + n\left\{\frac{(1-i_r)^t-1}{i_r(1+i_r)^t}\right\}\right] \tag{12}$$

So, cost is calculated by

$$NPW = \frac{PW_{1-t}}{t} = \frac{1}{t}\left[I + n\left\{\frac{(1-i_r)^t-1}{i_r(1+i_r)^t}\right\}\right] \tag{13}$$

The total cost of the wind energy is calculated by the following equation

$$T_c = \frac{PW}{E} \tag{14}$$

Here E is referred as energy generated by the wind turbines annually. The annual energy is computed by below equation. Where E refers to energy, T_{Ah} refers to total time in year (hours), $R_P$refer to rated power of wind turbine and $C_F$refer to capacity factor of wind turbine.

$$E = T_{Ah}\times R_P\times C_F \tag{15}$$

$$E = \frac{1}{T_{Ah}}\left(\frac{1}{R_p C_F}\right)\left[\left[I + n\left\{\frac{(1-i_r)^t-1}{i_r(1+i_r)^t}\right\}\right]\right] \tag{16}$$

6. SITE SPECIFIC SENSITIVITY ANALYSIS

The sensitivity analysis has been carried out to investigate the tangential force of the wind climate upon the components and wind turbine. The wind turbine components are subject to variable loading with dynamic amplitude. The basic idea is to enhance the life of the components while taking into account the wind data and wind shear data. So the unsteady nature of the wind causes the change in the torque pass out through the drive train. Therefore the dynamic cyclic loading changed at each revolution is subject to changing another load upon the wind turbine drive train components. The weight factor is changing throughout the year. Farrugia mentioned the seasonal weight factor changing[26]. In the winter season it move up to 0.47 and in the summer decreased 0.35. Similarly Firtin et al mentioned the weight factor of more than fifteen locations[17]

$$Weight\ Factor = \frac{(\Sigma T_f)_{mean\ year \propto} - (\Sigma T_f)_{\text{mean month}\propto}}{(\Sigma T_f)_{mean\ year \propto}}\times 100 \tag{17}$$

$T_f$refers to the tangential force of the weight component on ith components,$\propto$refers to the weight factor.

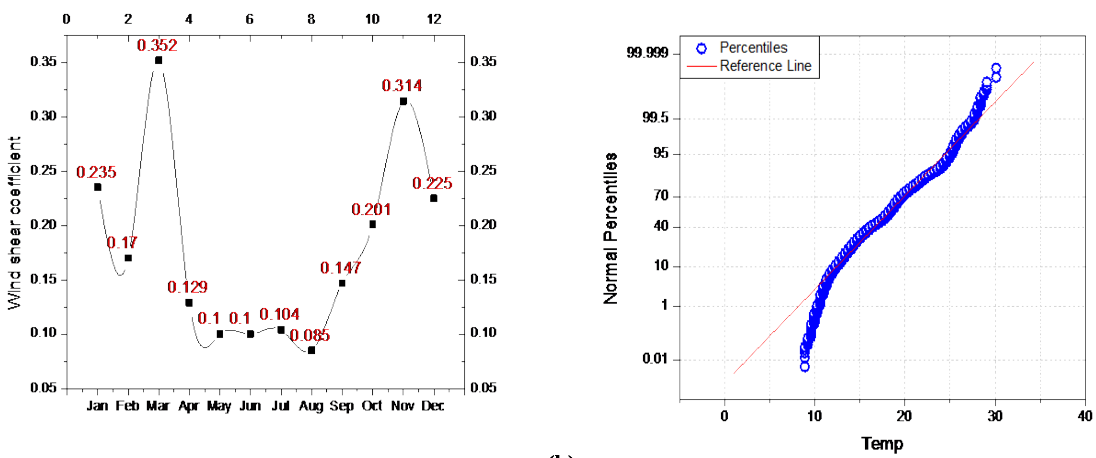
7. RESULTS AND DISCUSSION

7.1. Wind Shear

Wind shear is termed as the rate of change of speed and direction of wind with height in the atmosphere. It is considered as the important reasons that can rapid change the lift and the drag. The performance of the wind turbine is affected by the wind shear. Rehman et al also mentioned in his study the role of wind shear factor which effected the energy production 6 % as compared to 1/7th power law[17]. F.castellani investigated the atmospheric stability and wind profile and concluded how wind behavior and wind shear coefficient influences the energy production. Similarly Ebubekar et al also mentioned the importance of the wind shear that the accurate determination of wind shear is critical to the wind turbine design and energy maximization[18]. The mean wind shear coefficient for south coastal area is 0.1757 whereas the mean monthly wind shear coefficient is changeable refer figure 1(a).

7.2. Air Density:

Air density is essential factor while considering the wind power of the site. Later is directly proportional to the air density. The denser air is responsible for more energy generation. The mean air density of site found 1.188kg/cm³. The maximum value of air density found 1.22 in the month of December and minimum value 1.164 in the month of June refer figure 4. The impacts of seasonal variations also observed in air density values. The mean seasonal air density from December to February, March to May, June to August and September to November is 1.211kg/cm³,1.183kg/cm³,1.166kg/cm³ and 1.178kg/cm³ respectively. Similarly the Weibull temperature of site for year is given in figure 1(b).



(a) (b)

Figure 1 Results (a) Wind shear (b) Yearly simulated temperature of site

7.3. Wind speed variation analysis

The wind data is collected for a year 2009-10. The data is taken at the height of 30m refer figure 2. The wind varies throughout day, month, and year. The average wind speed at the height of 30m found5.199m/s for a year. The average wind speed from April to September is greater than other months. In fact, seasons have pivotal impact upon wind speed. There are four seasons in Pakistan including winter that starts from December lasts up to February. Spring starts from March to May, summer from June to August and autumn from September to November. The average seasonal wind speed during the months from December to February, March to May and June to August and September to November are 4.339 m/s,5.26m/s6.59,m/s and 4.60m/s at the height of 30m respectively.

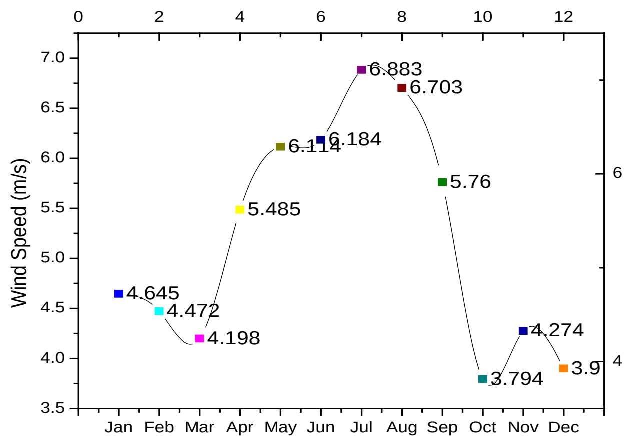


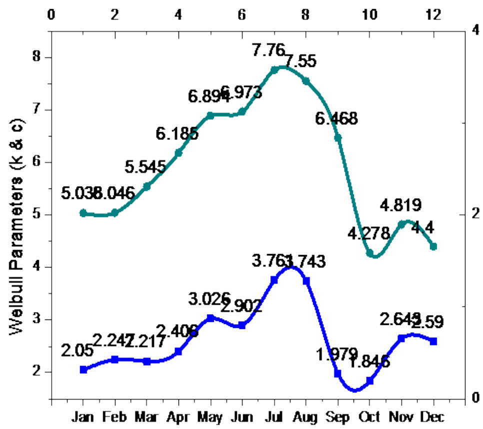
Figure 2 Site specific wind speed at the height of 30m

The wind speed is also analyzed according to most probable point and maximum energy produced. Accordingly, the most probable wind speed is 6.883m/s and 6.703m/s in the months of July and August. The maximum energy extracted in July and august is 0.88 *GWh* and 0.82 *GWh* at the height of 30m respectively while taking the parameters of wind turbine into account.

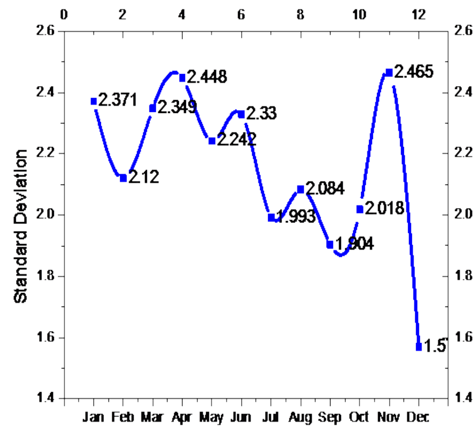
7.4. Weibull Probability Distribution Method

In this paper, two parameter Weibull distribution function is used to determine the effectiveness of the wind speed. The k parameter is also termed as the dimensionless parameter whereas the c is termed as scale parameter measured in m/s. The value of scale parameter c is spread in wide range i.e. wind speed data and has a tendency of higher and lower or varaited wind speed for a time. Similarly the value of k factor is dimensionless; if it remains in between 1 and 2 then the wind speed can be termed as the low level wind. If the value of k factor showing increasing tendency the distribution can be considered as skewed to high level of winds.

The mean Weibull dimensionless parameter k at the heights of 30m found 2.617. The dimensionless parameter k was minimum 1.846 in the month of October and maximum 3.761 in the July at the height of the 30m. The monthly mean Weibull scale parameter c at the height of 30m is 6.087respectively. According to the computed data, the Weibull scale parameter c is minimum in the month of December and maximum in July. The minimum values found 4.4 and maximum in 7.76 at 30m height. The average standard deviation found 2.157 at the height of 30m respectively. The results of Weibull parameters k & c and standard deviation are depicted in figure 3(a) and (b).



(a)

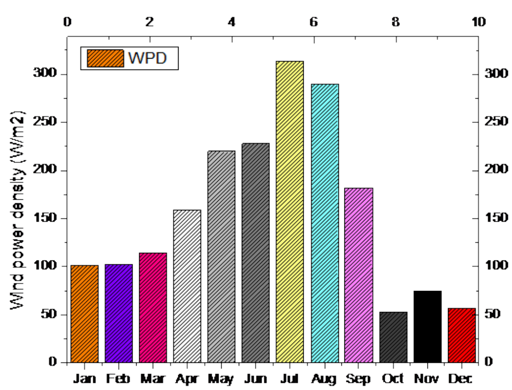


(b)

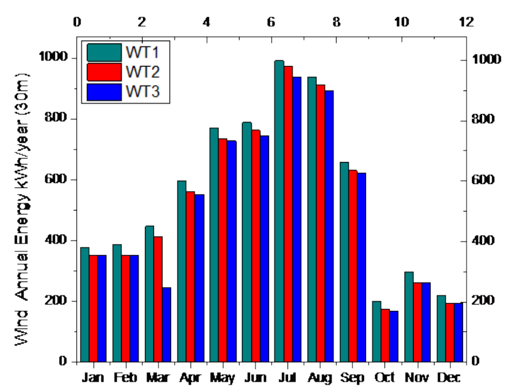
Figure 3 Results of site specific (a) Weibull *k&c* parameters and (b) Standard deviation of site

7.5. Wind Power and Annual Energy Calculation

The wind power density calculated for the three different wind turbines at the height of 30m. The mean wind power density found 157.9W/m^2 158.2W/m^2 and 154.6$W/m^2$for the wind turbine 1, 2 and 3 respectively. The mean wind power density of wind turbine is given in figure 4(a). The annual energy at the heights of 30m calculated for three compared wind turbines. The mean annual energy found555.9kWh/m^2, 526.8kWh/m^2and504.1kWh/m^2 for wind turbine 1,2 and 3 respectively refer figure 4(b). Similarly the wind annual energy is influenced by the seasonal variations. The mean seasonal wind power density from December to February is 327.3kWh/m^2,298.3kWh/m^2and298.3$kWh/m^2$for wind turbine 1,2and3 at the height of 30m respectively. The mean wind density power is calculated for the months from March to May is,604.6kWh/m^2,569.6 $kWh/m^2$and 508.3 kWh/m^2 of wind turbine 1,2 and 3 respectively. For the months from June to August is,906 kWh/m^2,882.6 $kWh/m^2$and 859 W/m^2 for the wind turbine 1,2 and 3 respectively. Similarly the wind power density for the months from September to November is385.6 kWh/m^2,356.3 kWh/m^2, and 350.6 kWh/m^2 for the wind turbine 1, 2 and 3 respectively.



(a)



(b)

Figure 4 Results of (a) Wind power density (b) Annual energy of wind turbines *kWh*/year/m2

7.6. Selected Wind Turbines Configuration, Power Curve and Energy Generation

The performance assessment of three wind turbines, considering the mechanical configuration, at the height of 30m have been selected to maximize the energy output. The detailed configuration of three compared wind turbines is given in the table 2.

Table 2 Wind turbine configuration at the height (30m)

Features	Hub Height 30m		
	WT 1	WT 2	WT 3
Swept Area	876	692.7	572
Rated Power	300	250	150
No: of Blades	3	3	3
Cut In speed	3	3	3
Cut out speed	25	25	25
Gear Box Ratio	1:48	1:25	1:25

The power curve is most important measure of the wind turbine which elaborates the power curve density of the site. The power curve density of selected wind turbines for study is depicted in figure 5. The IEC 61400-12 also describes the power curve as important measure of wind turbine. Moreover the selection of the wind turbine and its features are necessary for maximum output. This is based upon the wind turbine features including hub height, rotor diameter and swept area, cut in and out speed, rated power and gear ratio etc. In this paper the analysis of wind turbines has been carried out to get maximum energy output at the hub height of 30m respectively. In this regard three different wind turbines have been considered and for features refer table 3.

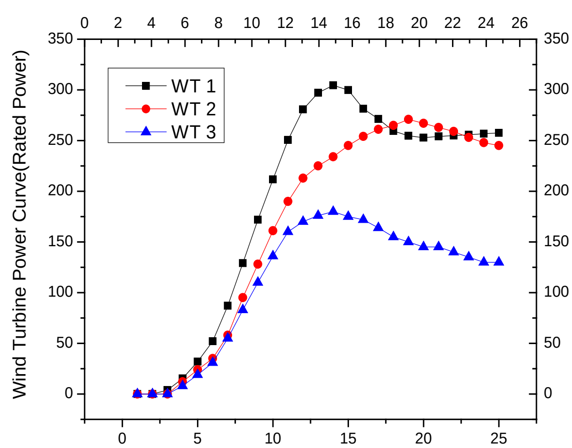


Figure 5 Wind power curve of turbine

The wind turbine 1 has maximum annual energy output of 5.87*GWh* as compared to wind turbine 2 and 3 which have lower annual energy output i.e.4.124 *GWh* and 4.29*GWh* respectively. The mean energy output during December to February, March to May, June to august, September to November is 0.29*GWh*, 0.526*GWh*, 0.803*GWh* and0.336 *GWh* by the wind turbine 1 respectively. The mean energy output during December to February, March to May, June to August, and September to November is 0.186*GWh*, 0.373GWh, 0.58*GWh* and 0.23*GWh* by the wind turbine 2 respectively. Similarly, the mean energy output during December to February, March to May, June to August, and September to November is 0.166*GWh*, 0.29*GWh*, 0..49*GWh* and 0.48*GWh* by the wind turbine 3 respectively. Capacity factor is referred as energy output measure. The calculated mean annual capacity factors at the height of 30m found 18.6, 15.8 and 23.2 of wind turbine 1, 2 and 3 respectively see figure 6.

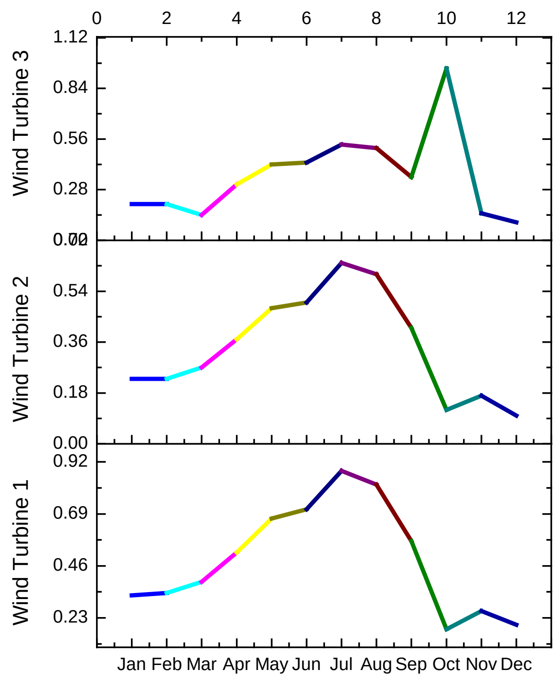


Figure 6 Annual Energy Production of three compared Wind turbines at 30m height

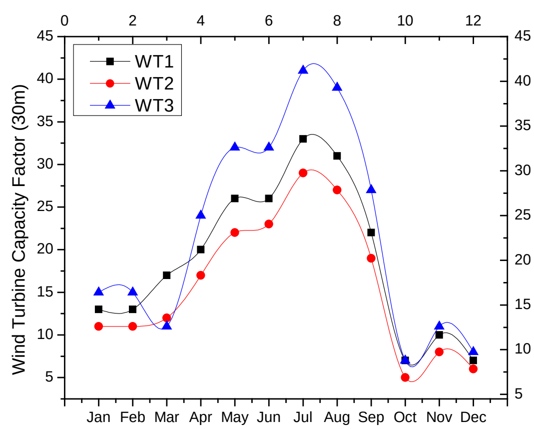


Figure 7 Capacity factors of three wind turbines

8. ECONOMIC ANALYSIS OF WIND TURBINES

The economic analysis is essential while investing in large utility wind turbine plants. The large utility wind turbines cost estimated, according to thumb rule as $ 1000*kWh*, are US$ 450,000. The installation cost is taken as a further 20% of the turbine cost, and operation and maintenance cost as 2% of the turbine cost/year. The estimated wind turbine life is 20 years and a real interest rate of 5% [19, 20]. The economics of wind turbines at the height of 30m showed that US$0.0312*kWh*, US$0.038*kWh*, and US$0.028*kWh* wind turbine 1, 2 and3 respectively. The most feasible option among all categories is wind turbine 1 at the height of 30m which has higher production as compared to other two wind turbines 5.87*GWh* with lower production cost US$0.0312 *kWh.* However, wind turbine 3 has lower value of *kWh* but its production is comparatively lower *1.58 GWh* than the wind turbine1.

The second part of economic assessment is impact of this research on consumer while paying fewer amounts per *kWh.* Current levelized tariff is based upon peak and non peak periods. During November to February is considered as non peak months while from March to October is peak. Peak refers to excessive load on network. The peak and non peak rates are Pak Rs: 18.00 and 12.33 respectively (reference). The payable calculated wind energy cost for consumer found Pak Rs: 3.2448 *kWh*. The consumer will save Pak Rs: 12.32 per *kWh* and 6.6515 per *kWh* during peak and nonpeak time respectively.

9. SITE SPECIFIC SENSITIVITY ANALYSIS

The site specific wind assessment sensitivity analysis has been carried out to accurately know the wind climate and their impact upon the wind turbine. Sensitivity analysis is based upon the weight factor in terms of rise in tangential force upon the blade and drive shaft of wind turbine. Another important factor of the sensitivity analysis is to investigate the decrease of the wind energy due to weight factor. The results of the sensitivity analysis are showing the increased rise in the force in the months of November 78.71%. The minimum tangential force is in the month of February 3.2%. The effect of the changing weight factor is visible from the result. Favoring the rise in the tangential force resulted into impact on the power generation. This idea would be provide the site specific design optimization of the wind turbine.

Table 3 Site specific Sensitivity Analysis

Months	Weight factor	Rise in Force %
January	0.235	33.75
February	0.17	3.2
March	0.352	50.08
April	0.129	26.57
May	0.1	43.08
June	0.1	43.08
July	0.104	40.8
August	0.085	51.62
September	0.147	16.33
October	0.201	14.39
November	0.314	78.71
December	0.225	28.05

CONCLUSION

Pakistan presently suffers acute shortage of electricity in urban and rural areas including 8 hours and 12 hours respectively. So, need of the hour is to overcome electricity shortfalls. This can be possible by focusing on wind energy. Currently, *kWh* per unit cost by natural gas, high speed diesel and furnace oil is Pak Rs: 7.55, 11.5 and 10.5 respectively. This will minimize costly oil imports and gap of balance of payments. In this regard, the south coastal land of Karachi is inspected. The wind investigation showed the site could generate 587*MWh* at the height of 30m with minimum cost $0.0312*kWh* by the wind turbine1.Another important advantage is consumer would save additional amount Pak Rs: 12.32*kWh* and 6.6515*kWh* during peak and non peak times. The wind assessment showed that site is a viable location for production of energy. The site has another advantage that it is centrally connected with the national grid. The city is major hub of the industrial and other development activities. The site is viable option for installation of large and medium utility wind power plants.

REFERENCES

1. Shami, S.H., et al., Evaluating wind energy potential in Pakistan's three provinces, with proposal for integration into national power grid. Renewable and Sustainable Energy Reviews, 2016. **53**: p. 408-421.
2. Kaldellis, J.K. and D. Zafirakis, The wind energy (r) evolution: A short review of a long history. Renewable Energy, 2011. **36**(7): p. 1887-1901.
3. Mostafaeipour, A., et al., Wind energy feasibility study for city of Shahrbabak in Iran. Renewable and Sustainable Energy Reviews, 2011. **15**(6): p. 2545-2556.
4. Mostafaeipour, A., et al., Evaluation of wind energy potential as a power generation source for electricity production in Binalood, Iran. Renewable energy, 2013. **52**: p. 222-229.
5. Mostafaeipour, A., Feasibility study of harnessing wind energy for turbine installation in province of Yazd in Iran. Renewable and Sustainable Energy Reviews, 2010. **14**(1): p. 93-111.
6. Keyhani, A., et al., An assessment of wind energy potential as a power generation source in the capital of Iran, Tehran. Energy, 2010. **35**(1): p. 188-201.
7. Kwon, S.-D., Uncertainty analysis of wind energy potential assessment. Applied Energy, 2010. **87**(3): p. 856-865.
8. Mohammadi, K. and A. Mostafaeipour, Using different methods for comprehensive study of wind turbine utilization in Zarrineh, Iran. Energy conversion and Management, 2013. **65**: p. 463-470.
9. Mirhosseini, M., F. Sharifi, and A. Sedaghat, Assessing the wind energy potential locations in province of Semnan in Iran. Renewable and Sustainable Energy Reviews, 2011. **15**(1): p. 449-459.
10. Dahmouni, A., et al., Assessment of wind energy potential and optimal electricity generation in Borj-Cedria, Tunisia. Renewable and Sustainable Energy Reviews, 2011. **15**(1): p. 815-820.
11. Li, M. and X. Li, Investigation of wind characteristics and assessment of wind energy potential for Waterloo region, Canada. Energy Conversion and Management, 2005. **46**(18): p. 3014-3033.
12. Lashin, A. and A. Shata, An analysis of wind power potential in Port Said, Egypt. Renewable and Sustainable Energy Reviews, 2012. **16**(9): p. 6660-6667.
13. Himri, Y., et al., Wind energy for rural areas of Algeria. Renewable and Sustainable Energy Reviews, 2012. **16**(5): p. 2381-2385.
14. Đurišić, Ž. and J. Mikulović, Assessment of the wind energy resource in the South Banat region, Serbia. Renewable and Sustainable Energy Reviews, 2012. **16**(5): p. 3014-3023.
15. Ouarda, T., et al., Probability distributions of wind speed in the UAE. Energy Conversion and Management, 2015. **93**: p. 414-434.
16. Al-Abbadi, N.M., Wind energy resource assessment for five locations in Saudi Arabia. Renewable Energy, 2005. **30**(10): p. 1489-1499.
17. Rehman, S. and N.M. Al-Abbadi, Wind shear coefficients and their effect on energy production. Energy Conversion and Management, 2005. **46**(15): p. 2578-2591.
18. Fırtın, E., Ö. Güler, and S.A. Akdağ, Investigation of wind shear coefficients and their effect on electrical energy generation. Applied Energy, 2011. **88**(11): p. 4097-4105.
19. Ullah, I. and A.J. Chipperfield, An evaluation of wind energy potential at Kati Bandar, Pakistan. Renewable and Sustainable Energy Reviews, 2010. **14**(2): p. 856-861.
20. Association, D.W.T.M., Guided tour on wind energy. 1999: Danish Wind Turbine Manufacturers Association.

MIXED MODEL ASSEMBLY LINE BALANCING BY USING OF SUB-ASSEMBLY PARALLEL SHOP

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Abstract: Line balancing is vital for smooth and efficient running of all assembly line processes. Automotive, electrical appliances and others industries usually assembled different model in same line in order to avoid huge capital expenditure incurred for separate line. Line balancing of mixed model assembly line is easier if the variation of process time among different models are less or negligible, but in case of larger variation it becomes challenging. The challenging task is to find out ratio of model mix, sequence and quantity of each model been produced per shift or per day. In order to optimize Mixed-Model Assembly line concept of parallel sub assembly shop had been used. Mathematical model using linear programming and work leveling method had been used for line balancing and deciding the amount of work to be performed on parallel sub assembly shops. Mathematical model provide a correlation between Product Mix Assembly line and Sub-assembly shops. This paper aims to handle the optimization of Product Mix Assembly line complication in the assembling of different models at same line, line balancing and sub assembly parallel shop.

Keywords: Mixed model Assembly line, parallel sub-assembly shop, Line optimization

1. INTRODUCTION

Mixed-model assembly line has been used by manufacture and assemblers. The advantages of using it against single-model assembly line are to get more flexibility product design and reduction in capital expenditure. But Mixed-model assembly line caused less utilization and creates complexities in line balancing due to variation of cycle time of every seperate model.

Reducing total workstations and increasing the productivity are the predictable roles of assembly line balancing. The elimination of non-value added operations is essential for assembly line efficiency. In part Assembly line, the identical or interchangeable parts or components joined together at various stages at different workstations to make a single model or product. This paper addresses the problem related such as idleness of the operator, utilization of workstation and others similar issues. The concept of subassembly parallel shop is suggested to make a well-balanced assembly line for higher utilization and reduce overall production costs of the unit for the company. The suggested shop is against the problem highlighted in this paper. For mixed-model assembly line we consider system as to be Just-In-Time (JIT).

1.1 Literature Review

In the era of the 18th century, the Industrial Revolution brought the technology to a prominent position. It originates the founding of the modern manufacturing system and leads to the develop assembly line. Assembly line usually depends on material handling line, interchangeable parts and system type of the production line. In 1785 the first evidence of registered bulk material handling equipment is used in flour mill (Roe, 1916). Similarly industrial assembly line started in 1901. This production system had been done by the Olds Motor car company, and registered by a patent as "assembly line" by Mr. Ransom Olds, owner of the “Olds Motor car company” (Domm, 2009). In the year 1913, Henry Ford's Model T was assembled in line assembly and consider as integrated transport means with the concept of the assembly line and innovation. This gives significant industrial success in assembly line technology.

Until 1955, assembly line balancing problem was done by allocate tasks to the workstation on an ad-hoc basis. Salveson′s (1955) was the first attempt to solve line balancing problem. His initial method for line balancing based upon linear programming algorithm. Gutjahr and Nemhauser (1964) show that assembly line balance problem lies into the class

NP-hard combinatorial optimization. Which means an optimal solution doesn't give quality result for sure of problems of curtain size. Due to that reason, heuristic methods have become the most popular techniques for solving the problem of assembly line problem. The same thing is verified by Wee (1982) in his research that usually assembly line problem is considered as NP-hard. All this research is based upon single line assembly line with a model or product produced at a time.

Over the last six decades a research and innovations have been done in the area of technological advancement and simplicity of complex assembly lines, as well as in the methods and techniques used to solve. The suggested mathematical model is based on objective to optimize line utilization, minimize total idle time by minimizing number of workstations or workers required in assembly line considering a fixed cycle time. As suggested by Macaskill (1972) and Thomopoulos (1974) mixed-model can be assembled in single line by considering it as single model assembly line. This is based upon neglecting the model to model variation of cycle time. Scholl (1999) provides a detail review of assembly line balance and its problem faced on performing it. Boysen (2008) suggested that in mixed-model assembly, setup times among different models to be reduced enough so that it can be ignored, by this way mixed-model can be assembled on the same assembly line. Pearce (2015) had discussed various algorithm used for line balancing and mixed model assembly line in detail. In actual application model-mixed assembly line can't be consider as single model assembly line. Model suggested is based upon assumption that there is low variation of cycle times which can be easily neglected. But in many cases the larger variation results in un-even distribution of work content in different workstation. It can cause in less utilization of workstation and line stoppage due to bottleneck

The objective of line balancing is to distribute total workload among stations as evenly as possible. In Mixed-Model assembly line, all models are assembled in single assembly line. The assembly line speed is usually based upon highest cycle time of largest model in any workstation to avoid line stoppage due to bottleneck. This method caused underutilization of workstation. The total underutilization will be the difference of cycle time amongst different models multiply by number of workstations on main assembly line. In order to avoid idleness of workstations, parallel sub-assembly shop/shops are suggested. The suggested total workload at subassembly shop will be equal to net difference of cycle time of all workstations. It will help to make distribute equal workload on each workstation. This model is suggested on the basses of the assumption that the assembly line is run FIFO (first in first out) system and total work content at parallel sub-assembly shop must be less that the net difference of cycle time of all workstation.

1.2 Basic Terminology

1.2.1 Assembly

As defined by (Scholl, 1999) *assembly*, is a type of manufacturing process that converts a parts, work piece or subassembly into finished product by defined sequence of attachments. *Parts,* in general is interchangeable and standardized with other parts of the same category is defined as physical inputs of the assembly process. A *subassembly* is a combination of parts that are joined together before final fastening or assembly to make complete assembly.

1.2.2 Tasks

Task is the work performed during the assembly process. It is the smallest possible indivisible activity. Each of them requires a defined time to be completed. The sequence in each task may be limited in such manner that some task must be done before starting another task, because of design, subassembly, safety or any other cause. Single or multiple tasks can be performed in single workstation.

1.2.3 Assembly Lines, Stations, and Workers

An assembly line may be a conveyor or similar material handling device that moves evenly spaced work-pieces or part from the beginning to end of assembly process. The transportation path is separated as per distance in a series of successive stations, so that there is one workpiece or a subassembly in each workstation. Each workstation has been assigned specific tasks to complete. Fixed rate assembly lines move workpiece at a constant speed from one workstation to another, resulting in a constant cycle time at each workstation. Each workstation had to complete its tasks before send to next.

1.2.4 Single Model Assembly Line

If a mass production of single product is required, the final product is produced with the same single setup or it does not change the existing single setup. It is known as single model assembly line

1.2.5 Mixed Model Assembly Line

The model in which the product is manufactured in various product models by different workers on the same single assembly line. This type of assembly line is called as mixed-model assembly line. It is used to produce various models of the main product within the same setup time. Basically in this mix model the setup time is reduced in such a way that we normally ignore it, so the mix model determines assembled on the same line.

1.2.6 Multi Model Assembly Line

In this type of assembly line the regularity of the assembled products and the production system is not as much important to integrate the validation of the different products and their production levels. In order to save the time and cost the assembly is usually arranged into groups. This allows the short term manufacturing issues which made in groups of the product models into batches and their resultant will be on the assembly levels. It is used when there is major variation in the assembly processes of the each model. To minimize the flaws of the setup time between models groups are used and it arises the disposal problems. Figure 1 shows basic characteristics of different type of assembly line.

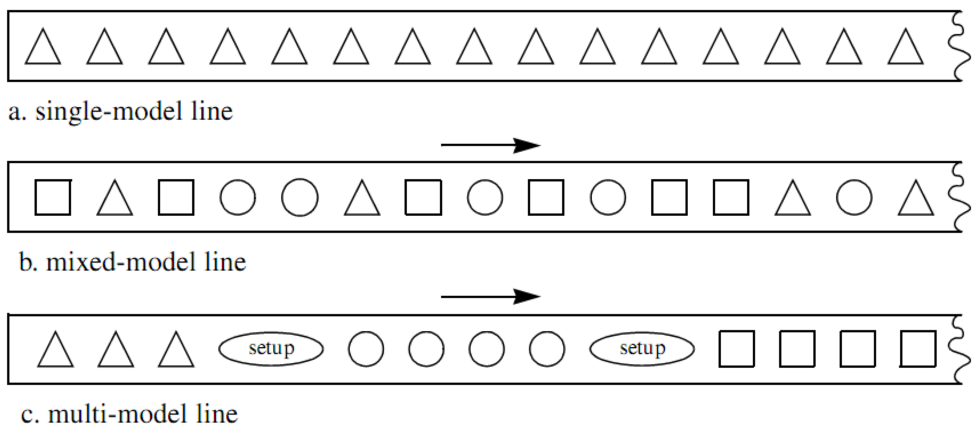

Figure 1. Types of Product line

In current world market demand, mass customization is a need of an hour. The Single or Multi-Model Line is the least suitable production systems for mass customization scenarios. The Mixed Model Line (Kumar) is better solution to respond to flexibility and efficiency.

1.2.7 Precedence

It is normally represented in graph or nodes. In assembly line of any type the products have to comply this rule. The work piece cannot move to the next workstation until the work don't complete at the previous one. The products flow from one station to the other station is shown by it.

1.2.8 Cycle Time

Cycle time is the maximum time allowed at any workstation (Kumar, 2013). It is calculated by dividing required units per day to production time available per day.

$$Cycle\ time = \frac{Production\ Time\ Per\ Day}{Unit\ Required\ Per\ day} \tag{1}$$

1.2.9 Lead Time

The total summarizes Production time of particular model or work-piece or assembly along the assembly line. It is also known as total work content of the model and denoted by T_{wc}

$$Lead\ Time\ (T_{wc}) = \sum Production\ time\ along\ the\ assembly\ line \tag{2}$$

1.2.10 Takt time

The maximum amount of time that is needed to produce the product in order to satisfy the demand of the customer is called a takt time (Kumar, 2013). *Takt* is a German origin word which means "pulse". Set by the end customer demand, it is calculated as follows

$$T = \mathrm{Ta}/D \tag{3}$$

Where; T = Takt time

T_a = Net time available to work,

D = Demand

1.2.11 Smoothness Index (SI)

This index (Kumar, 2013) is used find the relative smoothness of a under studied assembly line. The more the value near zero, the more the line is towards balanced.

$$SI = \sqrt{\sum_{i=1}^{k}(\mathrm{STmax} - \mathrm{STi})^2} \quad (4)$$

Where; STmax = maximum work station time (Cycle time) &

STi = workstation time for i. (i= 1,2,3,…..)

In a mixed-model assembly line

2. LINE BALANCING ALGORITHM

There are many models used for line balancing. Most of the models are heuristic in nature. The objectives of all models are same, which is,

$$Minimize(\omega T_s - T_{wc}) or\ Minimize\ \sum_{i=1}^{w}(T_s - T_{si}) \quad (5)$$

Having two major constraints

1- $\sum_{k\in i} T_{ek} \leq T_s$ (6)

2- All Precedence requirements must be obeyed

Where:

w = numbers of workers on the line

T_S = Cycle time of the line (min/cycle)

T_{wc} = Work content time (min/pc)

T_{ek} = Time to performed work element

T_{si} = Task time at station i

2.1 Line Balancing Algorithm

This work involved applying the one of three famous heuristic algorithms for line balancing as a starting solution. After that parallel subassembly shop is introduced for better utilization of Production line. The three main models are 1-largest candidate Rule (LCR), 2- Kilbridge and Wester (KWC), and 3-Ranked Positional Weight (RPW).

2.1.1 Largest Candidate Rule (LCR)

In LCR the total workload on the assembly line is distributed as evenly as possible, without considering either it is possible or not to obtain a perfect line balance among the workers. LCR used method to arranged work content of each station in descending order, Considering to each station T_{ek} value will not cross the allowable preceded Ts (Groover).

2.1.2 Kilbridge and Wester Column(KWC)

It is a heuristic procedure that selects work content for assignment at stations according to their positions in the precedence diagram not on the basses of workload. These methods known for its reliability as it do consider procedure and successors which is not considered in Largest Candidates Rule method where an element could be selected with respect to high T_e value (Groover).

2.1.3 Ranked Positional Weight (RPW)

In RPW method a value is calculated for each element in the system. The RPW looks for each T_{ek} and its position on in the precedent diagram. T_{ek} is a time to perform work element k, minute and hence these values of T_{ek} are additives (Groover).

Kilbridge and Wester Column (KWC) method is used as starting solution of our problem. The reason of selection is based upon its successful application in complicated line balancing problem by different industries (Prenting).

3. LINE BALANCING OF MIXED-PRODUCT ASSEMBLY LINE.

As suggested mixed-model assembly line is considered as the single model Assembly line. This is done by considering the mean demand time for every activity. The generalized steps involved in line balancing are (Groover, 2008),

1. Making a relationship among tasks and make a precedence diagram.
2. Find the theoretical workstation cycle time.
3. Find theoretical workstations required.
4. Starting from first workstation, assign each activity at a time, until sum of all task times is equal to the workstation cycle time.
5. Evaluate the efficiency and smoothness index of the balanced line.
6. Rebalance the line if required.

3.1 Discussion

For easy understanding we are making the assumptions that the equal load is distributed in each work station and initially ignoring the sequential relationship among workstation and making of precedence diagram. We are considering a system having two models, A and B having total lead time or task time as L_A and L_B respectively. Total demand per day is D (D_A and D_B) where D_A and D_b are demands of Model A and Model B respectively per day. Assumptions for total working hours are 8hrs per day and 5 working days per week.

First we consider single model is assembled at a time then the two models were assembled on the fixed rate launching method, having fixed interval between two consecutive models. The time interval between two consecutive launches is denoted by $T_{cf.}$

3.1.1 Single Model Assembly line

In a single model assembly line one model is assumed to be assembled at a time in assembly line. The parameters for line balancing can be calculated with the help of equation number (1), (2), (3) and (4). Some customised equation is as follows.

$$Cycle\ Time\ (T_c) = \ ((8hrs * 60min)/(day * hrs))/(D_A or\ D_B) \tag{7}$$

$$Theoritical\ number\ of\ workstation\ (\omega^*) = Min\ Integer \frac{(L_A\ or\ L_B)}{T_c} \tag{8}$$

$$Line\ Efficency\ (E) = \frac{(L_A OR\ L_B)}{(\omega^*)(T_c)} \tag{9}$$

3.1.2 Two model Assembly line

If we consider mixed-model assembly line having two models then equation (7), (8) and (9) becomes

$$Cycle\ Time\ (T_c) = \ ((8hrs * 60min)/(day * hrs))/D \tag{10}$$

$$Theoritical\ number\ of\ workstation\ (\omega^*) = Min\ Integer \frac{(L_A + L_b)}{T_c} \tag{11}$$

$$Line\ Efficency\ (E) = \frac{(L_A + L_B)}{(\omega^*)(T_c)} \tag{12}$$

As we consider the fixed rate launching for two models, then cycle time per station must be consider of lowest one. The reason of selection is to avoid line blockage. If one product having higher cycle times then it required more time to assemble in the station.

Under this algorithm there will be idleness in each work station equal to T_{CA}-T_{CB} or Vice versa. In order to fully utilize the each station then a Parallel Assembly shop is suggested.

3.2 Suggested outcome and Results

The Parallel assembly shop is suggested in such a manner that it will store the sub assembly as a buffer total activity difference of each in each station must be performed here.

If the assembly line had total ω^* of work station then total work content to be performed at shop (T_{wc}*) will be

$$T_{wc} *= \omega * |T_{CA} - T_{CB}| \tag{13}$$

Now we can homogenised the work content equally in each work station and consider the line as a single assembly line with T_c (Cycle time) equivalent to least cycle time of model among all models.

4. CONCLUSION.

Suggested method for introducing parallel sub-assembly shop gives the benefit or utilizing the line with all workstation evenly. This will increased the overall line efficiency by fraction difference of cycle times of different product. Although setting up another shop caused requirement of capital. But it will be less as compare to setting up of new line. The recovery of capital expenditure will be done on the bases of efficiency improvement of line balancing. Actual industrial data is required for further correction of suggested model.

5. REFERENCES

1. Boysen, N., Fliedner, M., & Scholl, A. (2008). Assembly line balancing: Which model to use when?. *International Journal of Production Economics*, *111*(2), pp. 509-528.

2. Chutima, P., & Chimklai, P. (2012). Multi-objective two-sided mixed-model assembly line balancing using particle swarm optimisation with negative knowledge. *Computers & Industrial Engineering*, *62*(1), pp. 39-55.

3. Domm, R. W. (2009). *Michigan Yesterday & Today*. Voyageur Press.

4. Groover, M.P. (2008). *Automation, Production Systems, and Computer-Integrated Manufacturing*. 3rd Edition, ISBN: 0132070731. USA.

5. Gutjahr, A. L., & Nemhauser, G. L. (1964). An algorithm for the line balancing problem. Management Science, 11(2), pp. 308-315.

6. Kumar, D. M. (2013). Assembly line balancing: a review of developments and trends in approach to industrial application. *Global Journal of Research in Engineering*, *13*(2).

7. Macaskill, J. L. C. (1972). Production-line balances for mixed-model lines. *Management Science*, *19*(4-part-1), pp. 423-434.

8. Pearce, B. (2015). A study on general assembly line balancing modeling methods and techniques. Dissertations. Paper 1549.

9. Prenting, T. O., & Thomopoulos, N. T. (1974). *Humanism and technology in assembly line systems*. Spartan Books;[distributed by] Hayden Book Co., Rochelle Park, NJ.

10. Roe, J. W. (1916). English and American tool builders. Yale University Press.

11. Salveson, M. E. (1955). The assembly line balancing problem. *Journal of industrial engineering*, *6*(3), pp. 18-25.

12. Scholl, A., & Scholl, A. (1999). *Balancing and sequencing of assembly lines*. Publish by: Physica-Verlag.

13. Wee, T. S., & Magazine, M. J. (1982). Assembly line balancing as generalized bin packing. *Operations Research Letters*, *1*(2), pp. 56-58.

IDENTIFICATION OF VARIABLES TO CONTROL COST ESCALATION, A STUDY OF SHAHEEN COMPLEX EXTENSION, IN THE CONSTRUCTION INDUSTRY OF PAKISTAN KARACHI
-FOCUSED ON SPACE QUALITY MANAGEMENT (SQM)- 2017

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Abstract: there is a need for an extension at Shaheen Complex, Karachi. Control of cost escalation is one of the fundamental criteria for project success. Shaheen complex is planned to be extended based on today's demand, the extension was forecasted earlier while design, thus a provision for an expansion was planned at the time of design for the structure system. In Pakistan, majority of the construction projects have met cost related issue e.g. Shaheen Complex. This research has embraced field survey philosophy to reveal basic components prompting control of cost escalation in the construction business of Pakistan. Eighteen variables prompting control of cost escalation were identified and ranked with respect to level of importance. In overall perspective, primarily, due to the sensitive location of the building. Secondly, "Effective communication of scope of required tasks", that is whether it is feasible to expand, and how much will be economical and accurate expansion. "Zero tolerance on fraudulent practices, kickbacks, corruption etc", the five most important factors prompting control of cost escalation in the construction business of Pakistan.
A construction venture is successfully finished after a progression of a few planed or unplanned occasions, exercises and communications, in continually changing work surroundings. In addition, in a construction venture several evolving members, partners and procedures are involved. There are a few variables that prompt the fruitful fulfillment of these ventures. Among such, one of the key variables is control of cost escalation.
Conclusively 20% more space is achieved by the subtle addition of the new block which is according to the current language of the building without compromising on the iconic and monumental view of the building as its current condition

1. INTRODUCTION

There are numerous variables that are in charge of cost escalation and fluctuate along with the size, scope, locations and types of ventures. Cost escalation is a regular and basic phenomenon in construction ventures around the world; however this trend is more critical and significant in developing countries.

There are numerous variables that are in charge of cost escalation and fluctuate along with the size, scope, locations and types of ventures. Cost escalation is a regular and basic phenomenon in construction ventures around the world; however this trend is more critical and significant in developing countries.

In Pakistan, Construction segment is both energetic and capital intensive. Regardless of the accessibility of several project control software and cost control strategies, several construction ventures in Pakistan experience the adverse effects of cost escalation. Thus for the advancement of construction segment in Pakistan and to keep pace with the improvement of alternate areas of the economy, it is crucial to identify major variables leading to control of cost escalation, in the construction business of Pakistan.

The comprehensive analysis of healthcare facilities in Pakistan in relation to healing environment improvement of spatial Organization, Area Distribution and Design Determinants with the aim to improvements based on research objectives. If we want to remove all sorts of wastage of space in hospital and variation of space Muda and Muri Concept could be applied.

Mura (Wastage of physical strength of people) is removed by axial lines which are created in space syntax. Muri (Variation in spaces) can be tackled with maximization of connectivity and muda (wastage of space) is dealt through visibility graph in space syntax. The aim of the research was to "improving office facilities in Pakistan by adding efficient environment based on design determinants, spatial organization, and areal distribution". As construction ventures in Pakistan are exceedingly capital intensive and since in Pakistan, ventures have restricted budgetary assets to meet there formative needs, it is essential to recognize variables that will prompt the control of cost escalation. There are a several perspectives that are in charge of the control of cost escalation. This paper endeavors to identify major factors prompting control of cost escalation, in the construction business of Pakistan.

Pakistan is having a large real estate industry in which there are many locations which are still untapped. There is a new boom of high rise buildings which includes Malls, Hotels, Offices Building, Technology Parks and Experience Center. These high rise towers and buildings will create a brand identity for the project owners to enlighten their name as showcase model in this under developed area. As this is a new boom of this industry so every buddy wants to position their self at number one position in many areas, in this craziness every owner wants to achieve a standard of international level. As a case we have picked Dolmen City Karachi project and classified our study in Electrical, Mechanical, Civil, Architect and Project department for our paper areas. Our paper focus on the analysis of the cost impact on Dolmen City project, we have gathered all information from the Project Manager of Dolmen City, Mr. Nauman Khan, who has leaded all projects there.

1.1. Research Backgrounds and Objectives

The fundamental reason for this study is to recognize major variables prompting control of cost escalation, in the construction business of Pakistan and to assess whether there is an agreement or difference among the sentiments of each pair of major stakeholders / respondents groups i.e. client and consultant. Here the Client is Shaheen Air force Services and consultant is the architect. The methodology required to complete this study, involves following steps:

- Detailed literature review of Shaheen Complex in this study, Pakistan.
- Development of a questionnaire to extract information regarding major factors leading to control of cost escalation.
- Compilation of information and assessment of the returned questionnaires.
- Analysis of questionnaires & making suggestions /recommendations based on the conducted study.

Data Sources/Survey Target Audience

The data sources/ survey target audience for this research comprises of following:

Masters students at NED University, through which necessary information can be gathered.

Construction industry professionals belonging to all the three principal stakeholders i.e. client, consultant & contractor.

1.2 Data Collection Methodology

In this study, a blend of both qualitative and quantitative strategies has been utilized to reveal major variable prompting control of cost escalation, in the construction business of Pakistan. In the first stage, secondary information has been accumulated from different sources through qualitative information gathering techniques. These sources include research papers, internet, journals, discussion with construction practitioners etc. The information embraced, has been used for the development of a questionnaire.

In the second stage, primary information has been accumulated from questionnaire survey, through quantitative data collection technique. Opinion of all three principal stakeholders of the construction business (i.e. owner, consultant and contractor), has been accumulated in this regard, with a specific end goal to acquire a more extensive point of view. The gathered information was finally been utilized to investigate the view of Pakistan construction industry, with respect to elements prompting control of cost escalation.

Data collected from different departments in engineering consultancy firm is as follows.

	Departments				
	Electrical (Group-A)	Mechanical (Group-B)	Civil (Group-C)	Architecture (Group-D)	Projects (Group-E)
Causes					
Quality	4	3	4	5	5
Coordination	3	4	4	5	4
Time	4	4	5	4	3
Technology	5	5	3	4	3
Scope	4	3	5	3	5

Where “5” represent very strong relation, “4” represent strong relation, “3” represent normal relation, “2” represent weak relation and “1” represents very weak relation between problem and causes.

Above data was put in the online ANOVA calculator and following results were found:

2. LITERATURE REVIEW

The construction business, particularly little and medium sized contractors, has very little consideration for continuous improvement (kaizen) methodology and long lasting learning. Kaizen which implies continuous incremental improvement

(Imai 1997), is not simply a discretionary expression; rather, it is a methodical, formal, very much organized philosophy, utilized as a major part of quality-management approach. The continuous improvement (kaizen) principles were applied in this study for recognizing main considerations provoking control of cost escalation, in the construction business of Pakistan The other approach to spatial organization is the hierarchical analyses of spaces which is usually simulated to have a set of three distinctive movement patterns of patients, staff and visitor and other is medical supply or sterile movement. Though the most critical is the patient movement pattern which is simulated on depth map analysis from the derivatives of connectivity, integration and intelligibility where lobby as a core area has most high level of spatial cognition movements Oh et al (2015). This is apparent from the case of 600 bed tertiary healthcare facilities at Korea. Thus Oh et al (2015) explains that spatial organization pattern in healthcare facilities of Korea are one of the finest example also established that connectivity and intelligibility are the most valuable spatial setting that created one of the best quality of healing environment. These spatial ingredients may be localized and then applied in Pakistani healthcare setting. Kaizen theory has a component known as 5-S that is also applied on areal distribution Pitt et al. (2009) the 5S for sustainable construction: is mainly the acronym for five Japanese language terms i.e. Seiri, Seiton, Seiso, Seiketsu and Shitsuke which means Organisation, Neatness, Cleanliness, Standardization and Discipline as discussed, Zhang et al. (2016) discussed Kaisen in office organization according to the relationship between Process Management and Quality Performance in the Service Industry. . He referred these as the five keys to achieve total quality environment if applied to upgrade healthcare facilities it would result in with an utmost quality of areal distribution. (Kaizen Theory). There is a significant gap between the factors effecting office setting and spatial improvement as explored by Alshehri (2016) in terms of factors shaping the office employees areas Quality management system for building, work and labor places, and employees section. Moreover as studies explored by Ramos et al (2015) spatial modification in indoor environmental setting are based on individual's usage and functional area distribution. A similar analyses for Pakistani scenario was carried out by Norford et al. (1994) where low-energy' office building environment from the perspective of spatial organization was discussed. It is very important to note that spatial organization of healthcare facilities and healing environment in Pakistan is still at the developing stage therefore the future healthcare facilities may require major improvement with relation to standards and its application. Currently at national scale spatial organization of healthcare facilities and healing environment demands for detailed study and research as only one case of Shaheen Complex provides some relevance. This is the most significant case example in learning about the spatial organization of healthcare facilities and healing environment in Pakistan.

3. CASE STUDY

The current location of Shaheen Complex and the building present planning could be referred. Organizations as large as Shaheen Complex (based on this principle the expansion was planned and it also aimed to maintain the current integrity of the visibility graph so that the passerby from the road gets the same view of the monumental building), because the building and the company, which are client and the tenants. Here was an expansion but on the same time maximizing the size and having minimum impact on the ambiance and glory of the pivotal building location as shown in Fig. 1. it was to have more rentable space and less intervention with the building form. Though here in this project even the big data from socially responsive architecture is considered.

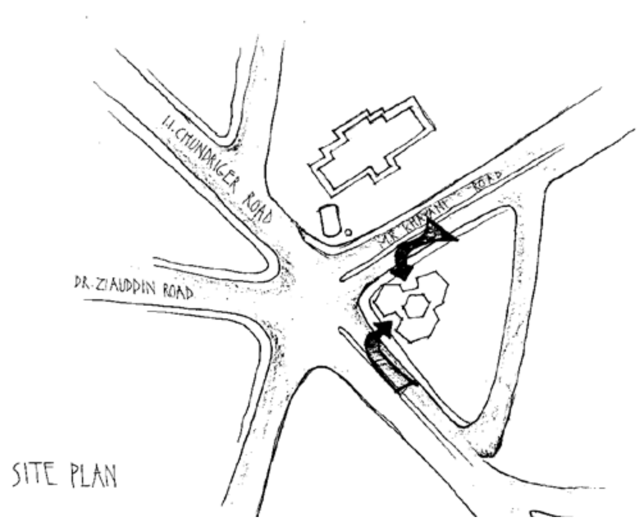

Figure one: The site plan of the complex

Fig. 1 shows the plan and approach of the complex at a pivotal position
This will be aimed to be kept as it is to maintain the integrity and the historic monumental and iconic visibility of the building.

This study documented 50 departments presented in a longitudinal cross sectional model provided by 12 architectural firm and 25 hospitals present in different province of Pakistan. As a result the research sought both a range and mean of schematic design function for current design solutions for Pakistan.

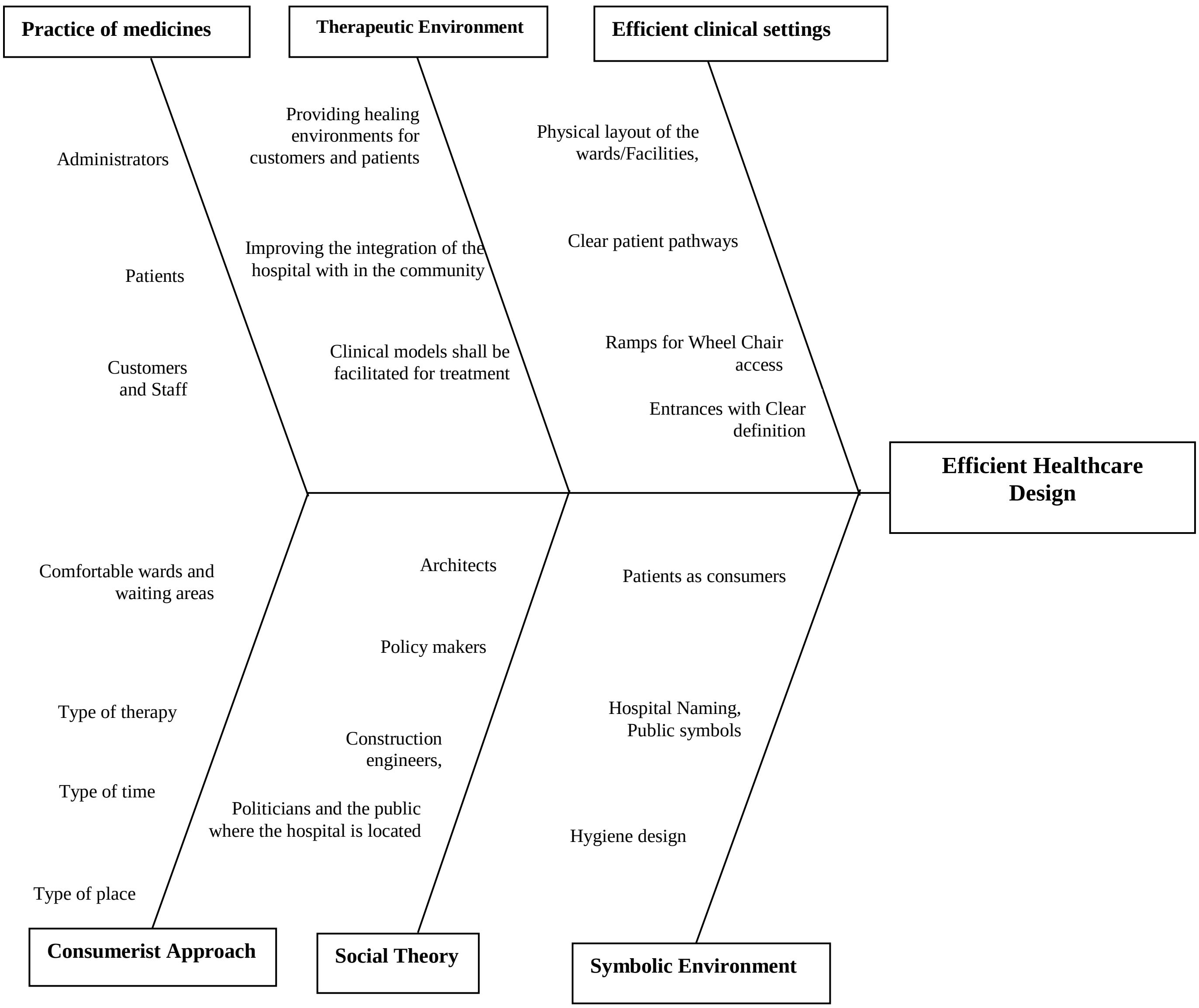

Fig two Overlapping domains of SCM and QM

The design criterion is organized using a (fishbone) cause and effect diagram. Figure 7 shows a diagram which is developed based on the criterion extracted from the literature review. The fishbone diagram is helpful to divide methodology which is required to fulfil the particular design demands pin point out by the patient and users to fill the gap of hospital design. The next step comprises of selection for a tool that will fulfil the criterions which is selected for determination of utmost probability to quantify the data collected. A two prong strategy has been devised which is Areal Distribution and spatial organization. The verification process of functional zoning, and the measurement of understanding for the patient of the Spatial Distribution is also an important aspect to measure.

3.4 Process approach

For construction along with higher structural strength, and shorter lead times for construction of extension, improved space for customers and better predictable results for space allocation as desired by the client for extension, establishing clear responsibilities for expansion of plan, and evaluating risks for structure for those who shall be using the space.

Main benefits include ability to focus effort for expansion during the key processes, understanding the interdependencies between the processes of the system, structured approach to synchronize and integrate processes, and reduce cross-functional barriers, for expansion. (See Figure 2)

This sequence continues of analysis will continue throughout this entire dissertation on all the chapters of Case Study, Results and Conclusions. The fish bone diagram for this research is drawn as under which defines the parameters for research. To build a fishbone, begin by identifying the primarily challenge by inquiring regarding the difficulty.

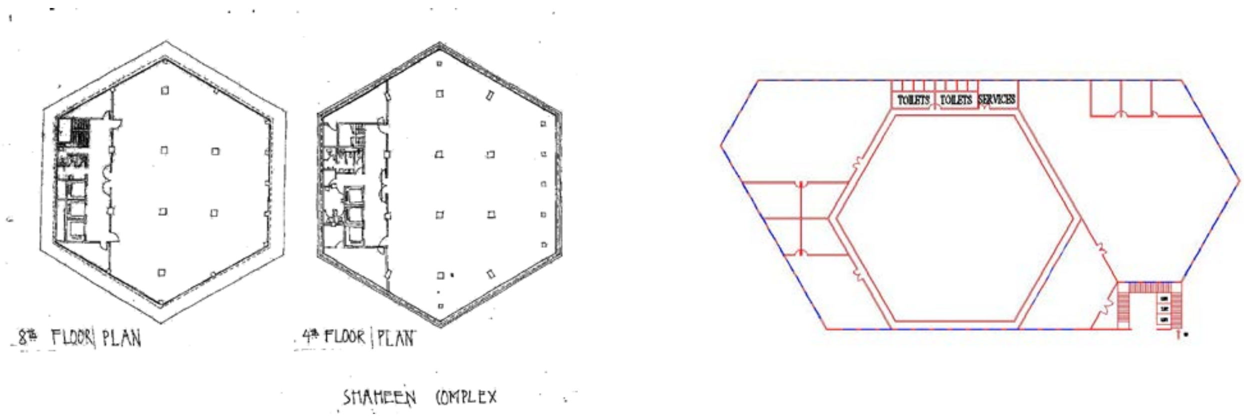

Fig. three. The plan of the office building

The photo shows the planning and the model to maximize the rentable space as Kim and Sohn (2002) analyzed the relationship between land use density for office buildings similar to Shaheen Complex as shows in Fig. 2 and urban street configuration, similar to I.I. Chundrigar Road as a Case studies of two areas in Karachi by space syntax analysis.

As construction ventures in Pakistan are exceedingly capital intensive and since in Pakistan, ventures have restricted budgetary assets to meet there formative needs, it is essential to recognize variables that will prompt the control of cost escalation. There are a several perspectives that are in charge of the control of cost escalation. This paper endeavors to identify major factors prompting control of cost escalation, in the construction business of Pakistan.

Keeping in view the global and national perspective of the spatial organization the application of fish bone analysis was conducted for this proposed study which gave us the variables to be investigated in healthcare facilities. These are the connectivity, visibility, accessibility, way finding, walkability, waiting areas, entry and parking. Kaizen theory has a component known as Poka Yoke which is a Japanese terminology for detecting and preventing error. It is also known as zero defect theory. This theory is applied to the spatial organization globally however it is also need to be verified within the local healthcare facilities in Pakistan. So as the outcome may result in the form of no wastage space and a zero defect healthcare facility in Pakistan which can promote the betterment in the office space.

Intensive literature review suggested that the wastage of space Muda, Muri unevenness in planning and variation eradication is proposed and Mura referring to overstressed people can be removed by space syntax usage where unused space removal can result in an appropriate design, leading to spatial organization which caters to *poka yoke* zero defect system. This criterion is applied to office space at Shaheen Complex.

The methodology of research is derived from the critical review of literature of the key concepts of healing environment and the variables that forms its basis. This theoretical framework is then transformed into conceptual framework and hypothesis was developed. The development of hypothesis then subdivided into research parameters. These parameters are then broken into those indicators that identifies the tools and techniques of research and to fulfill the parameters of research and ultimately prove the hypothesis.

Scores of researches done so far where principles and methods of space syntax and total quality management are applied for improvement of healthcare facilities and addition of efficient environment. The proposed research is also one such attempt where the case studies of 25 office from two provinces of Pakistan shall be done. The tools and techniques applied shall be depth map analysis, matrix of house of quality, cause and effect {fishbone diagram as analyzed by Latino and Flood (2004) where they optimized root cause analysis RCA in health care}, kaizen theory i.e. muda (eliminating wasted spaces), poka-yoke (Vinod et al 2015, zero defect system) 5s and lean six sigma theories. These tools of analysis shall be applied to design determinants, spatial organization, and areal distribution of selected 25 office facilities at secondary and tertiary scale in Pakistan.

Table one: Quality Management Activities

		Building	Processes	Structure
Quality, policy, objectives and responsibility	• Determine cost objectives and quality related	✓ ✓	✓ ✓ ✓	✓ ✓ ✓
Quality planning	• Determine Quality characteristics	✓ ✓	✓ ✓	✓ ✓
Quality Control	• Provide quality techniques	✓	✓	
	• Prepare and carry out quality related tests for the structure bearing capacity	✓	✓	✓
	• Control testing and inspection equipment			✓
	• Laboratory inspection		✓	✓
Quality assurance	• Organize, establish, maintain planning related do cumentation	✓	✓	✓ ✓
	• Organize, establish, maintain structure related do cumentation		✓ ✓	
	• Develop, establish and maintain 3D models	✓		✓

The reason of simulation is an evidence of hypothesis, allowing us to experiment the performance of the mechanisms under various circumstances easily. This prototype offers an examination under a true situation. Due to page constraint, we offer only an illustrative subset of experiments in this segment from figure 1 to 4.

3. Separation of various kinds of traffic, pedestrian from vehicular and patient, staff, visitor service from each other.

4. Here room standard for eight patient is used for prototype module, and toilet size act as a repetitive component thus development of modular spaces, to provide maximum flexibility. Room sizes are seldom so critical that a variation of 10 % to 20 %will not make any difference in their usefulness if a module can be developed that is acceptable for a larger variety of occupancies.

5. Careful consideration to orientation is studied and applied as shown in figure 4 and 6. Here sun control and building material according to the local context of Karachi is used. The development of air conditioning and artificial illumination have a significant effect on office design. A construction venture is successfully finished after a progression of a few planed or unplanned occasions, exercises and communications, in continually changing work surroundings. In addition, in a construction venture several evolving members, partners and procedures are involved. There are a few variables that prompt the fruitful fulfillment of these ventures. Among such, one of the key variables is control of cost escalation.

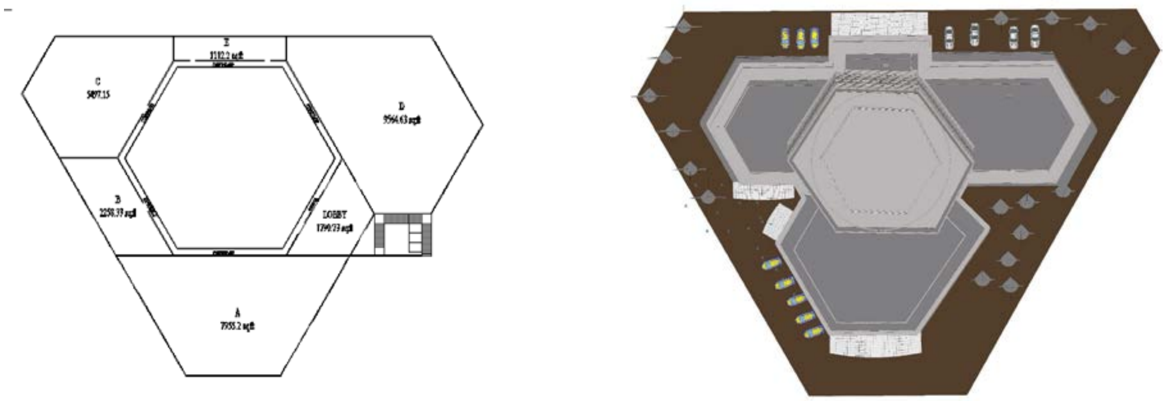

Figure four: the two floors added in a way that it is not compromising on the current integrity of the building

The case study analysis of Shaheen Complex, fig 3 where the waiting area is direct with the entrance and reception counter. More than one public telephone boxes are installed as required by the citizen of Karachi in appropriate position. Lavatory accommodation for both male and female patient are designed at easily accessible location. As, Institute of Office Design (1999) summed up leading health indicators for healthy people and ISO (2002) several surveys, Gratia & Herde (2004) developed a strategy where he discussed ways for the management double-skin façade for information and Natural cooling strategies efficiency systems for services in healthcare in third world countries he also analyzed and studied contextualize framework where he understood the waiting space design determinants for office building, Jonsson et al (2007) summarized the health research systems where capacity building and priority setting for data collection for guideline and practices are applied on waiting space. Thus the quality deployment tool is applied to study this specific design determinant which is waiting area.

There are numerous variables that are in charge of cost escalation and fluctuate along with the size, scope, locations and types of ventures. Cost escalation is a regular and basic phenomenon in construction ventures around the world; however this trend is more critical and significant in developing countries.

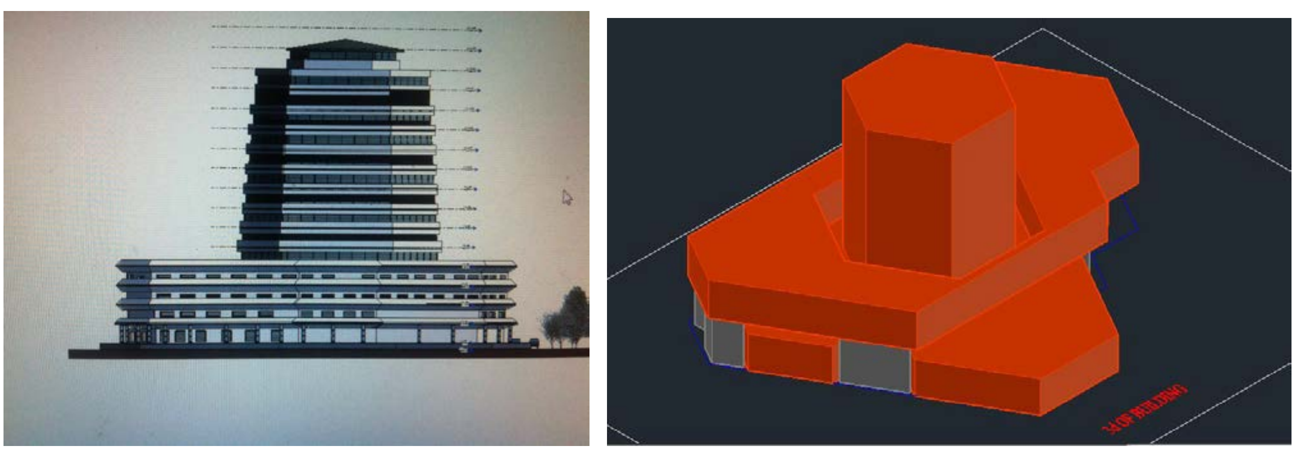

Figure five: Area covered =30591.9 sq:ft for the extension planned for complex

In Pakistan, Construction segment is both energetic and capital intensive. Regardless of the accessibility of several project control software and cost control strategies, several construction ventures in Pakistan experience the adverse effects of cost escalation. Thus for the advancement of construction segment in Pakistan and to keep pace with the improvement of alternate areas of the economy, it is crucial to identify major variables leading to control of cost escalation, in the construction business of Pakistan. In addition, it is a necessity for the industrial, commercial, socio-economic and political development of the nation.

A construction venture is successfully finished after a progression of a few planed or unplanned occasions, exercises and communications, in continually changing work surroundings. In addition, in a construction venture several evolving members, partners and procedures are involved. There are a few variables that prompt the fruitful fulfillment of these ventures. Among such, one of the key variables is control of cost escalation.

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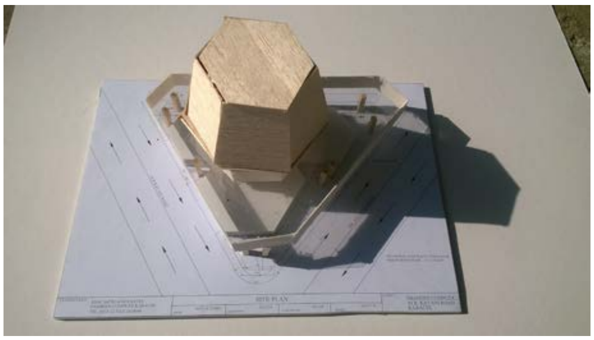

Figure six: Area covered =30591.9 sq:ft for the extension planned for complex

The main lobby entrance in fig 5 for Shaheen Complex is convenient to the visitors as well as to the patients and the waiting space is provided adjoining to the main lobby with sitting arrangements and toilet facilities for both male and female. A telephone, wifi and information desk has been provided in the waiting area. From the lobby users have easy access to the cashier and business office as well as to the admitting and social service office. From this lobby one has the passage to the elevators and staircase.

Results also indicate that “zero tolerance on fraudulent practices, kickbacks, corruption etc.” has played a significant role in the control of cost escalation. It is apparent from the survey that fraudulent practices, kickbacks, corruption etc. has now become an integral part in the construction business of Pakistan which is quite alarming. It is therefore imperative that construction professionals take his stance on fraudulent practices, kickbacks, corruption etc. Additionally the concerned powers should implement strict check and balance in this regard, with the end goal to eradicate corruption from our society.

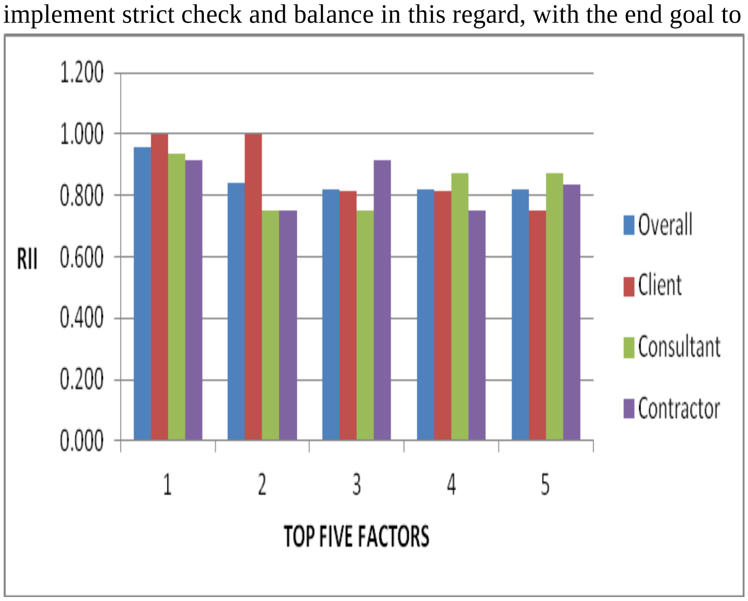

Fig seven. Comparison of relative important index (RII) of five most important factors

Intensive literature review suggested that efficiency in terms of spatial organization in a office design can be improved by the use of lean six sigma which is a continuous improvement where Muda, Muri and Mura, implies wastage in terms of space, this can be reduced by applying space syntax application on depth map i.e. axial line, connectivity and visibility graph this will remove the wastage in space (Mura), and unevenness due to an array of variation found in the planning. Moreover (Muri) describes over exhausted people: This can be achieved by simulation of the office plan on space syntax and unused spaces can be eradication, the axial lines on the plan describes the visual connectivity and approach from one point in the hospital to the other.

Factors	**RII**	**Overall ranking**	**RII**	**Client ranking**	**RII**	**Consultant ranking**	**RII**	**Contractor ranking**
Effective communication of scope of required tasks	0.841	2	1.000	1	0.750	11	0.750	7
Zero tolerance on fraudulent practices, kickbacks, corruption etc.	0.818	3	0.813	5	0.750	11	0.917	1
Use of experienced subcontractors and suppliers	0.818	3	0.813	5	0.875	2	0.750	7
Use of appropriate construction methods	0.818	3	0.750	9	0.875	2	0.833	4
Frequent coordination among the stakeholders	0.795	6	0.875	3	0.813	5	0.667	14
Effective site management and supervision	0.795	6	0.688	13	0.875	2	0.833	4
Developing skiled human resources in the construction industry	0.795	6	0.813	5	0.813	5	0.750	7
Proper emphasis on past experience	0.773	9	0.750	9	0.813	5	0.750	7
Clear information and communication channels	0.773	9	0.813	5	0.750	11	0.750	7
Implementing systematic control mechanism	0.750	11	0.750	9	0.750	11	0.750	7
Proper project planning and scheduling	0.750	11	0.625	14	0.750	11	0.917	1
Comprehensive contract administration	0.727	13	0.875	3	0.813	5	0.417	18
Effective strategic planning	0.682	15	0.500	18	0.750	11	0.833	4
Proper risk analysis	0.659	16	0.750	9	0.625	18	0.583	15
Frequent progress meeting	0.636	18	0.500	17	0.813	5	0.583	15

From TABLE III it is evident that the five most important factors leading to control of cost escalation, as perceived by stakeholders (clients, consultants and contractors) are:

The following discussion is based on the result of the survey which provides valuable information about the critical factors leading to control of cost escalation, in the construction business of Pakistan. The relative importance index of eighteen identified factors and their rankings. These factors were rated by three different stakeholders i.e. client, consultant & contractor. As presented in Table 1, by training and implementing SQM techniques, supply chain activities such as integration, coordination and information sharing have been supported and improved. Cost and lead time reduction, elimination of inspection of incoming products, standardization, reduction of number of suppliers, and documentation were also positive results gained from the application of SQM techniques. In the three cases, it was seen that the systematic problem-solving tools and techniques ease the solution approach of a problem by structuring, organizing and documenting it. In fact, these tools and techniques are relatively easy to learn and can be applied in any industry

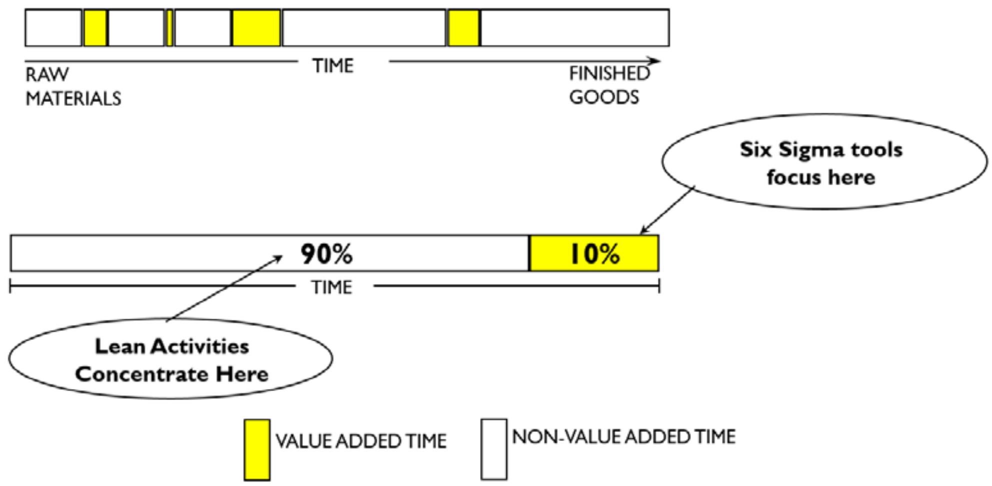

Fig eight. The Lean activity for the construction company

Therefore it could be inferred that the Lean Six Sigma is a methodology that combines the elements of **Lean (cycle time reduction)** with the elements of **Six Sigma (variation reduction)** to produce an overall strategy to improve construction processes. **Lean** improves **process speed** dramatically and **Six Sigma** brings a process under **statistical control**. **Together** the two methodologies interact to produce **fast stable process**

4. CONCLUSION

While conducting the research, a strong affiliation linking the efficiency of office architectural design and spatial, temporal and areal application was confirmed. On the other hand, it was surveyed that less attempt was done by theoretical literature for awareness of the setbacks and inadequacies of design determinants, spatial organization and areal distribution of architectural design processes. Therefore, it is believed that there is a huge vacuum in the theoretical literature to be researched for enlarging the competence of office design. In order to play a role for a structure invention for office architectural design industry, it is determined to emphasis on concluding wasted spaces of architectural design and their effect over office building project value parameters specific to Pakistan.

1. Improving contract award procedure by giving less weight to prices and more weight to the capabilities and past performance of contractors (RII=0.955)
2. As indicated from Fig 2 & TABLE III, foremost factor leading to control of cost escalation is to improve contract award procedure by giving less weight to prices and more weight to the capabilities and past performance of contractors.

The major deficiency of the lowest bidding procurement method, commonly used for bidding, is the likelihood of giving a contract to a contractor that quotes, either deliberately or not deliberately, an idealistic price, which results in cost escalation. It is therefore imperative that government should improve contract award procedure, in order to cope with this issue.

"Effective communication of scope of required tasks" has also been a significant factors leading to control of cost escalation in the construction business of Pakistan. Result demonstrates that training of construction professionals in scope management is insufficient. Training of construction professionals in this regard can play a fruitful role in successful scope management and in preventing construction ventures from cost escalation.

5. REFERENCES

1. Imai, M. (1997). Gemba Kaizen: a commonsense, low-cost approach to management. McGraw-Hill.
2. Kwanchai Roachanakanan (2005), A Case Study Of Cost Overruns In A Thai Condominium Project.

3. Salama, M., and Habib, A.P. (2009), "Investigating the causes of variation within the construction projects in UAE." In: Dainty, A. (Ed) Procs 25th Annual ARCOM Conference, 7-9 September 2009, Nottingham, UK, Association of Researchers in Construction Management, pp. 949-957.
4. Chang A. Shing-Tao (2002). "Reasons for cost and schedule increase for engineering design projects." Journal of Management in Engineering, ASCE, Vol. 18, No. 1, pp. 29-36.
5. Kaming, P.F., Olomolaiye, P.O., Holt, G.D., and Harris, F.C. (1997). "Factors influencing construction time and cost overruns on high-rise projects in Indonesia." Construction Management and Economics, Vol. 15, No. 1, pp. 83-94.
6. Frimpong, Y., Oluwoye, J., and Crawford, L. (2003). "Causes of delay and cost overruns in construction of groundwater projects in a developing countries; Ghana as a case study." Int. J. Project Management, Vol. 21, pp. 321-326.
7. Koushki, P.A., Al-Rashid, K., and Kartam, N. (2005). "Delays and cost increases in the construction of private residential projects in Kuwait." Construction Management and Economics, Vol. 23, No. 3, pp. 285-294.
8. Ameh1., O.J., Soyingbe, A.A., and Odusami, K.K. (2010). "Significant factors causing cost overruns in telecommunication projects in Nigeria." Journal of Construction in Developing Countries, Vol. 15.
9. Rummler, Geary A., and Alan P. Brache. Improving Performance: How To Manage the White Space on the Organization Chart. The Jossey-Bass Management Series. Jossey-Bass, Inc., 350 Sansome Street, San Francisco, CA 94104, 1995.
10. Becker, Franklin D., and Fritz Steele. Workplace by design: Mapping the high-performance workscape. Jossey-Bass, 1995.
11. Gratia, E., & De Herde, A. (2004). Natural cooling strategies efficiency in an office building with a double-skin façade. *Energy and buildings*, *36*(11), 1139-1152.
12. Pitt, M., Tucker, M., Riley, M., & Longden, J. (2009). Towards sustainable construction: promotion and best practices. *Construction innovation*, *9*(2), 201-224.
13. ZHANG, G., Lingling, Y. U. A. N., & Yuelin, Y. A. N. G. (2016). The Relationship between Process Management and Quality Performance in the Service Industry. *International economy and trade*, *5*(2).
14. Alshehri, A. R. (2016). *Quality management system for building maintenance* (Doctoral dissertation, Heriot-Watt University).

Impact of Computer Integrated Manufacturing on Manufacturing Enterprises: A Multiple Case Study

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Abstract

It has been noticed that in today's modern manufacturing industries, implementation of Computer Integrated Manufacturing (CIM) system /advanced manufacturing technology (AMT) has increased day by day to meet products of standard quality in economical cost and satisfy the need of customers in this competitive global market. This research deals with the use of CIM enablers in manufacturing enterprises. This research aims at find out the types of CIM enablers which have been implemented to improve the manufacturing parameters in manufacturing enterprises that have significant impact on plants efficiency and performance. Therefore the main purpose of this research is to assess the impact of CIM enablers to contribute in the productivity as well as in the quality and overall efficiency of the plant. The research has carried out in three Manufacturing industries that have implemented AMT/ CIM enablers. The findings of this research shows the impact of CIM enablers on manufacturing parameters such as Quality, productivity, manufacturing lead time and manufacturing cost. Ten manufacturing parameters have chosen to assess the impact of each CIM enablers. The research has found that total six different types of CIM enablers have been implemented in manufacturing enterprises.

Key words: CIM, AMT, Impact, Manufacturing Enterprises, Multiple Case study

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1. INTRODUCTON

In the modern world, the survival of manufacturing enterprises is only possible when manufacturing enterprises installed CIM system and latest AMTs and use them proper and effectively for the purpose of producing high quality products within economical cost. Manufacturing enterprises are facing the pressure from their customers for the timely delivery of the products at the economic cost which is more challenging using conventional equipment's and technologies (Faircloth, 2014). Therefore in fulfilling the above demands from customers, manufacturing enterprises need to improve the efficiency of the plant, produce high quality products with no defects, and reduce the lead time and cycle of process, if a manufacturing industry has reduces the waste ultimately they increase their productivity. This all is only possible with the introduction of CIM system in their manufacturing enterprises and use it effectively and efficiently (Marri et al., 2006).

Joseph Harrington in 1978 gave the concept of Computer Integrated Manufacturing (CIM) and explain that CIM is the integration of manufacturing processes which enables production planners, schedulers, shop floor supervisors and accountants to use same database for the production (Tansel, 2012).

2. METHODOLOGY USED IN THIS RESEARCH

The methodology used in this research is based on literature review, developments of conceptual model, design of questionnaire, questionnaire feedbacks follow up and conducted an empirical analysis of data collected from manufacturing enterprises .For analyzing the data simple statistics was used. In analyzing the data two software were used SPSS (Special Package for Social Scientists) and Excel.

3. RESEARCH AREA

The research area for this study is the manufacturing enterprises in which CIM system and latest advance manufacturing technologies have installed to performing the various operations related to production. For the purpose of research three (03) manufacturing enterprises have selected, all three manufacturing industries are in the Karachi city.

4. DATA COLLECTION

The method adopted for gathering the data was the cross-sectional survey through the questionnaire of selected Manufacturing enterprises such as Aftab Technologies Limited (ATL), Omar Jabran (OJ) and Karachi Tool Dies and Mould Company (KTDMC). In this regard questionnaire was prepared to fulfill the objective of this research. The scale selected for the questionnaire was 5-point Likert Scale, which includes strongly agree (SA), agree (A), uncertain (UC), disagree (DA), strongly disagree (SD). Questionnaires were sent to the production department of the manufacturing enterprises which has adopted CIM system for the purpose of collection of data.

5. RATE OF RESPONSE

The questionnaires were sent to the production department of each manufacturing enterprise. The questionnaires were filled by 30% of the total persons worked in production department of each manufacturing enterprise. A few questionnaires were discarded because of partially filled. Remaining questionnaires were used for analysis purpose.

6. RELIABILITY OF DATA

To know the internal consistency of the scale, reliability of data is measured. Cronbach's alpha was applied to measure the internal consistency of data. Croanbach's alpha co-efficient for the internal consistency of the current data is 0.73.

7. IMPACT OF CAD/CAM ON MANUFACTURING PARAMETERS

Manufacturing enterprises under study were asked to indicate the level of impact of the CAD/CAM on the various manufacturing parameters. Data was collected and statistically analyzed in terms of mean value and % of impact which is mentioned in Table no.1 and also graphically represented.

Analysis reveals that mean value for quality is calculated as 4.33 which reflects that manufacturing enterprises were agree that there quality has improved. However analysis further reveals that overall impact on quality was calculated as 11.61%. Mean value for productivity is 4.67 which indicate that manufacturing enterprises strongly agreed to their productivity has improved to great extent, however overall impact on productivity was calculated as 12.50%. Mean value for lead time is 4.67 which indicates that manufacturing enterprises strongly agreed to their lead time reduces in great extent, however overall impact on reduces lead time is calculated as 12.50%. Analysis reveals that mean value of manufacturing cost is calculated as 4.33 which indicates that manufacturing enterprises agreed to their manufacturing cost is reduced to good extent, however overall impact on reduces cost is 11.61%. Mean value mean value for both Flexibility and Profitability is 4 which indicate that manufacturing enterprises agreed to their Flexibility and Profitability has increased to good extent, however overall impact on Flexibility and Profitability is calculated as 10.71%. Mean value for Due date delivery is calculated as 3 which indicate that manufacturing enterprises has not sure that due date delivery has increased or decreased, however overall impact is 8.04%. Mean value for complexity in design is calculated as 2.67 which indicate that manufacturing enterprises has not sure that complexity in design has increased or decreased, however overall impact is 7.14%. Mean value for reduces rework is calculated as 3 which indicate that manufacturing enterprises has not sure that there has increased or decreased in reduces rework, however overall impact is 8.04%. Mean value of reduces scrap is calculated as 2.67 is near to 3 which indicates that manufacturing enterprises has not sure that there has increased or decreased in reduces scrap, however overall impact is 7.14%.

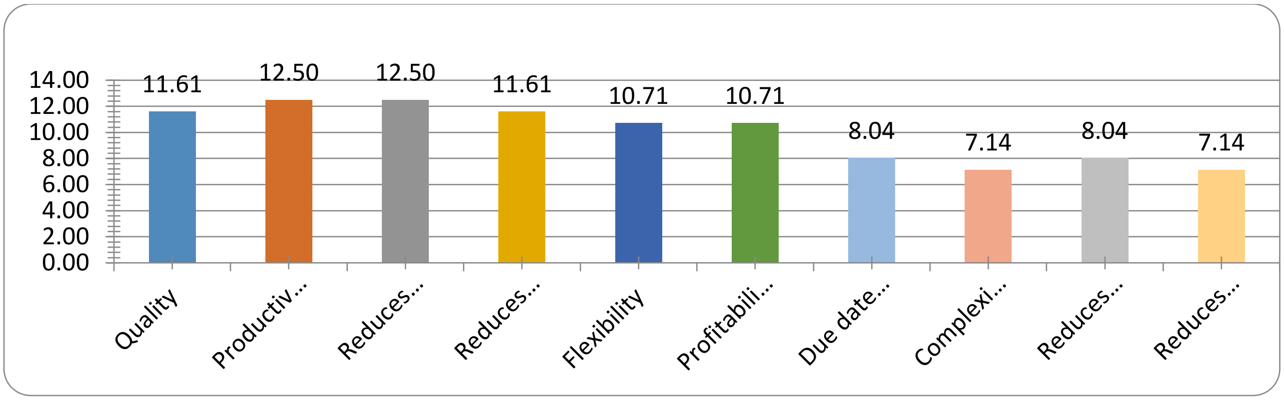

Figure 1.: shows the impact of CAD/CAM on Manufacturing Parameters

Table 1.Shows the impact of CAD/CAM on Manufacturing Parameters

	Manufacturing Parameters	MEAN	IMPACT in %
1	Quality	4.33	11.61
2	Productivity	4.67	12.50
3	Reduces lead time	4.67	12.50
4	Reduces cost	4.33	11.61
5	Flexibility	4	10.71
6	Profitability	4	10.71
7	Due date delivery	3	8.04
8	Complexity in design	2.67	7.14
9	Reduces rework	3	8.04
10	Reduces scrap	2.67	7.14

7.2 Impact Of CNC On Manufacturing Parameters

Manufacturing enterprises under study were asked to indicate the level of impact of the CNC on the various manufacturing parameters. Data was collected and statistically analyzed in terms of mean value and % of impact which is mentioned in Table no: 1.2 and also graphically represented.

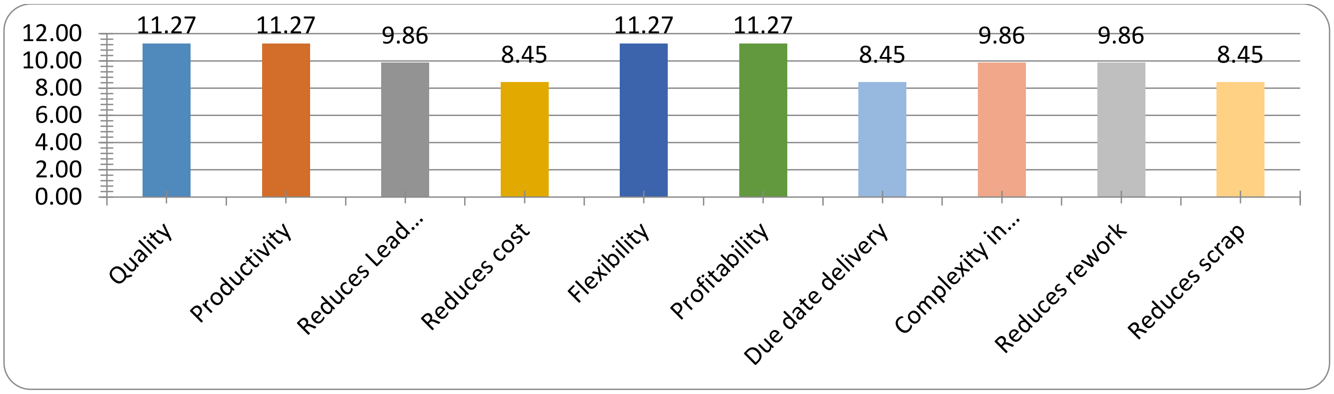

Figure 2. Shows the impact of CNC on Manufacturing Parameters

Table 2. Shows the impact of CNC on Manufacturing Parameters.

	Manufacturing Parameters	Mean	IMPACT in %
1	Quality	4	11.27
2	Productivity	4	11.27
3	Reduces lead time	3.5	9.86
4	Reduces cost	3	8.45
5	Flexibility	4	11.27
6	Profitability	4	11.27
7	Due date delivery	3	8.45
8	Complexity in design	3.5	9.86
9	Reduces rework	3.5	9.86
10	Reduces scrap	3	8.45

7.3 Impact Of CAE On Manufacturing Parameters

Manufacturing enterprises under study were asked to indicate the level of impact of the CAE on the various manufacturing parameters. Data was collected and statistically analyzed in terms of mean value and % of impact which is mentioned in Table no.3 and also graphically represented.

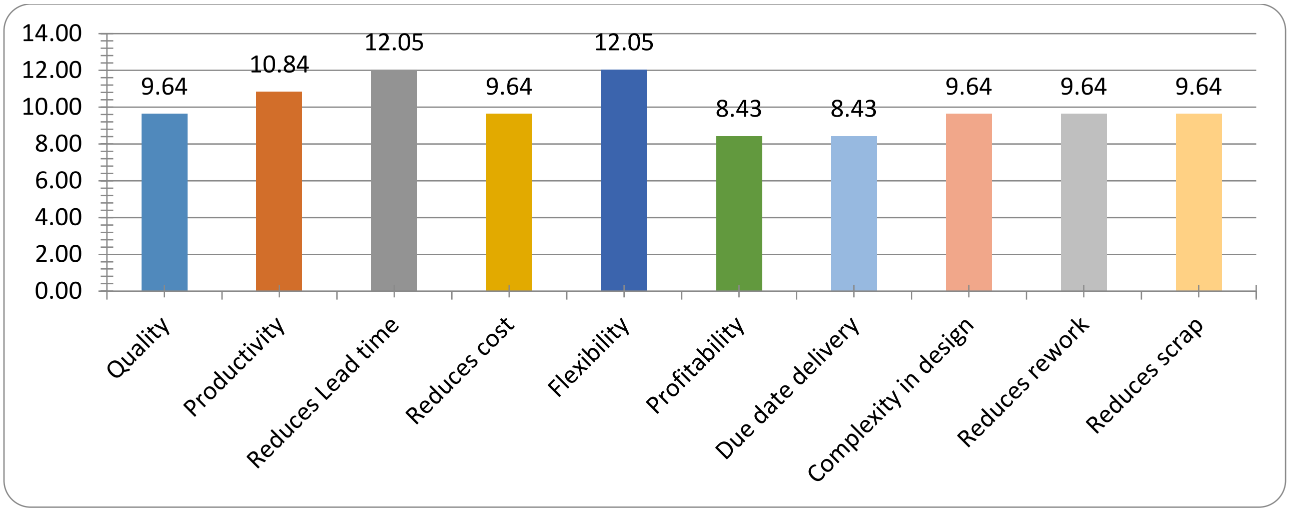

Figure 3. Shows the impact of CAE on Manufacturing Parameters

Table 3. Shows the impact of CAE on Manufacturing Parameters

	Manufacturing Parameters	Mean	IMPACT in %
1	Quality	4	9.64
2	Productivity	4.5	10.84
3	Reduces lead time	5	12.05
4	Reduces cost	4	9.64
5	Flexibility	5	12.05
6	Profitability	3.5	8.43
7	Due date delivery	3.5	8.43
8	Complexity in design	4	9.64
9	Reduces rework	4	9.64
10	Reduces scrap	4	9.64

7.4 Impact Of JIT On Manufacturing Parameters

Manufacturing enterprises under study were asked to indicate the level of impact of the JIT on the various manufacturing parameters. Data was collected and statistically analyzed in terms of mean value and % of impact which is mentioned in Table no.4 and also graphically represented.

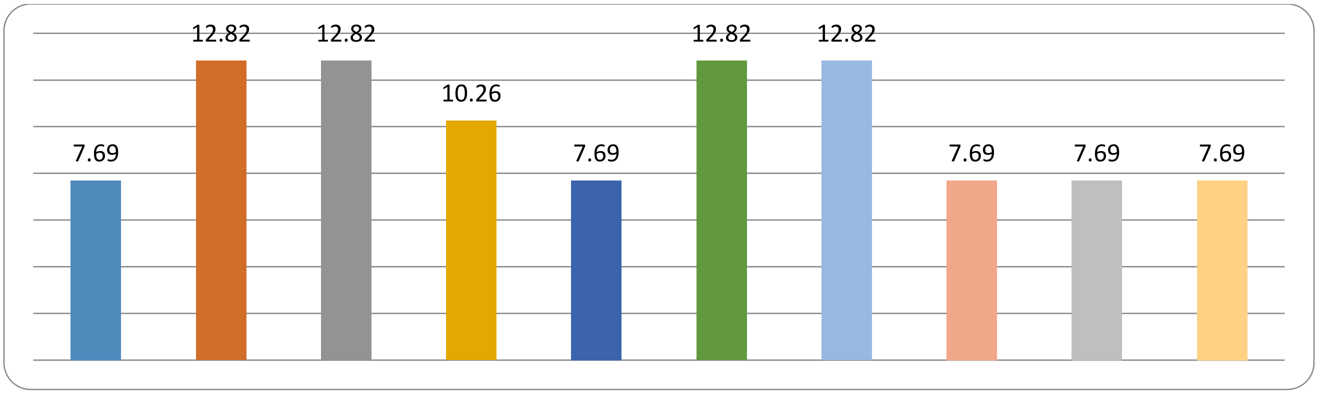

Figure 4. Shows the impact of JIT on Manufacturing Parameters

Table 4. Shows the impact of JIT on Manufacturing Parameters

	Manufacturing Parameters	Mean	Impact in %
1	Quality	3	7.69
2	Productivity	5	12.82
3	Reduces lead time	5	12.82
4	Reduces cost	4	10.26
5	Flexibility	3	7.69
6	Profitability	5	12.82
7	Due date delivery	5	12.82
8	Complexity in design	3	7.69
9	Reduces rework	3	7.69
10	Reduces scrap	3	7.69

7.5 Impact Of TQM On Manufacturing Parameters

Manufacturing enterprises under study were asked to indicate the level of impact of the TQM on the various manufacturing parameters. Data was collected and statistically analyzed in terms of mean value and % of impact which is mentioned in Table no.5 and also graphically represented.

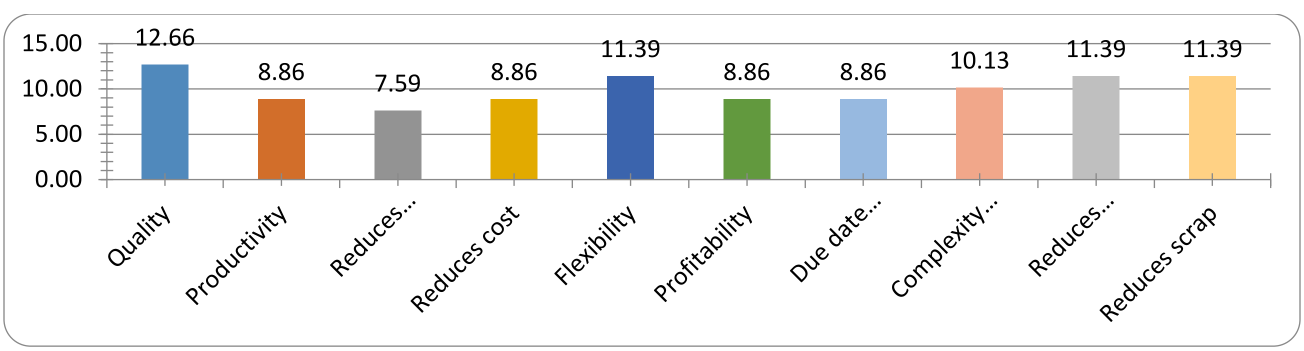

Figure 5. Shows the impact of TQM on Manufacturing Parameters

Table 5. Shows the impact of TQM on Manufacturing Parameters

	Manufacturing Parameters	Mean	Impact in %
1	Quality	5	12.66
2	Productivity	3.5	8.86
3	Reduces lead time	3	7.59
4	Reduces cost	3.5	8.86
5	Flexibility	4.5	11.39
6	Profitability	3.5	8.86
7	Due date delivery	3.5	8.86
8	Complexity in design	4	10.13
9	Reduces rework	4.5	11.39
10	Reduces scrap	4.5	11.39

7.6 Impact Of MRP On Manufacturing Parameters

Manufacturing enterprises under study were asked to indicate the level of impact of the MRP on the various manufacturing parameters. Data was collected and statistically analyzed in terms of mean value and % of impact which is mentioned in Table no. 6 and also graphically represented.

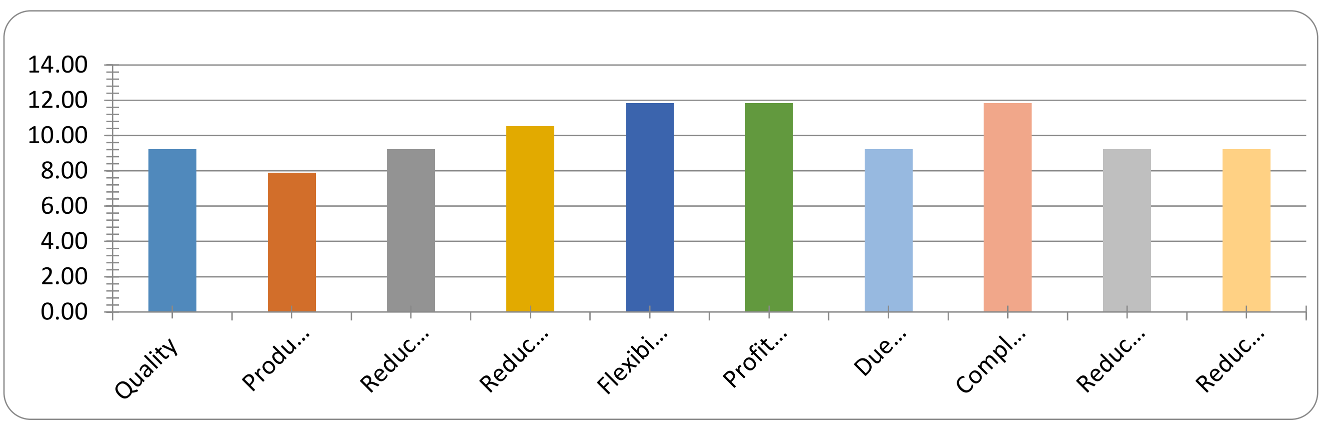

Figure 6. Shows the impact of MRP on Manufacturing Parameters

Table 6. Shows the impact of MRP on Manufacturing Parameters

	Manufacturing Parameters	Mean	Impact in %
1	Quality	3.5	9.21

2	Productivity	3	7.89
3	Reduces lead time	3.5	9.21
4	Reduces cost	4	10.53
5	Flexibility	4.5	11.84
6	Profitability	4.5	11.84
7	Due date delivery	3.5	9.21
8	Complexity in design	4.5	11.84
9	Reduces rework	3.5	9.21
10	Reduces scrap	3.5	9.21

8. CONCLUSIONS

This research has aimed to assess the impact of CIM enabler /Advance manufacturing technologies in productivity improvement and overall efficiency of the plant that want to manufacture the high quality products for consumers and avail maximum advantages and profits within available resources. The result and findings of this research shows that CIM system has very good impact on selected 10 manufacturing parameters in a great extent and improves the productivity and efficiency of the plant along with streamline and integrate the many functions of the plant and has accomplished maximum benefits and profit.

According to the result of research, all the latest manufacturing technologies/ CIM enablers such as CAD/CAM, CNC, CAE, JIT, TQM and MRP enablers has good impact on the manufacturing parameters. According to the result of research with the use of these technologies manufacturing enterprises has able to produce the high quality products along with increase in their productivity with customer satisfaction through timely delivery of products. This research encourage to industrialist to install CIM system/ latest technologies in their manufacturing enterprises to compete in the global market through customer satisfaction.

REFERENCES

1. Adriana, Tiron Tudor.; Monica, Zaharie. and Codruta, Osoian. (2013), “Innovation development needs in manufacturing companies” V. 27 No. 1 Pg. 56-75..

2. Bo Song, Zuhua Jiang (2013) “Proactive search enabled context-sensitive knowledge supply situated in computer-aided engineering”. Advanced Engineering Informatics V. 27 No. 1 Pg. 66-75.
3. Brecher, C.h, and Lohse, W (2013), “Evaluation of tool path quality: User-assisted CAM for complex milling processes”, Journal of Manufacturing Science and Technology, v 6, pp. 233–245.
4. Sheikh, G.Y.; Marri, H.B and Irani, Z. (2006), “An Investigation into the Effects of Computer Integrated Manufacturing Systems in the Productivity of SMEs in Pakistan European and Mediterranean Conference on Information Systems (EMCIS) , July 6-7, Costa Blanca, Alicante, Spain.
5. Marri, H.B; Irani, Z. and gunasekaran, A. (2006), “A Framework of Justification Criteria for Advanced Manufacturing Technology Implementation in Small and Medium Enterprises” European and Mediterranean Conference on Information Systems (EMCIS) 2006, July 6-7 2006, Costa Blanca, Alicante, Spain.
6. Liming, Shen.; Na, Yu.; and Siegfried. Lewark, (2011), “Drivers and Barriers for Implementing Advanced Manufacturing Technology in China's Furniture Industry: An Exploratory Study”. Forest Products Journal, V. 61, No. 1, pp. 83-91.
7. Marri, H.B.; and Sohag, R.A., (2004), “Top management role for facility location and layout when implementing advanced manufacturing technology”. *2nd International Industrial Engineering Conference,* K.S.U, Riyadh, Saudi Arabia.
8. Musara, Mazanai. (2012) “Impact of just-in-time (JIT) inventory system on efficiency, quality and flexibility among manufacturing sector, small and medium enterprise (SMEs) in South Africa”, African Journal of Business Management Vol. 6(17), pg. 5787-5788
9. Rozmarina Dubovska, Jaroslav Jambor, Jozef Majerik (2013) “Implementation of CAD/CAM system CATIA V5 in Simulation of CNC Machining Process” 24th DAAAM International Symposium on Intelligent Manufacturing and Automation.
10. Shaikh, G.Y., Marri, H.B. and Irani, Z,2009,An Investigation into the Effects of Computer Integrated Manufacturing Systems in the Productivity of SMEs in Pakistan, EMCIS.

11. Tufan, Koc.; and ErhanBozdag, (2007), “The impact of AMT practices on firm performance in manufacturing SMEs” Department of Industrial Engineering, Istanbul Technical University , Macka, Istanbul, Turkey.

12. Yusuf Tansel, (2012), An experimental design approach using TOPSIS method for the selection of computer-integrated manufacturing technologies _Ic- Department of Industrial Engineering, Faculty of Engineering, Baskent University, Ankara, Turkey.

EVALUATING THE DYNAMICS OF LAND SURFACE TEMPERATURE IN RESPONSE TO LAND COVER CHANGES USING REMOTE SENSING AND GIS TECHNIQUES

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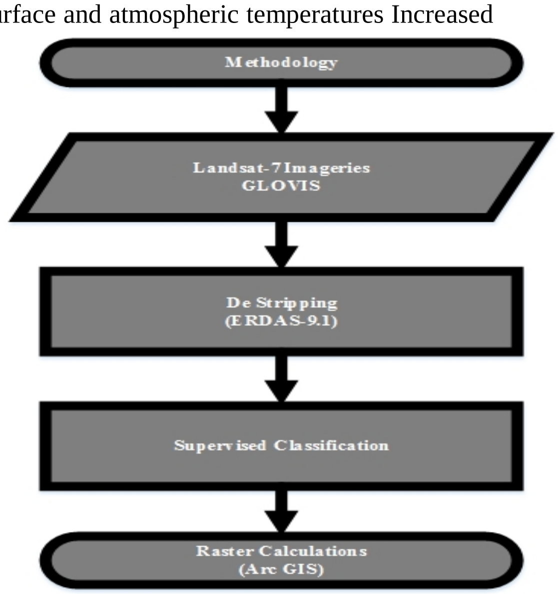
Abstract: Continuous shift in the land use pattern resulting recession in vegetation and water bodies in addition anthropogenic activities raise the heat emission from land surface and atmospheric temperatures. High land surface temperature (LST) is mostly due to increment in paved land cover. This study illustrates the spatio-temporal dynamics of land use/cover of Hyderabad District of Pakistan. Landsat satellite imageries of two different time periods i.e 2000 and 2015 were acquired from GLOVIS site and evaluation was made over the period of 15 years using GIS and Remote Sensing techniques. Supervised classification methodology has been employed using maximum likelihood technique in ArcGIS 10.1 and ERDAS 9.1 Software. The images of the study area were categorized into five different classes namely Vegetation, Non-cultivated Area, Urban Area, Hilly Area and water body.
Keywords: Land Surface Temperature, Land Cover, Spatio-Temporal Dynamics, GIS and Remote Sensing

1. INTRODUCTION

Land usage pattern and land cover changes triggered by anthropological actions have robust effects on regional environment. Land surface temperature plays an significant role in examining the effect of Land Use and Land Cover (LULC) changes on regional atmosphere (Bharath et al. 2013, Rawat. 2015) Severe fluctuations in the land cover with the vegetation decay and water bodies due to human actions increases the heat production from land surface and atmospheric temperatures Increased land surface temperature LST is mostly due to upsurge in intense human activities, cemented land cover (Turner 1995, Friedl et al. 1997). Now a day's detection of land cover changes and correlating it with some environmental condition is of utmost interest for research community, because since man is changing his surroundings for his need and comfort, the damaging effect of these changes are increasing day by day (Lambin. 2003, Weng. 2004). These changes have hampered the climatic condition of the regions, therefore it very important to apply a check to these changes (Sobrino. 2004). In this paper we are detecting land cover changes for District Hyderabad, having focused Urbanization Pattern, and its correlation with Land Surface Temperature (LST) and Hydro climatic condition of the Region. Hyderabad is located in province of Sindh Pakistan, 25.3818N and 68.3694E being its coordinates. It is 2nd most populous City of Sindh and ones it was the Capital of the Sindh. Due to its strategic business position it is developing day by day with rapid increase in urbanization. This paper demonstrates the spatio-temporal changes of land cover of Hyderabad district, Sindh, Pakistan. Landsat satellite imageries of two different time periods, i.e., Landsat Image of 2000 and 2015 were acquired by GLOVIS and earth explorer website in order to calculate the dynamics in the Hyderabad district from 2000 to 2015. Supervised classification procedure has been used using maximum likelihood



technique in ERDAS 9.1 Software. The imageries of the area under study were characterized into five different classes namely vegetation, agriculture, barren, built-up and water body.

2. METHODOLOGY AND MATERIALS

Landsat 7 imagery having row and path being 151 and 41 respectively, were downloaded from glovis.usgs.gov/ website for the year 2000 and 2015, Rain gauge data from the station near District Hyderabad was acquired from 1980 to 2014.
The Landsat 7 imagery for the year 2015 was having strips due to SLC being off for the satellite, the images were de striped using software ERDAS 9.1, the Landsat 7 composed of 8 bands detailed as under:

Figure 1 Methodology

Band 1	Blue Light
Band 2	Green Light
Band 3	Red Light
Band 4	Near Infrared (NIR)
Band 5	Short wave Infrared
Band 6	Thermal Infrared
Band 7	Another Short wave Infrared
Band 8	Panchromatic Band

After de striping these band were composited analyzed in Pseudo Natural Colour for both years (Band Combination being 7, 4, 2), the images then classified in 5 classes namely: Water, Vegetation, Non cultivated Area, Urban Area and Hilly Area, then these classes were mapped and area under each class was calculated, this exercise was performed using ESRI ArcGis 10.1 software package, (Results are shown under the heading of Results.) Then Land Surface Temperature was calculated using ArcGis 10.1 and Band No.6 of Landsat 7 imagery, as stated above, it is thermal band, the calculations are as under:
Step1.

$$L\lambda = ((LMAX\lambda - LMIN\lambda)/(QCALMAX-QCALMIN)) * (QCAL-QCALMIN) + LMIN\lambda$$

Step 2.

$$T=(K2/\ln(K1/ L\lambda+1))-273.16$$

These equations are provided in Landsat 7 Science data User's Manual.

For Band No.6 $LMAX\lambda=17.04$, $LMIN\lambda=0$, $QCALMAX=255$, $QCALMIN=1$

After performing these calculations through Raster calculator we have obtained Land Surface Temperature Map.(shown in Results and discussed in conclusion).

3. RESULTS

Results obtained in graphical format were analyzed and interpreted that are shown below

3.1 Pseudo Natural Colour Images:

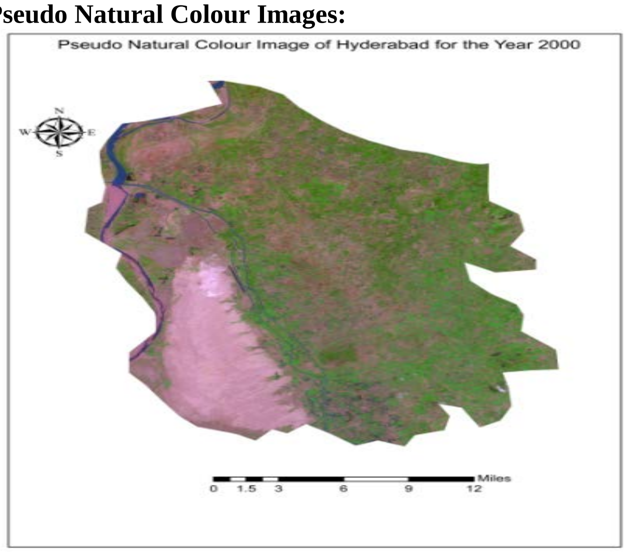


Figure 2 Pseudo Natural Color 2000

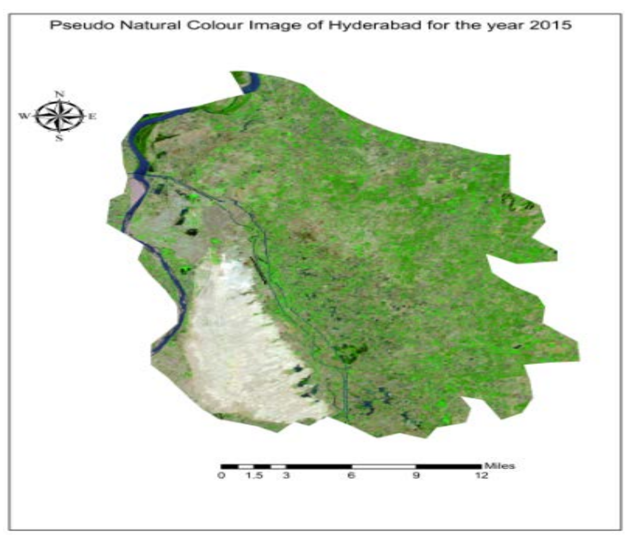


Figure 3 Pseudo Natural Color 2015

3.2 Classified Images:

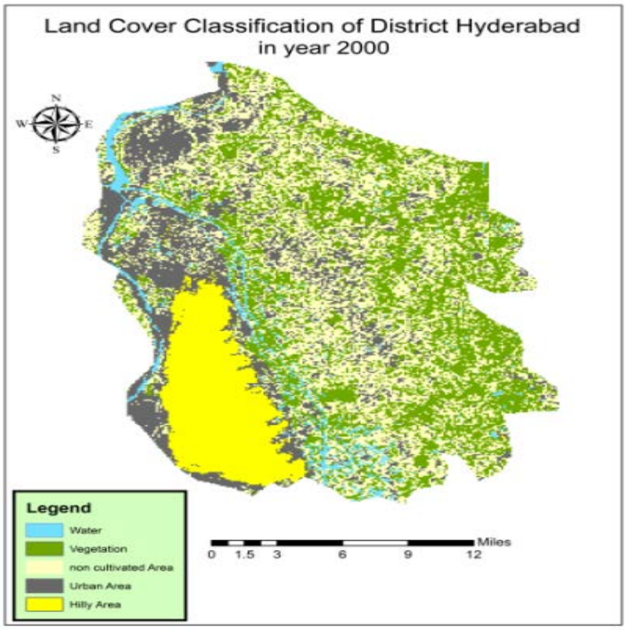


Figure 2 Land Cover Classification 2000

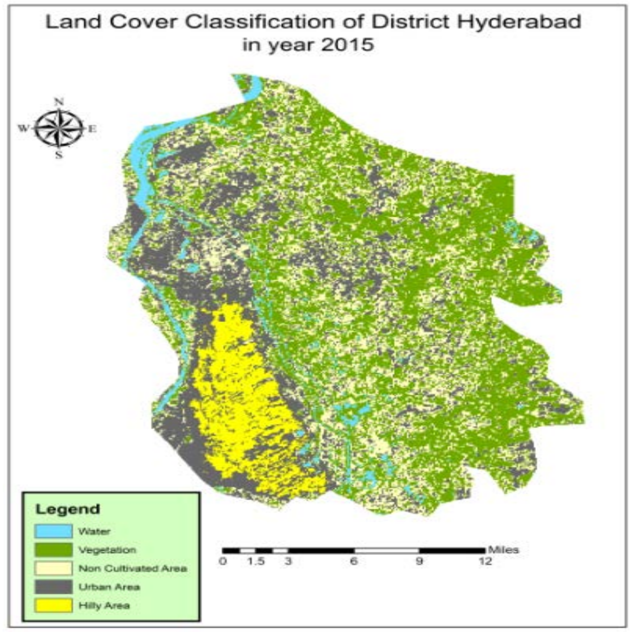


Figure 5 Land Cover Classification 2015

Table 1 Land Cover Classification

Class	Area under this class in 2015 (Hectors)	Area under this class in 2000 (Hectors)
Water	4116.46	4299.39
Vegetation	40036.68	30438.56
Non Cultivated Area	27523.94	37289.86
Urban Area	25557.70	20325.15
Hilly Area	7636.16	12537.56

3.3 Thermal Mapping (Land Surface Temperature):

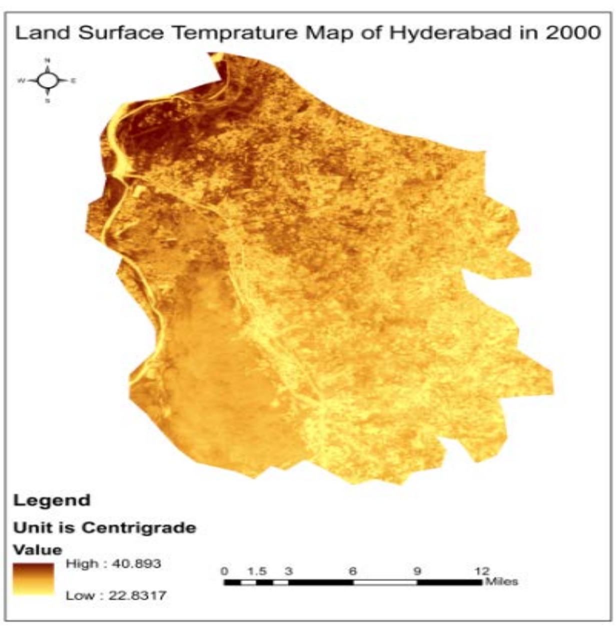


Figure 6 Land Surface Temperature 2000

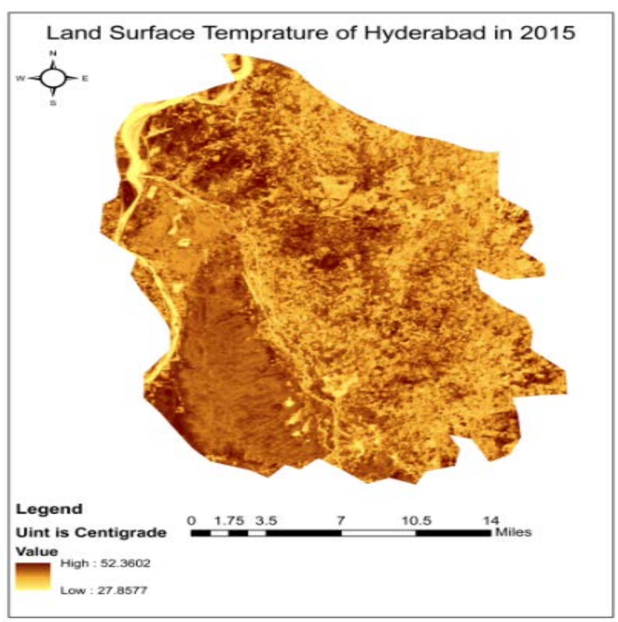


Figure 7 Land Surface Temperature 2015

4. DISCUSSION AND CONCLUSION

4.1 Classified Images: While looking at the classification map and table we can conclude easily that there is not much change in Urban Areas, the change is only 25.75%, major changes are in Deh Ghanj Takar, where Daman-e-Khosar and Gulistan-e-Sarmast is situated, and in Hala naka or ISRA University side where number of housing scheme are being developed.

4.2 Land Surface Tempereture: Urban heat Island can be traced easily, lower left areas of map can be taken to analyze the same, which is Deh Ghanj Takar where there is mass urbanization, hilly Khosar has been converted into Urban Area. The maximum temperature of year 2015 image is more than of year 2000 image, may be it is because the images were of two different months, for year 2000 the image was of June and in 2015 the image was of May, eventually the month of May is hotter than month of June in Hyderabad. To conclude this discussion it can be said that the temperature of Urban Areas are more than of Rural Areas, and urbanization is very much linked to change in Land Surface Temperature.

5. REFERENCES

1. Bharath, S., Rajan, K. S., & Ramachandra, T. V. (2013). Land surface temperature responses to land use land cover dynamics. Geoinformatics Geostatistics: An Overview, 1(4).

2. Friedl, M. A., & Brodley, C. E. (1997). Decision tree classification of land cover from remotely sensed data. Remote sensing of environment, 61(3), 399-409.

3. Lambin, E. F., Geist, H. J., & Lepers, E. (2003). Dynamics of land-use and land-cover change in tropical regions. Annual review of environment and resources, 28(1), 205-241.

4. Rawat, J. S., & Kumar, M. (2015). Monitoring land use/cover change using remote sensing and GIS techniques: A case study of Hawalbagh block, district Almora, Uttarakhand, India. The Egyptian Journal of Remote Sensing and Space Science, 18(1), 77-84.

5. Sobrino, J. A., Jiménez-Muñoz, J. C., & Paolini, L. (2004). Land surface temperature retrieval from LANDSAT TM 5. Remote Sensing of environment, 90(4), 434-440.

6. Turner, B., Skole, D., Sanderson, S., Fischer, G., Fresco, L., & Leemans, R. (1995). Land-use and land-cover change. In International Geosphere-Biosphere Programme, Stockholm; Report, 35.

7. Weng, Q., Lu, D., & Schubring, J. (2004). Estimation of land surface temperature–vegetation abundance relationship for urban heat island studies. Remote sensing of Environment, 89(4), 467-483.

SATELLITE BASED FLOOD MODELING USING TRMM DATA: CASE STUDIES OF 2010 AND 2011 FLOOD EVENTS OF PAKISTAN

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Abstract: The problem of flooding started since the independence year and Pakistan has experienced more than 21 major floods. These floods have killed a total of 8,887 people, damaged 109,822 villages, and caused $19 billion economic loss. These huge losses are the results of lack of attention, lack of coordination between the sectors, un-implementation of regulations and the policy failures. In this paper, all major floods, causes of floods at various river streams are briefly analyzed. The Floods of 2010 and 2011 were analyzed using TRMM DATA, ARC GIS and highly Remote Sensing Techniques.
Keywords: Flood Modeling, TRMM, 2010 and 2011 Flood and Remote Sensing.

1. INTRODUCTION

Floods are one of the most devastating and frequently occurring natural disasters which strikes numerous regions in the world each year. According to World Meteorological Organization (WMO) report (2011), during the last decades the trend in flood damages has been growing exponentially (Aziz and Tanaka 2011). The development of hydrological forecasting and warning systems is therefore a fundamental and crucial element in provincial and national planning. From 1930 the world has undergone over more than 200 deadliest floods including China's yellow and Yangtze river flood, Netherland's St. Lucia's flood, Bangladesh's monsoon floods, Iran's flood, Barcelona's flash flood, South and North Korean floods etc. These floods brought almost 8 million deaths across the globe (Weil. 2006). The statistics shown by statista.com and worldmapper.org just the flood of China (July 1931) led to 3.7 million deaths and 30.7 billion U.S. dollars economy's loss (Comrie. 2011, Shaikh. 2008).
Pakistan is also one of the most affected countries where heavy flood comes after every third or fourth year. According to the Federal Flood Commission (FFC) report, Pakistan has observed 20 major floods from 1950 to 2015. These floods affected 599,459 square kilometres area, snatched 11,239 precious human lives and caused losses worth over 39 billion U.S. dollars to the national economy. Due to heavy floods in 2010, 2011 and 2012, Pakistan lost 3,072 precious lives and had a financial loss of $16 billion (Ali 2013). United Nations Secretary-General Ban Ki-Moon interpreted 2010's Flood as the worst disaster he had ever witnessed (Houze. 2011). An estimated one-fifth of Pakistan's total land area (62,000 square miles) was submerged by the flooding (Ahmed 2010). The flood is approximated to have eventually affected more than 20 million Pakistanis, damaged 1.9 million households (OCHA 2010), caused $9.7 billion economy's loss (World Bank 2010) and demolished more 39 health care units. According to Pakistan National Disaster Management Agency (NDMA) flood 2010 caused 1,802 deaths and 2,994 injuries (World Health Organization 2011).

The 2010 flood was the worst flood of the Pakistan's history that kills the 1600 people, damaged 2 million of houses, displaced population of the 20 million, inundated 38600 km of the area and economic losses reached more than the $10 billion. The Sindh Province that is located at the tail end of the River Indus is mostly effected. Almost 43% of the Sindh, 26% of the Punjab, 12% of the KPK were inundated. This continuous flooding results high runoff in Indus, Ravi, Jehlum, Chenab, Kabul and Swat Rivers. In addition, hill torrents at Sulaiman Mountainous regions acted as a pressure force for the flooding. On the Indus River, the water level into the Tarbela Reservoir was equal to the flood event having a return period estimated at more than 3,000 years. The flood peak was the highest since the construction of Chashma Barrage in 1971 and at Guddu

Barrage the flood peak was exceeded by 25% of the designed capacity and 10% at Kotri Barrage (Gaurav et al. 2011, Tariq. 2012).

2. METHODOLOGY:

The Floods of 2010 and 2011 were analyzed using TRMM DATA, ARC GIS and highly Remote Sensing Techniques. The precipitation data of 2010 and 2011 was obtained from Tropical Rainfall Measurement Mission and further analyzed on Arc GIS. The flood inundation of 2010 and 2011 events of Pakistan and Sindh were acquired from National Disaster Management Authority (NDMA) and for flood inundation modelling of District Sanghar these were downloaded from the landsat-7 satellite imageries pre-and post flood evets and further they were studied using Arc GIS software to know the inundated area.

3. RESULTS

3.1 Flood 2010

Table 1 shows the precipitation in the months of August and September 2010. These results were determined by using TRMM data and were further analyzed on ARC GIS. During the months of August and September heavy rainfall occurred in all over Pakistan. During this month the maximum rainfall occurred in AJK and Punjab that were averaged 244 mm and basically contributed a lot in the low flood and turn it into higher flooding at the end of the month. In September the rainfall continued and were observed 660 mm average in Sindh Province that was maximum precipitation in the history. As a results the flood that was already generated due to the heavy rainfall of July and August at Upper Indus Basin and Punjab was converted into extreme flooding and brought the Catastrophe.

Table 1 Average Precipitation (m) during Aug-Sep by using TRMM data analysis on ARC GIS

August	**Precipitation (m)**	**September**	**Precipitation (m)**
AJK	0.244	AJK	0.103
Baluchistan	0.068	Baluchistan	0.011
KPK	0.0225	KPK	0.075
Sindh	0.198	Sindh	0.66
Punjab	0.255	Punjab	0.0101

Figure 1 below shows the graph of Monthly Average Precipitation Rate (mm/day) of Pakistan from June to October of 2010 that were analyzed by using the TRMM Data. During the month of June the Average Precipitation Rate was 1.3 mm/day at Pakistan at July it was reached to the 4 mm/day and in August 3.8 mm/day was observed. These Precipitation behavior is also shown into mm/hr in Fig-2 below. During the month of July the average rainfall rate was 0.16 mm/hr and in August it was 0.15 mm/hr. Both the graphs show that heavy precipitation during the months of July, August and September that was the main reason of the most catastrophic flood of Pakistan's history.

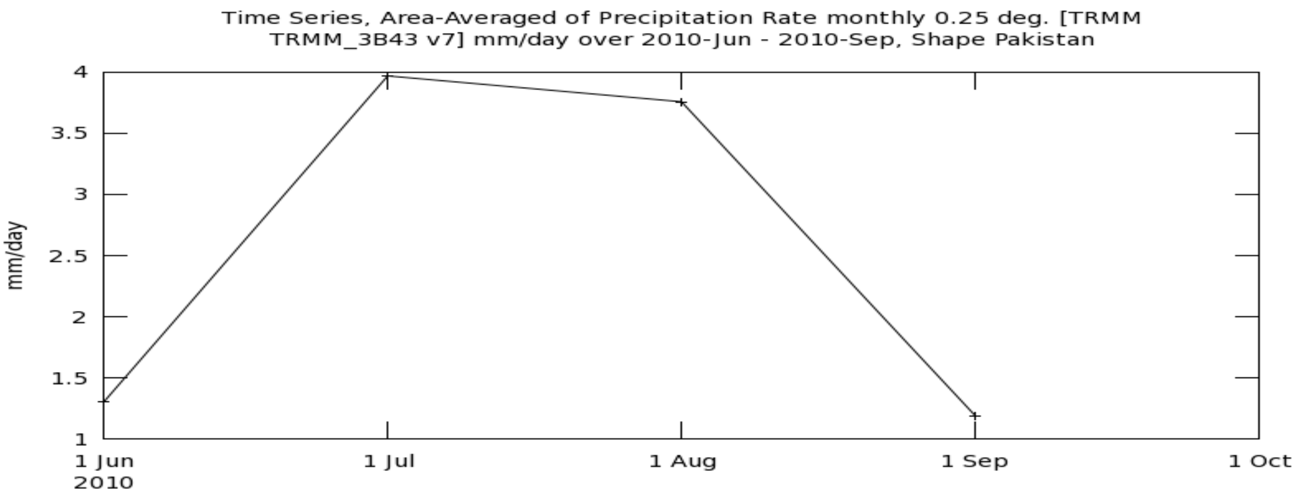

Figure 1 Monthly Average Precipitation Rate mm/day at 2010

Figure 2 below shows the overall the flood extent of 2010 and is taken from NDMA website. The blue areas shows the inundated areas due to flooding. In GB and upper stream side of River Indus and Swat Glaciers melted more than the normal as compare to the previous years because of higher temperature during May-June of 2010. In July Flood initiated in the very beginning at SWAT River and inundated the areas of the Saidu Sharif and Mardan. The continuous rainfall and the SWAT River's flood when entered the Indus it created the flash flood at Nowshehra. These both factors acted as a feeding force for the floods. The Jehlum and Chenab Rivers initiated from Himaliya and Kashmir the same factors also resulted their medium flood. The water level at Mangla Dam was already reaching at the maximum limits there for water was allowed to flow without any storage or barrier. At Trimmu Barrage where the Jehlum and Chenab meet flood acted as a massive pressure water inundated most of the areas of Jhang and Faisalabad Districts of Punjab. On the other hand the continuous rainfall at the KPK and FATA maximized the capacity of Kabul River and other streams. These streams and the continuous rainfall at nearby areas of Kalbagh, Mianwali, Daud Khel and Bhakar produced high flood and inundated most of the remote areas of these districts. The Ravi and Sutlej Rivers catchments were also suffering from such situations therefor India allowed excessive water to flow in Pakistan. At Punjnand-Rajanpur all Rivers fall in Indus s because already they were overloaded therefor the high floods of all Rivers at Punjnand and Southern Punjab converted into extreme flooding. A continuous rainfall was going on and in addition with above described factors were the main causes of the inundation of the Southern Punjab and North of the Sindh. The political influence and breaching of canals at various locations in order to save the important infrastructures were also contributed to flooding and inundation in Sindh.

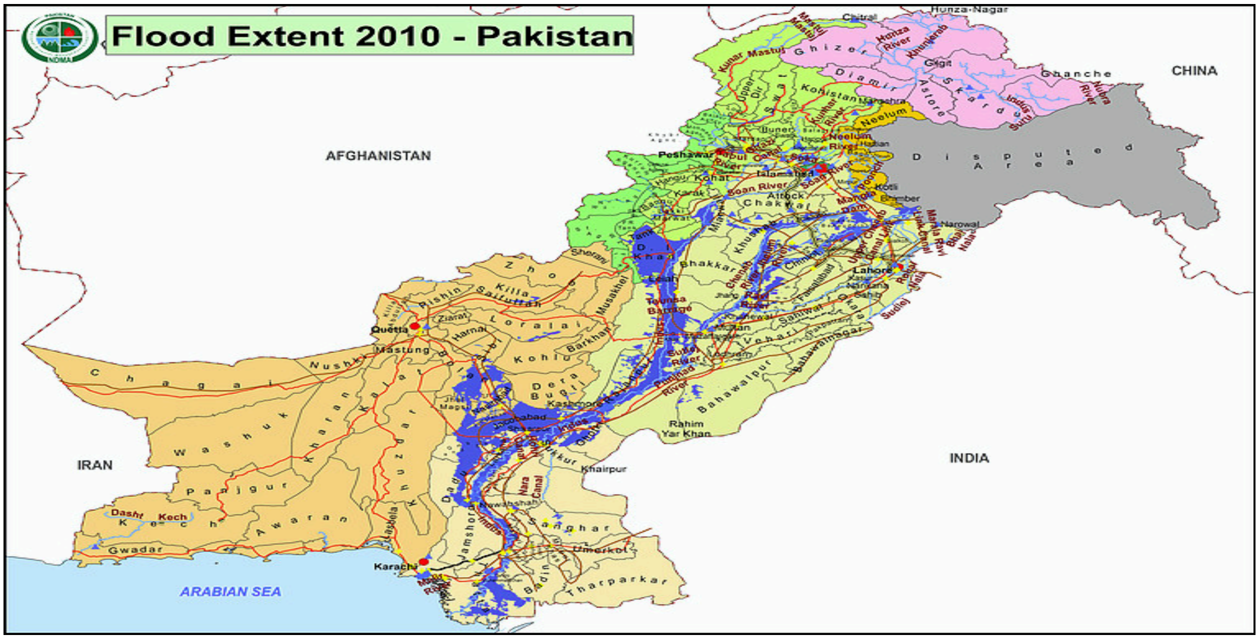

Figure 2 Flood Extent 2010

At 29th July rainfall (21mm to 280 mm) occurred continuously 24 hours in 18 Districts of the Sindh and on the next day same 24 hours rainfall occurred in the Northeren Pakistan at Kamra and Garhi Dopatta. The average rainfall for the month of the July 2010 in Sindh was 290 mm and 189mm in August that is more than the double than that of the normal average rainfall. Figure 4 shows the Flood Extent of 2010 at Sindh. More than 80% of the area of the Kashmore, Jaccobabbad, Shikarpur and Qambar Shadadkot were completely inundated and that results damages of crops because these areas are very fertile, causes more than 300 deaths. The whole Indus's route comparatively suffered many of the areas of Nawabshah and Matyari were in water. After Kashmore and Jaccobabad the Thatta that is already lower Indus side was mostly suffered.

Figure-3 below shows the results of remote sensing at District Sanghar area in order to know the inundated areas and is determined by using high remote sensing techniques. The whole area of Sanghar District is 10720 Km2. At 12 June 2010 the areas having water were only 540 Km2 that includes the water bodies etc. After the flooding of 2010 the Sanghar region was also suffered. The landsat analyses of 12th August 2010 the inundated area is found 1282 Km2 as shown in figure 4. The inundated area of Sanghar District is also shown in Table-2 below.

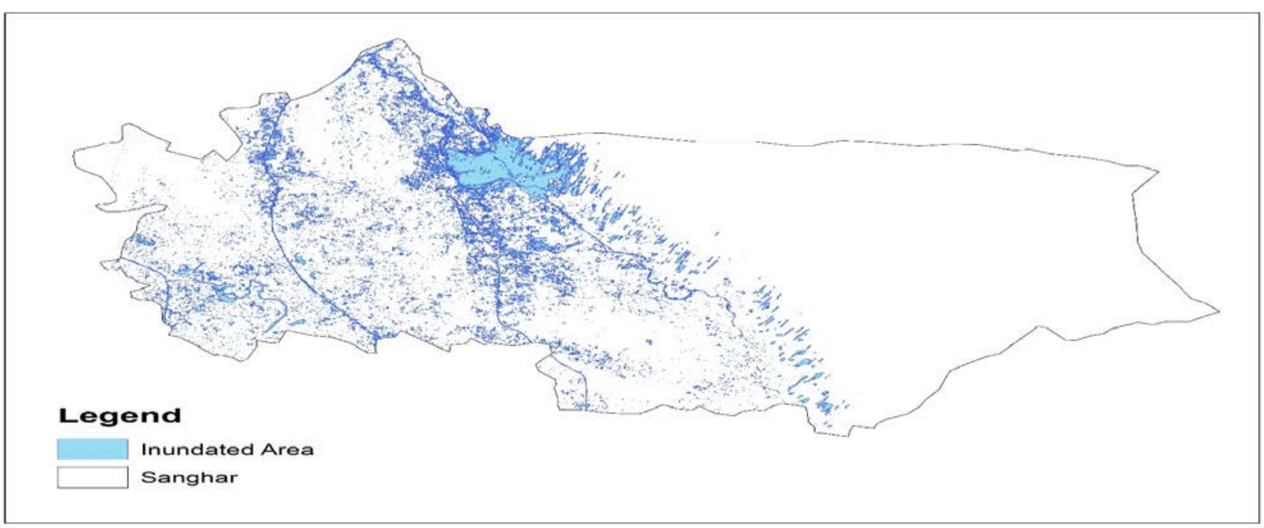

Figure 3 Inundated area of district Sanghar at 12th June 2010 (Determined using remote sensing techniques)

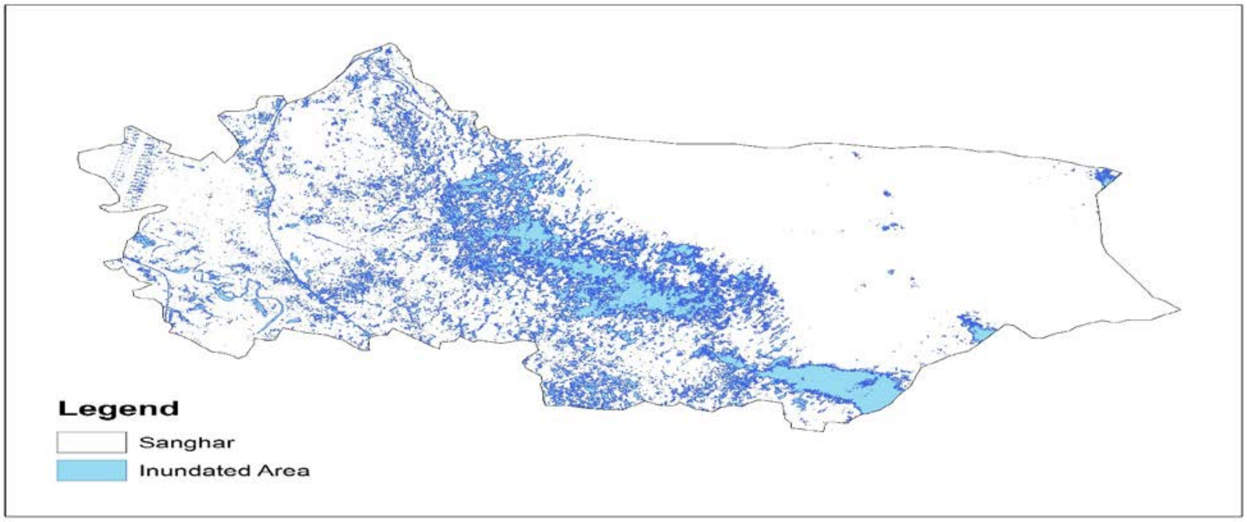

Figure 4 Inundated area of district Sanghar at 12th August 2010

Table 2 Inundated area of district Sanghar obtained using remote sensing technique

Date	Inundated Area	Remaining Area	Total Area (Km2)
12th June 2010	540.1494555	10180.83272	10720.98218
12th August 2010	1282.91386	9436.178837	10720.98218

3.2 Flood 2011

In 2011 yearly precipitation was in normal pattern but the disaster rapidly initiated during monsoon, Table 3 shows that the annual average precipitation in meters in Pakistan and Sindh which was affected most as determined by using TRMM data analyses on ARC GIS. The maximum precipitation occurred in September at all over the Pakistan. In the month of September the average rainfall was measured 0.35 m at Sindh that created the flood. Seasonally maximum precipitation rate of 2011 was observed in disputed area of Kashmir as 0.434762m and also the high precipitation rate was observed in Sindh. Furthermore the district wise maximum precipitation was observed in district Badin as 0.402096m and also high magnitude of rainfall was received in Nawabshah, Sanghar, Tharparkar, Thatta, Umer Kot, and Hyderabad.

Table 3 Precipitation of Pakistan and Sindh in 2011

Pakistan	Precipitation (m)	Sindh	Precipitation (m)
January	0.078177	January	0.017
February	0.088	February	0.02
March	0.039	March	0.009
April	0.049	April	0.0072
May	0.017	May	0.001
June	0.029	June	0.001
July	0.07	July	0.05
August	0.13	August	0.32
September	0.14	September	0.35
October	0.017	October	0.00032
November	0.013	November	0.00033
December	0.002	December	0.00014

Figure 5 is the annual precipitation pattern of 2011 as determined by using Arc GIS. The blue grids show the maximum precipitation as shown in figure the upper Indus Basin, Southern Punjab, FATA, Eastern Punjab and Southern Sindh received the maximum amount of the rainfall. At Peshawar, Azad Jamu and Kashmir, Islamabad, Nawabshah and Sanghar received 0.176 m of catastrophic rainfall.

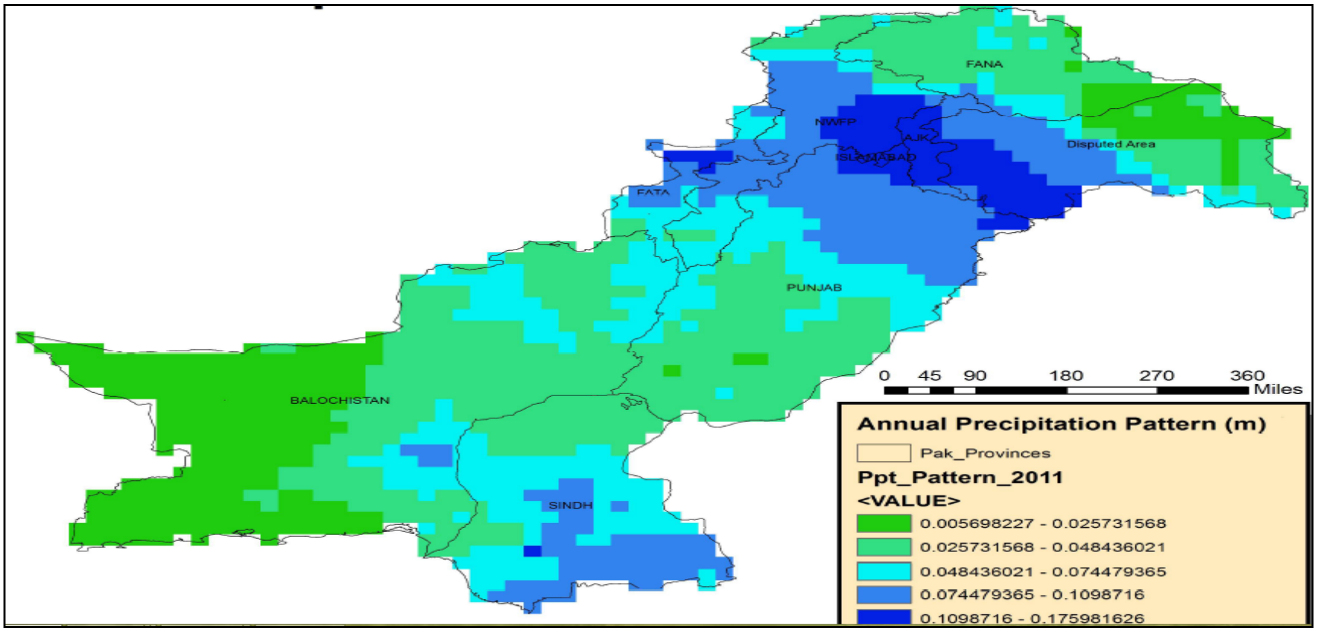

Figure 5 Annual Precipitation Pattern of 2011

The heavy rainfall occurred at Southern Punjab and Sindh in July and August 2011 that created the flood. Almost 580 persons killed, 1180 injured, 1.5 million houses were damaged and overall 25090 Sq-km was effected and around 880 thousand hectares of the crops damaged. The annual maximum precipitation rate was observed in Disputed Area of Kashmir as 0.175982m and the high precipitation rate was observed in AJK, KPK, Punjab and Sindh as 0.149847m, 0.14501m, 0.140054m, and 0.139441m.

Graphs below in figure 6 shows the Monthly Average Precipitation Rate mm/hr at 2011 and in mm/day during the monsoon period. During the months of August and September the maximum precipitation rate 0.14 mm/hr occurred. This trend started from 1st of August and continued at the mid of the September. The amount of rainfall rate measured 3.3 mm/day average during these months.

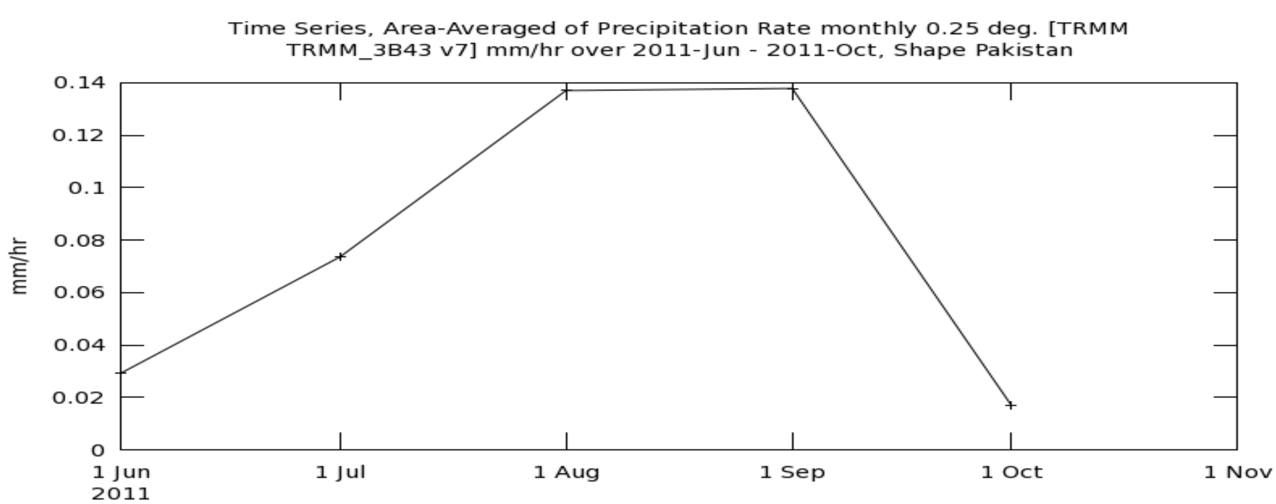

Figure 6 Monthly Average Precipitation Rate mm/hr at 2011

Figure 7 below shows the flood extent map of Pakistan during the flood of 2011 that describes the rivers and streams were flowing with maximum amount of water as per their capacity due to rainfall at upper Indus Basin, AJK, KPK and Punjab. When this flow from Indus entered into the Sindh because already the precipitation was going on, it acted as a pressure force in major canals of Sindh like Nara, Khairpur Thal. These Canals were already reaching their maximum limits plus the continuous rainfall at Sanghar, Nawabshah, Mirpurkhas, Badin and Thatta changed it into the Extreme event. Here the political influence and some poor strategies by the authority also played a vital role. The areas which were mostly suffered are the Naushohro Feroz, Moro, Nawabshah, Tandoadam, Shahdadpur, Sanghar, Mirpur khas and Badin.

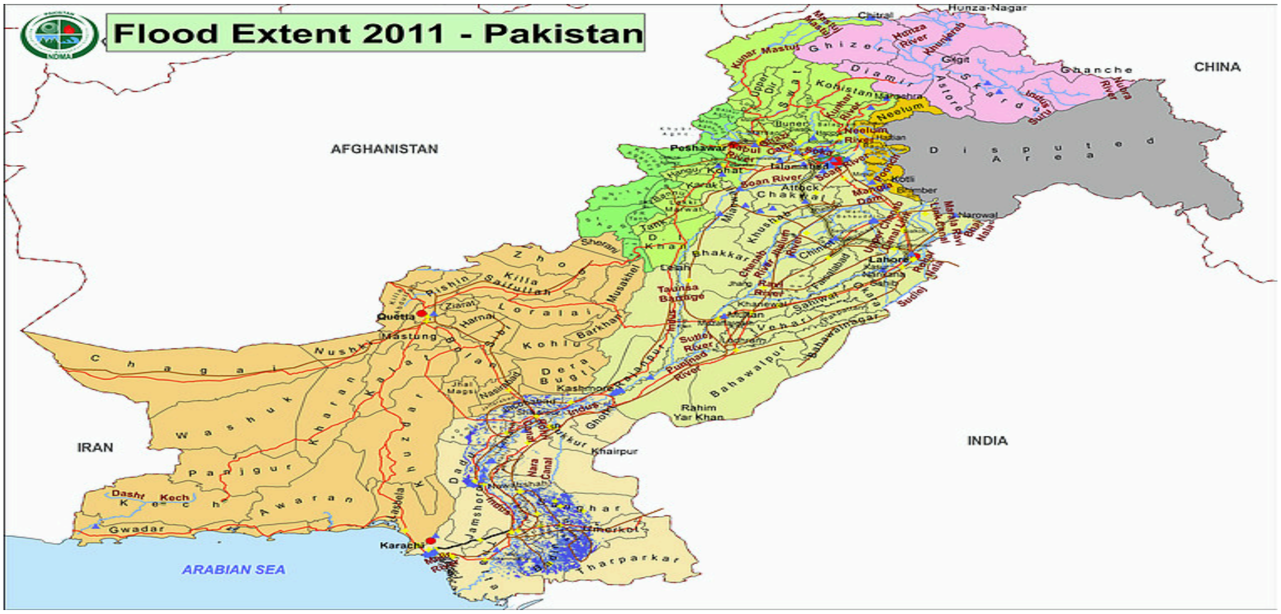

Figure 7 Flood Extent 2011 at Pakistan

Table 4 Precipitation at the Flood affected Areas of Sindh

Flood Affected Areas of Sindh (precipitation)	**August**	**Sept**
Nawabshah	0.33	0.52
Sanghar	0.35	0.49
Mirpurkhas	0.402	0.47
Badin	0.46	0.54

Table 4 shows the precipitation in areas which suffered most during the flood 2011. During the month of August Nawabshah received 0.33m precipitation, Sanghar 0.35 m , MPK 0.4 m and Badin 0.46 m. In September Nawabshah received 0.52m precipitation, Sanghar 0.49 m , MPK 0.47 m and Badin 0.54 m. That were the maximum precipitation of Pakistan of 2011. The water table of these cities were already higher because of 2010 flood. When the heavy rainfall of 2011 occurred the flooding started top and bottom both.

Figure 8 and 9 show the results of the remote sensing of District Sanghar in order to calculate the total inundated area due to flood 2011. Table 5 shows the Inundated Area of District Sanghar at 9th June 2011 before the monsoon period. The results are also shown in Table 8 at 9th June the inundated area was found 322 Km2. That was just the area of the water bodies etc in District. At 23rd August 880 Km2 was inundated because the rainfall initiated in the beginning of August and continued mid of September. At the end of this continuous rainfall the more than 60% area of Sanghar district was inundated.

Table 5 Results of the Remote Sensing

Date	Inundated Area	Remaining Area	Total Area(Km2)
9th June 2011	322.5353375	10398.47959	10721.01493
23rd August 2011	880.4679409	9839.05635	10721.01493

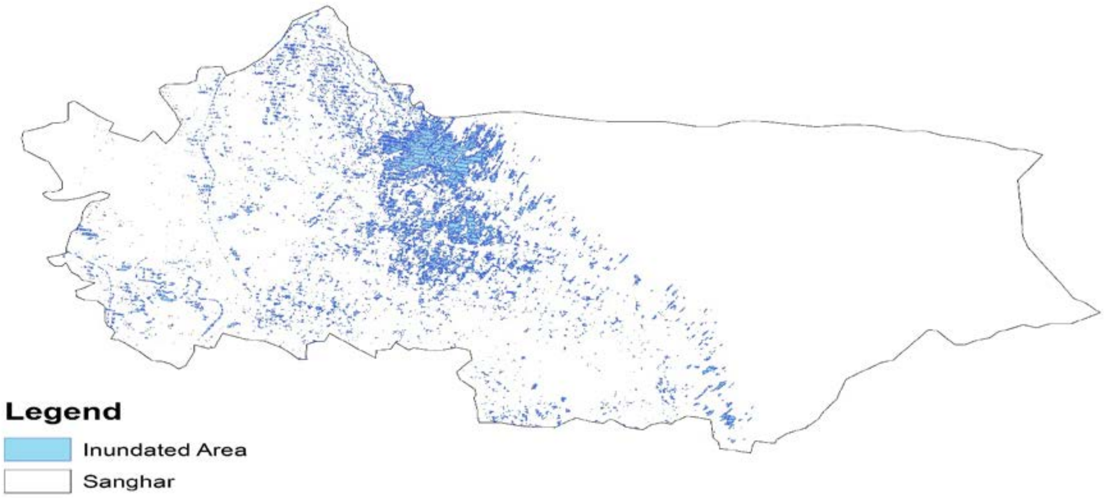

Figure 8 Inundated Area of District Sanghar at 9th June 2011 (Determined using high remote sensing techniques)

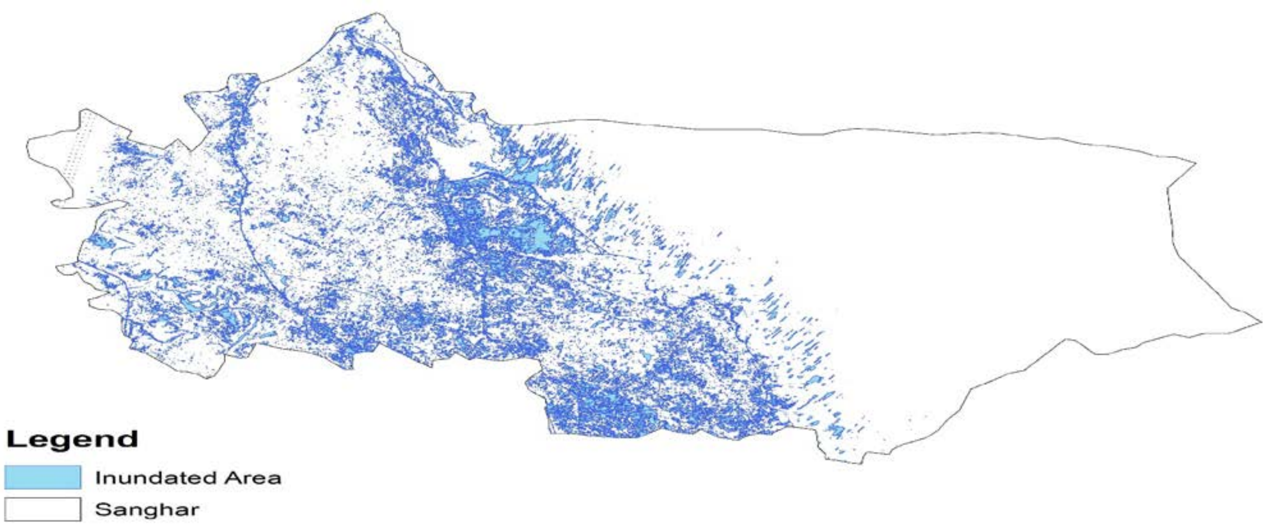

Figure 9 Inundated Area of District Sanghar at 23rd August 2011 (Determined using remote sensing techniques)

5. REFERENCES

1. Ali. (2013). Indus Basin Floods Mechanisms, Impacts, and Management environment, natural resources, and agriculture , Pakistan

2. Aziz, A. and Tanaka, S. (2011). Regional parameterization and applicability of Integrated Flood Analysis System (IFAS) for flood fore-casting of upper-middle Indus River. Pak. J. Meteorol 8 21-38.

3. Comrie, N. (2011). Review of the 2010–11 flood warnings & response. State of Victoria.

4. Gaurav, K., Sinha, R., & Panda, P. K. (2011). The Indus flood of 2010 in Pakistan: a perspective analysis using remote sensing data. Natural hazards, 59(3), 1815-1826.

5. Houze Jr, R. A., Rasmussen, K. L., Medina, S., Brodzik, S. R., & Romatschke, U. (2011). Anomalous atmospheric events leading to the summer 2010 floods in Pakistan. Bulletin of the American Meteorological Society, 92(3), 291.

6. OCHA, F. (2010). Financial Tracking Service.

7. Shaikh, I.B. (2008). Water management for mitigating floods & droughts. South-Asian Regional Workshop on Climate Change and Disaster Risk Management, Kathmando, Nepal.

8. Tariq, M.A.U.R. and van de Giesen, N. (2012). Floods and flood man-agement in Pakistan. Physics and Chemistry of the Earth, Parts A/B/C 47–48(0) 11-20.

9. Weil, B. (2006). The rivers come: Colonial flood control and knowledge systems in the Indus basin, 1840s-1930s. Environment and History 12(1) 3-29.

Comparing the effects of Day and Night shift on employees job satisfaction

A case study at Cement Industry

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Abstract

Job satisfaction is the most prevailed issue in today's competitive era especially in the manufacturing and service industries. It plays a major role in developing and growing the graph of industries annually in local and the global markets as well. A self developed survey based on Likert scale, was carried out on a sample of 40 employees from inter- cement industry to analyze their satisfaction and dissatisfaction levels working during the day and night shifts at the workplace environment of the company and suggestions were given on the outcomes of similarities and differences. The sample is divided equally in both shifts (20 during day shift and 20 during night shift). The results showed that job satisfaction level in areas i. Medical health facility ii. Pay, was same for employees working in day and night shifts. Whereas, significant difference was found by considering mean values for the employees working in day shift in the areas i. Wages ii. Job provision iii. Promotion, as compared to employees working in the night shifts. On account of findings, it is suggested that existing ways of work may be transformed in case of ergonomic factors during night shift and economic factors during day shift so as to attain increased satisfaction levels equally. This study may be useful to academia, researchers, industry (workshop managers) and other concerns who are interested to dig out the facts on the causes and likelihood of workplace injuries, monotony and other hazards that may affect job satisfaction.

Keywords: Job satisfaction, night shift and day shift.

1. INTRODUCTION

The cement industry of Pakistan holds unique importance in the growth and progress of the country since its inception [1]. Manufacturing sector plays critically a positive role in welcoming the new employees, not only for attaining performance of organizations at all levels deeply in the outbound activities, but also it helps the employees in achieving the satisfaction in their jobs professionally and personally. However, literature has also shown the mixed response for workers working in day and night shifts, especially with respect to the effects of performance on job satisfaction. This research therefore, rationally looks at comparing the satisfaction levels of employees working in both day and night shift in power cement Ltd.

The cement industry is dominated by many players (see Fig. 1.1). It also becomes mandatory to investigate the factors which are helping the companies to raise their standing in the name and share among the markets. The present study also ponders to understand that day and night shift hours among power cement Ltd [2].

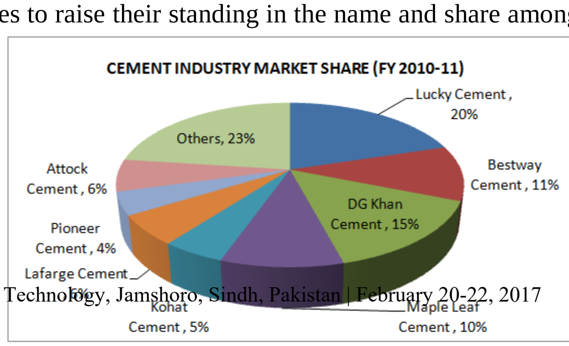

Fig.1.1 Major Players of the cement industry

Jadimurthi etal (2015) carried out inter-comparative study of day and night shift employees of tyre industry. Where, psycho-social (such as; social status, promotion, training, orientation, intelligence, capacity and social circle) and economic conditions (such as; salary, pension, gratuity, housing, medical care and job provision) were in light. Comparative analysis revealed that day shift employees are well-satisfied then night shift employees in psycho-social conditions. Whereas, in terms of economic conditions; it was observed, both day and night shift employees attain same level of satisfactions with the slight difference (i.e day mean (10.4) > night mean (9.56)) of means because both shift employees were availing the same facilities. Hence, author(s) suggested company has to focus on the workplace conditions, welfare facilities and promotion so as to attain the higher level of satisfaction at workplace.

Narayan etal (2013) conducted the survey based study to analyze the relevance of ergonomic factors (such as working environment, working time, machines, wage system and safety) and job satisfaction in the textile industry. They found that some of the employees were partially and some were highly satisfied. Author(s) recommended that company should strictly follow the ergonomic factors in order to achieve the maximum output in the shape of productivity, profit and quality so as to sustain the competition. See fig.

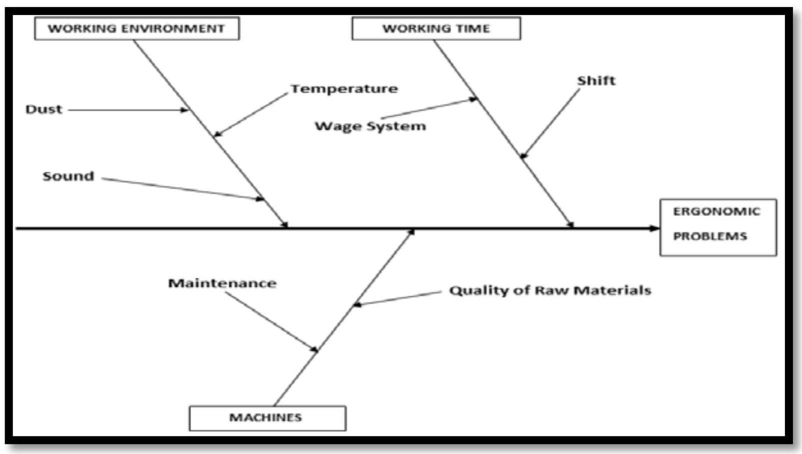

Fig1.2 Cause and effect of Ergonomic factors

Source: [4]

Suman jain etal (2012) descriptive-cum-analytically investigated the job satisfaction of public vs. private banks; there by considering working conditions, pay and promotion, work relationships, skills and abilities, benefits, work activities, empowerment, direction and feedback, and leadership. Results show that public sector banks are more satisfied than private sector employees. Low job security and challenging environment were identified as the major causes of dissatisfaction of employees in the private sector banks. Hence, in this regards author(s) advise that private banks should focus on secure job environment and welfare policies so that employees attain their perceived level of job satisfaction. Whereas, it is further suggested that public sector banks need some improvements so as to maintain and continue the satisfaction level in terms of rewards, task variety and training and development for reducing the certainty of boredom and blindness of vision.

Based on the work carried out by researchers and current issues, this study therefore, looks at evaluating the satisfaction levels of day and night shift employees. In this regards, following objectives have been set to carry out inter- comparison study:

- To study and analyze the economic factors.
- To study and analyze the ergonomic factors.

2. Research framework and Research questions:

The research model helps us to understand the effects of economic and ergonomic factors on job satisfaction in relation to the employees working in day and night shifts respectively.

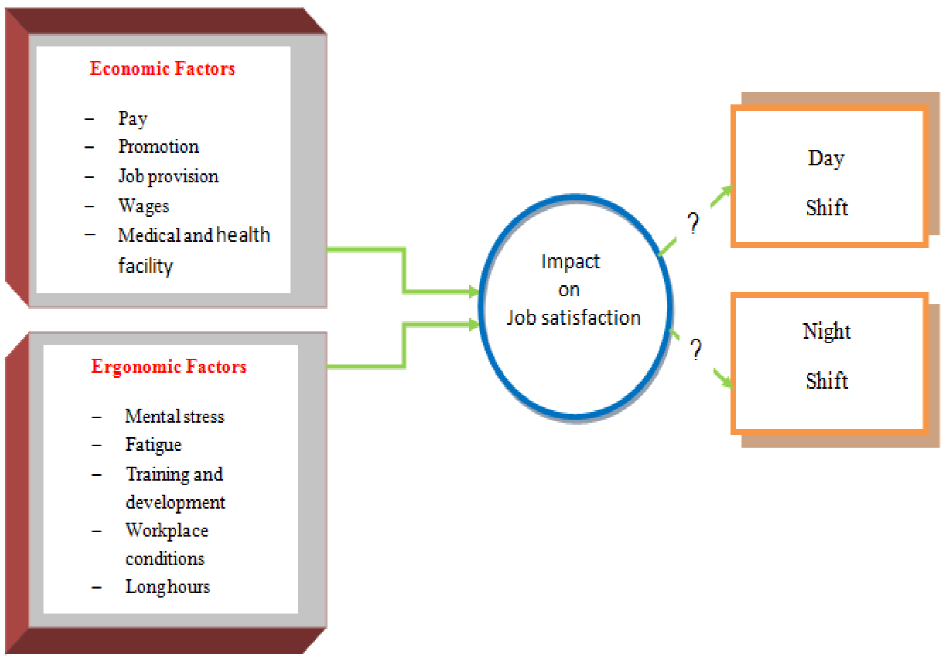

Fig.1.3: self-made conceptual model

The model aids to raise following research questions:

1. Does the economic and ergonomic condition of day shift employees have an impact on job satisfaction?
2. Does the economic and ergonomic condition of night shift employees have an impact on job satisfaction?

3. METHODOLOGY

Employee satisfaction study was performed to know the actual level of job satisfaction between day light hours and nighttime shift by availability sampling method (Convenience sampling) of 40 employees, as a result 20 employees from the day shift and 20 from the night shift equally surveyed. Furthermore, onsite data was collected via self developed job satisfaction survey with the help of Likert scale measurement. The collected data was then analyzed using statistical SPSS 20.0.

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4. LOCALE OF THE STUDY

For current inter-comparative case study, cement industry was selected from the location of Nooriabad industrial area, near Karachi M-9 road. Power cement's manufacturing plant is positioned at Dehkalokohar, Nooriabad industrial estate near the route as shown below in the Fig.1.4.

Fig.1.4 Location layout of study area
(Source: https://maps.google.com) f

5. RELIABILITY OF DAY AND NIGHT SHIFT DATA

According to Allen et al (2008), Cronbach's alpha is helpful to ascertain and measure the internal consistency of gathered data. Alpha range is given below for certainty.

Coefficient alpha range, α	Description
0.8 to 0.95	Very good reliability
0.70 to 0.80	Good reliability
0.60 to 0.70	Fair reliability
α <0.60	Poor reliability
Source: Zikmund, Babin, Carr, Griffin (2010), Business research methods (8th ed). New York: south-western/ Cengage Learning	

Table 1.1: Alpha Range

Reliability analysis	
Day shift employees	Night shift Employees
0.723	0.712

Table 1.2: Reliability of day and night shift employees

6. Demographic characteristics of respondents

Table 1.3: Socio-demographic characteristics of respondents

Demographics						
S.No.	Parameter	Variable	Day shift (N= 20)		Night Shift (N= 20)	
			Respondents/ %age		Respondents/ %age	
1.	Designation	Manager	1	2%	1	2%
		Asst.Mg	3	5%	2	3%
		Supervisor	4	6%	2	3%
		HR	1	2%	1	2%
		Workers	11	18%	14	23%
2.	Gender	Male	18	29%	20	33%
		Female	2	3%	0	17%
3.	Age	Below-30	12	20%	10	8%
		30-39	4	7%	5	7%
		40-49	2	3%	4	2%
		Above 50	3	5%	1	2%
4.	Experience	Refresher	6	10%	3	5%
		Below-10	3	5%	5	8%
		10-20	5	9%	7	11%
		Above 30	6	10%	5	8%
5.	Marital status	Single	6	10%	3	5%
		Married	14	23%	17	28%
6.	Qualification	NA (not acquired)	3	5%	4	7%
		Primary	2	3%	1	2%
		Matric	4	7%	4	2%
		Collegiate	3	5%	4	7%
		Diploma/ Graduate	8	13%	7	7%

7. Results and Discussion

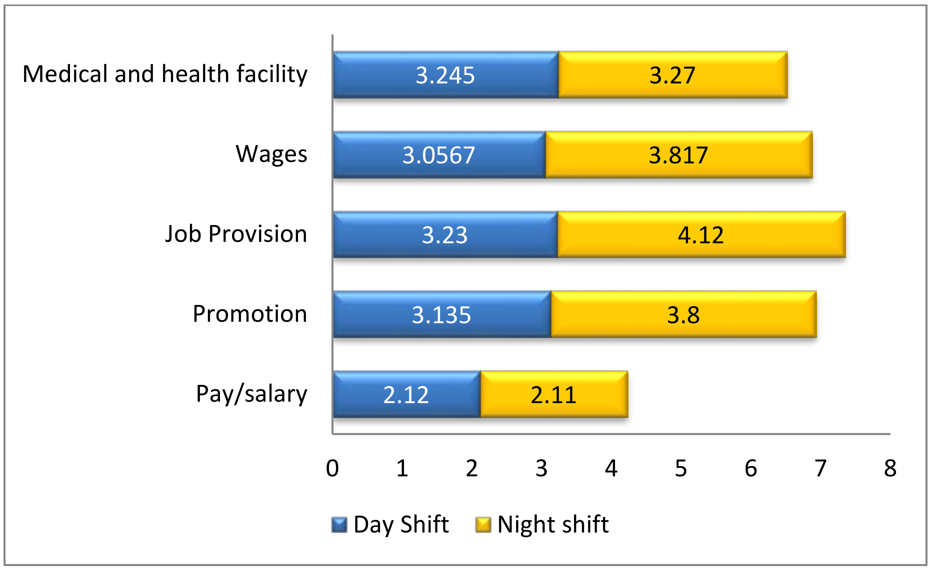
Pakistani industries have to give due importance to their employees' satisfaction for the survival, sustainability and competitiveness in the automation era as happy workers (satisfied employees) are the productive workers [2].

7.1 Economic Factors

The research study was aimed to analyze the satisfaction levels of employees by comparing mean values see table 1.4 and fig.1.5.

Table. 1.4 Economic Factors:

Economic Factors	Day Shift	Night shift
Pay/salary	2.12	2.11
Promotion	3.135	3.8
Job Provision	3.0567	4.12
Wages	3.23	3.817
Medical and health facility	3.245	3.27
Total	14.7867	17.117



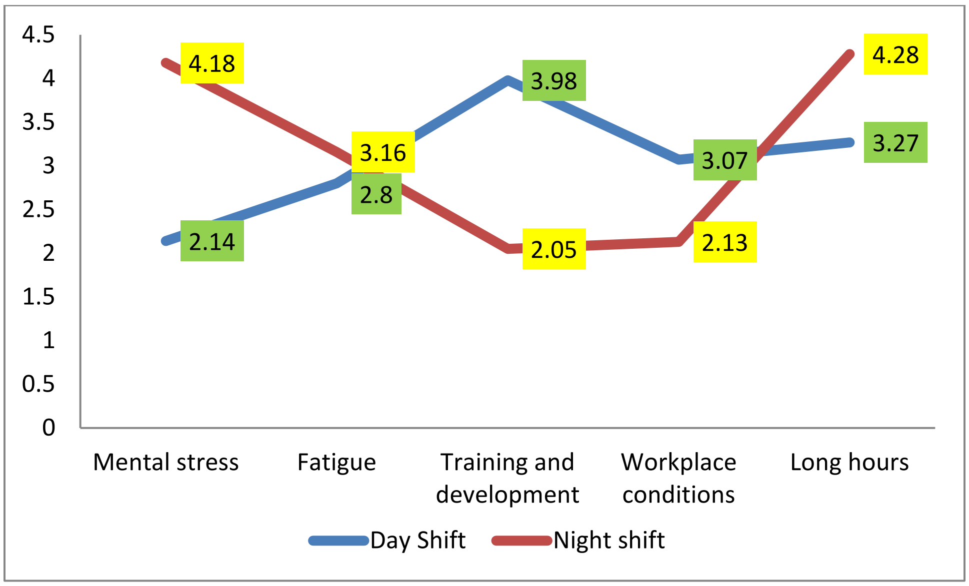
The above table 1.4 and Fig.1.5 indicates that the inter-comparison area of economic conditions is as follows: salary, promotion, job provision, wages and medical facility of the day and night shift employees. It further reveals that mean score of salary and medical health facility in night shift employees and a day shift employee are same because of same pay structure and facilities. Hence both are satisfied with the salary and medical facility. While there is a difference of mean score values in the promotion, wages (piece rate system), job provision (son quota) of night shift and a day shift employees because night shift employees have to work in excess hours to produce more quantity and also high risk is involved at work in the night hours, that’s why they are promoted earlier than the day shift employees in the next up-positions, and due to heavy risk involved, son quota is highly preferable for them. Hence in the wages, job provision and promotion factors, we can say that night shift employees are highly satisfied and the day shift employees are dissatisfied in promotion, wages and job provisions economic factors.

7.2 Ergonomic Factors

The research study was aimed to analyze the satisfaction levels of employees by comparing mean values see table

1.5 and fig .1.6.

Ergonomic Factors	Day Shift	Night shift
Mental stress	2.14	4.18
Fatigue	2.8	3.16
Training and Development	3.98	2.05
Workplace conditions	3.07	2.13
Long hours	3.27	4.28
Total	15.26	15.8



The above table 1.5 and Fig.1.6 point outs the between-plant comparison of ergonomic conditions. Hence, graph comparison results indicates the high mean scores of mental stress, fatigue and long hours in night shift than day shift employees, it implies that night shift employees are completely dissatisfied (negative statements were asked)and low score mean values indicates that day shift employees were satisfied and had less impacts of stress, fatigue and long hours respectively. In particular, in terms of training and development, workplace conditions' low score mean values of day shift employees show the satisfaction.

8. Practical Implications

In view of the significance of economic and ergonomic factors of day and night employee's satisfaction and its effect on job satisfaction of the organization, the management and business gurus should take necessary actions accordingly. The present research is also aimed towards future research provisions where in proper research programs can be devised in the field of job satisfaction.

9. Research limitations

- The size of the sample used was quiet small and population was vast.
- The lack of previous research studies on the subject in our country.
- Limited time scope.
- The study was restricted to the Site area Nooriabad in one industry and can be extended in other organizations and sectors as well.
- As respondents were from one cement industry only, so all the findings may not be generalized to overall employees of cement industries in Pakistan.

10. CONCLUSION AND RECOMMENDATIONDS

- **Achievement of Economic Factors**

Results of the analysis reveals that the majority of respondents in the night shift are highly satisfied in wages, job provision, promotion .while, they were not satisfied in terms of salary, medical and health facility because policies are same in these factors for both night and day shift employees and it makes no difference on their economic conditions.

  - Their salary should be increased than day shift employees so that they feel pride and motivation to achieve organizational goals collectively.
  - Employer should entertain their employees by introducing special health schemes to the night shift employees.
  - Sick pay leave should be given to the participants.

- **Achievement of Ergonomic Factors**

Results of the analysis reveal that the majority of respondents in night shift were not satisfied in terms of all ergonomic factors which resulted in highly fatigue situation, creates mental stress and decrease the working life professionally and personally.

  - Organization should arrange trainings and workshops for making night shift staff empowered.
  - Organization should increase the rest pauses for higher efficiency.
  - Better working environment should be provided.

Note: preference should be given to night shift employees because they work under pressure and suffers a lot for achieving maximum organizational goals.

This particular research was intended to study the effects of economic and ergonomic factors on job satisfaction of employees working in day and night shifts at cement industry. Conclusion of the study does not tend towards one direction, meaning that for some variables day shift employees are more satisfied whereas for other variables night shift employees are more satisfied, and in some variables both are satisfied.
Hence, critical findings of study may suggest increase and improve the quality of life of shift working employees in order to reduce the associated disorders and increase their job satisfaction levels personally and professionally.

ACKNOWLEDGMENT
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11. REFERENCES

[1]. Siddiqui, J., and Talal, M. (2012), "Analysis on the cement industry in Pakistan: Managerial Economics", Retrieved from: http://www.slideshare.net/aliamjad42/analysis-on-the-cement- industry-in-Pakistan.

[2]. Wright, T. A., and Cropanzano, R. (2007) "The Moderating Role of Employee Positive Well Being on the Relation between Job Satisfaction and Job Performance", *Journal of Occupational Health Psychology 2007*, Vol. 12, No. 2, 93–104.

[3]. Kumari,G. and Pandey, M. K. (2011) , "Job Satisfaction in Public Sector and Private Sector: A Comparison", *International Journal of Innovation, Management and Technology*, Vol. 2, No. 3, June.

[4]. Hudeda, J., Gandhi, S., and Jyothi, B. (2015), "Comparative Study on Job Satisfaction of Day And Night Shift Workers", A Case Study Of Falcon Tyres Ltd., Mysore., *International Journal of Social Science and Humanities Research*, ISSN 2348-3164 (online) Vol. 3, Issue 3, pp:372-379, Month: July – September.

[5]. Narayanan, A., Mathew, C. and Yeldo, V. (2013) "Improvement of Ergonomic Factors That Affects Employees in a Textile Industry", *International Journal of Engineering Science And Innovative Technology (IJESIT)*, Volume 2, Issue 1, January.

RANDOM DEMAND EFFECT ON WORK IN PROCESS BASED INVENTORY MODEL

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Abstract: Calculation of optimum lot size in imperfect manufacturing environment has been an important issue over the previous couple of decades. A substantial amount of research has been devoted to extend the basic EOQ and EPQ models in order to make them capable of handling real and practical situations in manufacturing industries. However, most of the developed models only consider the raw and finished good inventory, and ignore the work-in-process inventory. All inventory models that consider work in process inventory assume that demand of the customer is deterministic and shortages are not allowed. In this paper an inventory model is developed for imperfect manufacturing set up considering the effect of random demand, shortages, inspection, rework, reject and work-in-process inventory on optimum lot size. Numerical examples are presented for illustration of the mathematical model and sensitivity analysis of important parameters.

Keywords: EOQ, EPQ, random demand, work in process inventory, optimum lot size

1. INTRODUCTION

The first model in the field of inventory management was introduced by (Harris, 1990). Taft (1918) extended this in the direction that production is time consuming activity. One of the underlying assumptions in these basic inventory models is that process is perfect and all units produced are of good quality. This assumption is unrealistic in real world application if adopted can result in errors in the decision variables. As process may be suffered from numerous factors such as, aging, tool wear and tear, machine failures, break down etc. Therefore, an excessive amount of efforts has been devoted to extend these basic models to overcome their limiting assumptions.

Defects and rework are common occurrences in the manufacturing environment. Many researchers have investigated the effect of defective item and their rework on lot size. Gupta & Chakraborty (1984) considered recycling of defective items from final stage to initial stage and formulated an economic batch quantity model to calculate both economic production quantity and optimum rework batch size. They considered that shortages occur due to generation of defective items only but did not take into account shortages due to uncertainty in demand, also ignored inspection of defective products. Liu & Yang (1996) proposed inventory model for imperfect manufacturing system which produces two kinds of imperfect products reworkable and non-reworkable, the reworkable product are reprocessed while non-reworkable products are discarded from the system immediately. Rosenblatt & Lee (1986) developed EPQ model considering imperfection in production system. They concluded process imperfection results in reduction in lot size as well as production run length. Jamal, Sarker, & Mondal (2004) determined optimum batch size for single stage manufacturing system considering rework under two different policies; (1) reworking of defectives within same cycle, (2) reworking of defectives after fixed number of cycles. They assume that rework process is perfect and no poor quality product is generated in the rework process. Cárdenas-Barrón (2007) corrected the solutions of the numerical examples given by (Jamal et al., 2004). Cárdenas-Barrón (2008) developed simplified version of (Jamal et al., 2004) using algebraic approach. (Sarker, Jamal, & Mondal, 2008) revisited their previous study and determined optimum batch size in multi-stage production system for the same two reworking policies. They made errors in some mathematical expression which was later corrected by (Cárdenas-Barrón, 2009). Biswas & Sarker (2008) considered a lean manufacturing system and proposed an optimum lot size model under the assumption that rework and scrape are produced with in operational cycle. Cárdenas-Barrón (2007) developed EPQ inventory model for imperfect single stage manufacturing system with rework and planned back orders. He assumed that all defective items must be reworked and the of rework process is only producing good quality products. Recently,(Sarkar, Cárdenas-Barrón, Sarkar, & Singgih, 2014) further extended this model and proposed an economic production quantity model taking into consideration, rework process and backorders for a single stage production system with random production rate of defective items. All these models neither consider inspection process nor work work-in-process in the optimization of the lot size.

The detection of poor quality product needs inspection process integrated in the manufacturing set up. So inspection process and its impact on economic lot size has also been an area of study for researchers. Zhang & Gerchak (1990) investigated an EOQ model under the joint impact of inspection and lot sizing policy where the fraction of defective item is

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random. Assumption were made that inspected defective items are discard and uninspected defective items can be used or replaced with a penalty cost. Salameh (2000) proposed an economic order quantity model for the case where each incoming order comprises a random proportion of defectives. They assumed that as the order received 100% inspection is carried out and the resulted defective items are hold in stock and later sold in a single batch at discounted price. Goyal & Cárdenas-Barrón (2002) reconsidered (Salameh, 2000) and determined economic order quantity through simple approach. They showed that the obtained results are almost optimal. Eroglu & Ozdemir (2007) presented an EOQ model for an imperfect system where each lot consist a random fraction of defectives and considered complete backordering of shortages. Krishnamoorthi & Panayappan (2012) proposed an EPQ model considering both imperfections in production and inspection process. They assumed that a proportion of defective items is delivered to the customer which causes sale return. Ojaha, Sarker, & Biswas (2007) determined optimal lot size in imperfect production environment where raw materials are purchased, finished goods are produced and then delivered to the customers after inspection. They assumed that all defective items can be treated as perfect items after rework. Ben-Daya, Noman, & Hariga (2006) proposed joint inventory inspection model with and without replacement of defective items considering 0% inspection, sampling inspection, and 100% inspection. Assumption were made that demand is deterministic and shortages are permitted. Ben-Daya & Noman (2008) developed the same integrated inventory inspection models by assuming that demand of the customer is stochastic. Goyal, Huang, & Chen (2003) studied an imperfect production system and determined common economic order size for supplier and vendor considering total cost for both parties. They assumed that imperfect products are vended at lower price and shortages are not allowed. Darwish & Ben-Daya (2007) examined a two stage imperfect production system considering inspection errors and preventive maintenance with the purpose to find out the economical lot size for the system.

In the literature of inventory management, relatively less importance has been given to the work in process inventory. Boucher (1984) was the first who considered the work in process inventory and determined the optimal lot size under the assumption that process is perfect. His model GTOQ was later extended to GTOQIR by (Barzoki, Jahanbazi, & Bijari, 2011) for imperfect production system. They assumed that defective items are 100% qualified after the rework process and inspection takes no time. (Ullah & Kang, 2014) further extended it in the direction that rework process is also imperfect and inspection is a time consuming activity.

No model has considered work-in-process inventory and stochastic demand in a single treatment so far. The proposed model will bridge this gap by considering work-in-process inventory in an imperfect manufacturing system subject to stochastic demand.

2. PROBLEM STATMENT

Consider a company subject to random demand, issues a production order of size Q when its inventory level reaches to some specific level r. Due to uncertain lead time demand there are possibilities of overestimation and underestimation of demand which results in higher holding cost and stock out situations respectively. The company is interested to find the optimum values of lot size and reorder level to satisfy the random demand of the customer. The manufacturing process is carried out in two steps. In first step, products are produced, and inspection process is carried out which screens out the product into good quality items, reworkable items, and rejected items as shown in Figure 1.

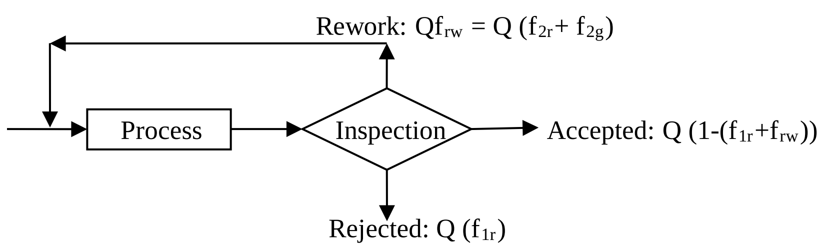
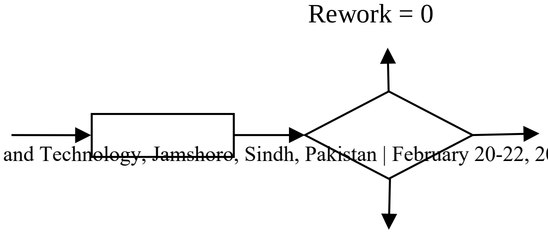


Figure 1. Processing of lot in step 1

In second step, the reworkable items are reprocessed and inspected again which results into good quality item and rejected items as shown in Figure 2.



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$Qf_{rw} = Q\,(f_{2r} + f_{2g})$ Process Inspection Accepted = $Q\,(f_{2g})$

Rejected = (P_{2r})

Figure 2. Processing of reworkable products in step 2

2.1 Notation

Q	production lot size per cycle
$E[D]$	expected annual demand
S_t	time per setup per cycle
m_{t1}	machining time for each product in step 1.
m_{tr}	machining time for each rework product
f_{1r}	fraction of rejected products in step 1
f_{1g}	fraction of good quality products in step 1
f_{2g}	fraction of good quality products in step 2
f_{2r}	fraction of rejected products in step 2
f_{rw}	fraction of reworkable products in step 1, $Qf_{rw} = Q\,(f_{2r} + f_{2g})$
f_r	fraction of rejected products at the end of cycle
T_c	cycle time
T_p	total processing time
$\overline{T}$	average processing time for each product item
m_c	material cost per unit product
$E[P_C]$	purchase cost per unit of time
$E[S_C]$	setup cost per unit time
$E[I_C]$	inspection cost per unit time
$E[WIP_C]$	work in process holding cost per unit time
$E[H_C]$	inventory holding cost per unit of time
$E[C_T]$	total cost per unit of time
$\overline{I}$	average on hand inventory
$\overline{W}$	average monetary value of the WIP inventory
C	average unit value of each product cost
R	rate charged per unit of cell production time including all overheads, moving cost, loading/unloading cost, etc.
y	lead time demand
$f(y)$	probability density function of lead time demand
r	re-order level
π	shortage cost per unit short

2.2 Assumptions

- Demand rate is stochastic and continuous.
- Shortages are allowed and back ordered.
- Reworked parts are re-inspected at inspection station.
- Demand for imperfect products with reduced price always exists.
- 100% inspection takes place at inspection station and inspection consumes time.
- Poor quality products are produced during the rework operation.
- Rework operation is performed only once.
- No stoppage is allowed during the manufacturing of one lot.

3. MODLING

The total cost is the sum of setup cost, material purchase cost, inspection cost, inventory holding cost, shortage cost and work in process inventory carrying cost. Prior to calculate these component we need to find relations for certain parameter such as total processing time, average processing time, cycle time and average value added to each product.

The total processing time in a cycle is given by

$$T_P = S_t + Qm_{t1} + IQ + Qm_{tr}f_{rw} + IQf_{rw} \tag{1}$$

Where S_t is the set up time, Qm_{t1} is the machining time of the lot of size Q, $Qm_{tr}f_{rw}$ is the machining time taken by reworkable item, IQ is the inspection time of the lot, and IQf_{rw} is the inspection time of reworkable items.
If the total processing time is divided by total items, average processing time per unit product will be obtained as

$$\overline{T} = \frac{T_P}{Q}$$

The average value of manufacturing cost per unit product is the production cost per unit time (R) multiplied by average processing time per unit product ($\overline{T}$)

$$V = R\overline{T} = R\left(\frac{S_t + Qm_{t1} + IQ + Qm_{tr}f_{rw} + IQf_{rw}}{Q}\right)$$

The production cost per unit product is the sum of material cost per unit (C_M) and the value added to each unit as

$$c = C_m + R\left(\frac{S_t + Qm_{t1} + IQ + Qm_{tr}f_{rw} + IQf_{rw}}{Q}\right) \tag{2}$$

The number of good quality product can be determined as

$$\text{No. of good quality product} = Q - Q(f_{1\mathrm{r}} + f_{2\mathrm{r}})$$

$$= Q(1 - (f_{1\mathrm{r}} + f_{2\mathrm{r}}))$$

In order to satisfy demand of the customer during the cycle we need to produce $E[D]T_C$ units of demand which must be equal to the number of good quality product

no of good quality product = customer demand

$$Q - Q(f_{1r} + f_{2r}) = E[D]T_C$$

$$T_C = \frac{Q(1 - (f_{1\mathrm{r}} + f_{2\mathrm{r}}))}{E[D]} \tag{3}$$

3.1 Components of Total Cost

3.1.1 Purchase Cost

Purchasing cost is procurement cost of the raw material. If C_m is the cost of raw material per unit product and Q is the number of units per lot, then the purchase cost per unit time is equal to

$$P_c = C_M Q / T_C$$

Using Equation (3), expected purchase cost can be written as

$$\mathrm{E}[\mathrm{P_c}] = \frac{C_M E[D]}{(1-(f_{1\mathrm{r}}+f_{2\mathrm{r}}))} \tag{4}$$

3.1.2 Set Up Cost

Set up cost occurs when set up takes place. Since one set up is required in cycle to produce a lot of size Q. therefore if A represents the set up cost for each order then the set up cost per unit time will be

$$S_C = \frac{A}{T_C}$$

From Equation (3) this becomes

$$\mathrm{E}[S_C] = \frac{AE[D]}{Q(1-(f_{1\mathrm{r}}+f_{2\mathrm{r}}))} \tag{5}$$

3.1.3 Inspection Cost

Inspection cost is incurred due to initial inspection of the lot and of re-inspection of reworkable items. If I is the inspection cost per product, then the total cost of inspection per unit time can be calculated is

$$I_C = \frac{IQ}{T_C} + \frac{(f_{1r}+f_{2r})IQ}{T_C}$$

$$\mathrm{E}[I_C] = \frac{IE[D]}{(1-(f_{1\mathrm{r}}+f_{2\mathrm{r}}))} + \frac{IE[D](f_{1\mathrm{r}}+f_{2\mathrm{r}})}{(1-(f_{1\mathrm{r}}+f_{2\mathrm{r}}))} \tag{6}$$

3.1.4 Inventory Holding Cost

From figure 3 the average on hand inventory per unit time is equal to

$$\bar{I} = \frac{1}{2}Q(1-(f_{1\mathrm{r}}+f_{2\mathrm{r}})) + r - E[y] \tag{8}$$

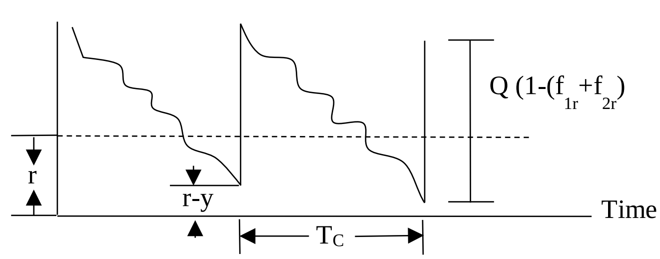

Figure 3 Average inventory over the cycle

According to (Ullah & Kang, 2014), the inventory holding cost per unit time is

$$H_C = ic\bar{I}$$

From Eq (2) & (8), H_C can be written as

$$\mathrm{E}[H_C] = \frac{1}{2} i \left(m_c + R\left(\frac{S_t + Qm_{t1} + IQ + Qm_{tr}f_{rw} + IQf_{rw}}{Q}\right)\right)\left(\frac{Q\left(1-(f_{1\mathrm{r}}+f_{2\mathrm{r}})\right)}{2} + r - E[y]\right) \quad (9)$$

3.1.5 <u>Back Order Cost</u>

Shortages occur whenever lead time demand exceeds the re-order point and can be defined as

$$S(y) = \begin{cases} y - r, & r < y \\ 0, & r \geq y \end{cases}$$

The expected shortages per cycle is

$$\bar{S}(y) = \int_{-\infty}^{+\infty} S(y) f(y) dy$$

$$= \int_{r}^{\infty} (y - r) f(y) dy$$

The expected shortages cost per unit will be

$$= \frac{\pi E[D]\bar{S}(y)}{Q\left(1-(f_{1\mathrm{r}}+f_{2\mathrm{r}})\right)} \quad (10)$$

3.1.6 <u>Work in Process Holding Cost</u>

(Ullah & Kang, 2014) used the following equation for the calculation of work in process holding cost.

$$WIP_C = i\overline{W} \quad (11)$$

Where i is the carrying charge and $\overline{W}$ is the average monetary value of work in process inventory. $\overline{W}$ can be calculated as

$$\overline{W} = \left(\frac{\frac{1}{2}QT_P}{T_C}\right) m_c + \left(\frac{\frac{1}{2}Q\left(1-(f_{1\mathrm{r}}+f_{2\mathrm{r}})\right)T_P}{T_C}\right) C + \left(\frac{\frac{1}{2}Q(f_{1r}+f_{2r})T_P}{T_C}\right) C$$

By simplifying and putting the vales of T_P, T_C and C, we get

$$\overline{W} = \frac{1}{2}\left(\frac{D}{1-(f_{1\mathrm{r}}+f_{2\mathrm{r}})}\right)\left(2m_c + \frac{RS_t}{Q} + Rm_{t1} + Rm_{tr}f_{rw} + IR + IRf_{rw}\right)(S_t + Qm_{t1} + IQ + Qm_{tr}f_{rw} + IQf_{rw}) \quad (12)$$

From Equation (11) and (12) the expected work in process holding cost is given by

$$E[WIP_C] = \frac{1}{2}\left(\frac{iE[D]}{1-(f_{1\mathrm{r}}+f_{2\mathrm{r}})}\right)\left(2m_c + \frac{RS_t}{Q} + Rm_{t1} + Rm_{tr}f_{rw} + IR + IRf_{rw}\right)(S_t + Qm_{t1} + IQ + Qm_{tr}f_{rw} + IQf_{rw})$$

3.2 Total Cost Calculation

The expected total cost over unit time is the sum of purchasing cost, setup cost, inspection cost, inventory holding cost, shortage cost and work in process inventory cost.

$$E[C_T] = E[P_C] + E[S_C] + E[I_C] + E[H_C] + E[B_C] + E[WIP_C]$$

$$E[C_T] = \frac{C_M E[D]}{1-(f_{1r}+f_{2r})} + \frac{AE[D]}{Q\left(1-(f_{1r}+f_{2r})\right)} + \frac{IQ}{T_C} + \frac{(f_{1r}+f_{2r})IQ}{T_C} + \frac{\pi E[D]\overline{S}(y)}{Q}$$

$$+\frac{1}{2}i\left(C_M + R\left(\frac{S_t + Qt_{m1} + IQ + Qt_{mr}f_{rw} + IQf_{rw}}{Q}\right)\right)\left(\frac{Q\left(1-(f_{1r}+f_{2r})\right)}{2} + r - E[y]\right)$$

$$+\frac{1}{2}\left(\frac{iE[D]}{1-(f_{1r}+f_{2r})}\right)\left(2m_c + \frac{RS_t}{Q} + Rt_{m1} + Rt_{mr}f_{rw} + IR + IRf_{rw}\right)\left(S_t + Qt_{m1} + IQ + Qt_{mr}f_{rw} + IQf_{rw}\right)$$

3.3 Optimum Lot Size

Value of optimum lot size is obtained by solving the following equation for Q

$$\frac{\partial E[C_T]}{\partial Q} = 0$$

This implies that

$$Q = \sqrt{\frac{2AE[D] + 2\pi E[D]\overline{S}(y) - 2iRS_t(E[y]-r)\left(1-(f_{1r}+f_{2r})\right) + iE[D]R{S_t}^2}{(1-f_r)^2(m_c + Rt_{m1} + IR + (Rt_{mr}+IR)f_{rw}) + E[D]i\left((t_{m1}+t_{mr}f_{rw})(2m_c + Rt_{m1} + Rt_{mr}f_{rw}) + I(1+f_{rw})(2m_c + IR + 2Rt_{m1} + 2Rt_{mr}f_{rw} + IRf_{rw})\right)}}$$

OR

$$\sqrt{\frac{2E[D](A+\pi\overline{S}(y)) - 2iRS_t\overline{S}(y)\left(1-(f_{1r}+f_{2r})\right) + iE[D]R{S_t}^2}{(1-f_r)^2(m_c + Rt_{m1} + IR + (Rt_{mr}+IR)f_{rw}) + E[D]i\left((t_{m1}+t_{mr}f_{rw})(2m_c + Rt_{m1} + Rt_{mr}f_{rw}) + I(1+f_{rw})(2m_c + IR + 2Rt_{m1} + 2Rt_{mr}f_{rw} + IRf_{rw})\right)}}$$

3.4 Optimum re-order Level

Optimum value of re-order level is obtained by solving the following equation

$$\frac{\partial E[C_T]}{\partial r} = 0$$

This gives

$$\int_r^\infty f(y)dy = \frac{iQ^*\left(1-(f_{1r}+f_{2r})\right)}{\pi E[D]}\left(m_c + \frac{Rs_t}{Q^*} + Rm_{t1} + RI + Rm_{tr}f_{rw} + IRf_{rw}\right)$$

The above equation represents the relationship between reorder level r and the cost parameter of the model. When shortage cost is greater as compare to holding cost then this equation adjusts r such that there is a little chance of stock out. This means that the system will carry large inventory than to risk a shortage and vice versa.

4. NUMERICAL ANALYSIS

The examples used for numerical analysis are based on the data of US tool manufacturing company introduced by (Boucher, 1984). (Barzoki et al., 2011)and (Ullah & Kang, 2014) also used the same data for analysis of their proposed models. The right side of Table1 shows the optimum values for decision variables, and the left side shows numerical values for input parameters. f_r = 20% is the percentage of rejected products, f_{rw} = 5% is the percentage of reworkable products, m_{tr} is 5% of m_1 and R is 3000 ($/year) in all five cases.
Assume that demand of lead time is uniformly distributed over the range 0 to 200 with expected value 100, as given by

$$f(y) = \begin{cases} \frac{1}{200}, & 0 \le y \le 200 \\ 0, & elsewhere \end{cases}$$

$$E[y] = 100$$

Table 1 Calculation of optimum lots

case no	I* (mints/unit)	A ($/unit)	E[D] (units/year)	mc ($/unit)	St (mints/setup)	Mt1 (mints/unit)	π ($/unit)	EOQ	GTOQ	GTOQR	GTOQIR	NEW	r*
1	20	14.349	77	5.63	574	100	8	27.87	26.48	31.88	30.81	79.14	136.38
2	20	12.75	233	1.57	510	32	8	84.63	80.60	97.09	85.67	90.09	191.78
3	20	12.951	580	1.42	518	87	8	109.26	86.78	96.29	88.05	89.48	195.39
4	20	14.349	1877	1.64	574	67	8	215.48	134.55	141.25	123.96	124.25	198.17
5	20	17.274	5361	1.12	691	41	8	496.71	255.33	260.87	208.09	208.16	199.25

Table 1 shows optimum values of lot size calculated by five models are different from each other. The difference depends on $\frac{m_c}{\pi E[D]}$ ratio, for higher ratio (case 1,2) the difference is significant while for smaller values of $\frac{m_c}{\pi E[D]}$ the difference becomes less significant. This behavior can be clearly seen in table 2 where different values of shortage cost have been used against the five different cases of table1.

Table 2 Increase in difference

case no	I* (mints/unit)	A ($/unit)	E[D] (units/year)	CM ($/unit)	St (mints/setup)	M1* (mints/unit)	π ($/unit)	EOQ	GTOQ	GTOQR	GTOQIR	NEW	r*
1	20	14.349	77	5.63	574	100	8	27.87	26.48	31.88	30.81	79.14	136.38
2	20	12.75	233	1.57	510	32	4	84.63	80.60	97.09	85.67	95.20	182.66
3	20	12.951	580	1.42	518	87	1	109.26	86.78	96.29	88.05	101.71	158.24
4	20	14.349	1877	1.64	574	67	0.25	215.48	134.55	141.25	123.96	134.25	136.70
5	20	17.274	5361	1.12	691	41	0.0625	496.71	255.33	260.87	208.09	217.14	100.12

Table 3 shows the total cost for each case considered in Table1.The total cost for each model is calculated by using the proposed model total cost equation for the economic order quantities of each inventory model. It is the sum of setup cost, purchase cost, cost of inspection, work in process inventory cost, inventory holding cost and back order cost. Table 4 shows the detail of total cost related to each model of Table 3.

Table 3 Total cost

case no	π ($/unit)	E[D] (units/year)	EOQ	GTOQ	GTOQR	GTOQIR	NEW	EOQ($)	GTOQ($)	GTOQR($)	GTOQIR($)	NEW($)
1	8	77	27.87	26.48	31.88	30.81	79.14	975.8630	988.5231	946.5274	953.4144	869.2979
2	8	233	84.63	80.60	97.09	85.67	90.09	648.7386	649.3216	648.3131	648.6280	648.3228
3	8	580	109.26	86.78	96.29	88.05	89.48	1398.3563	1394.9957	1395.0559	1394.8607	1394.7650
4	8	1877	215.48	134.55	141.25	123.96	124.25	4629.2112	4547.5531	4550.1478	4546.1189	4546.1088
5	8	5361	496.71	255.33	260.87	208.09	208.16	9201.8370	8777.7314	8782.8688	8754.9374	8754.9364

Table 4 Details of total cost

Case no	EOQ($)							GTOQ($)						
	C_p	C_S	C_i	C_{wip}	C_H	C_B	C_{total}	C_p	C_S	C_i	C_{wip}	C_H	C_B	C_{total}
1.00	541.8875	49.5582	0.0193	8.2154	152.6386	223.5441	975.8630	541.8875	52.1599	0.0193	7.8795	151.2972	235.2797	988.5231
2.00	457.2625	43.8769	0.0583	9.8110	134.0056	3.7242	648.7386	457.2625	46.0702	0.0583	9.4069	132.6134	3.9104	649.3216
3.00	1029.5000	85.9332	0.1450	73.9117	206.6087	2.2577	1398.3563	1029.5000	108.1965	0.1450	59.6631	194.6485	2.8426	1394.996
4.00	3847.8500	156.2423	0.4693	371.7223	252.3407	0.5866	4629.2112	3847.8500	250.2067	0.4693	237.9217	210.1662	0.9393	4547.553
5.00	7505.4000	233.0502	1.3403	1179.6129	282.3126	0.1211	9201.8370	7505.4000	453.3698	1.3403	624.2452	193.1406	0.2356	8754.937

Case no	GTOQR($)							GTOQIR($)						
	C_p	C_S	C_i	C_{wip}	C_H	C_B	C_{total}	C_p	C_S	C_i	C_{wip}	C_H	C_B	C_{total}
1.00	541.8875	43.3265	0.0193	9.1851	156.6745	195.4345	946.5274	541.8875	44.8209	0.0193	8.9278	155.5835	202.1754	953.41
2.00	457.2625	38.2459	0.0583	11.0618	138.4384	3.2463	648.3131	457.2625	43.3437	0.0583	9.9155	134.3691	3.6790	648.628
3.00	1029.5000	97.5093	0.1450	65.6900	199.6498	2.5618	1395.0559	1029.5000	106.6395	0.1450	60.4659	195.3086	2.8017	1394.861
4.00	3847.8500	238.3380	0.4693	248.9973	213.5985	0.8948	4550.1478	3847.8500	271.5807	0.4693	220.4195	204.7800	1.0196	4546.119
5.00	7505.4000	443.7314	1.3403	637.0009	195.1658	0.2306	8782.8688	7505.4000	556.2752	1.3403	515.6314	176.0015	0.2890	8755.024

Case no	NEW($)						
	C_p	C_S	C_i	C_{wip}	C_H	C_B	C_{total}
1.00	541.8875	17.4505	0.0193	20.6599	210.5658	78.7148	869.2979
2.00	457.2625	41.2178	0.0583	10.3590	135.9269	3.4985	648.3228
3.00	1029.5000	104.9330	0.1450	61.3731	196.0571	2.7569	1394.7650
4.00	3847.8500	270.9464	0.4693	220.8991	204.9269	1.0172	4546.1088
5.00	7505.4000	556.0949	1.3403	515.7866	176.0258	0.2889	8754.9364

To conduct sensitivity analysis for important model parameter the first case of Table 1 is considered. The value of shortage cost is taken as 15 (π =15). Result of such analysis are shown in Table 5.

Table 5 Sensitivity Analysis

		Q^*	R^*	C_{total}
I	10	42.9563	181.8119	909.6080
	20	42.3443	181.5222	919.6806
	30	41.7685	181.2324	929.7121
A	7.1745	30.3610	186.5545	906.1898
	14.349	42.3443	181.5222	919.6806
	21.5235	51.5477	177.6573	931.5085
C_M	2.815	46.27763	186.186637	546.0948
	5.63	42.3443	181.5222	919.6806
	8.445	42.4903	175.6616	1285.0210
S	287	41.6871	182.1460	913.4827
	574	42.3443	181.5222	919.6806
	861	43.0284	180.8870	925.6930
M_1	50	45.6579	182.9048	871.2413
	100	42.3443	181.5222	919.6806
	150	39.8738	180.1370	967.1767
π	7.5	95.6878	118.2423	855.9026
	15	42.3443	181.5222	919.6806
	30	35.3266	192.2346	938.4421
E[D]	38.5	112.4803	104.1387	558.5524
	77	42.3443	181.5222	919.6806
	115.5	43.0102	187.4950	1224.2142

It is observed from the table that the proposed model is more sensitive to demand and material cost of the product as compared to other parameters.

5. CONCLUSION

In this paper work-in-process based inventory model has been developed for imperfect manufacturing system subject to stochastic demand. Previously, it was assumed that demand of the customer for non-defective products is constant and known. In our paper we relaxed this unrealistic and impractical assumption by assuming that customer demand is a random parameter. The purpose is to determine optimal order size and re-order level for the inventory system such that the total inventory cost is minimized. The solution to find out optimal order size and re-order point is proposed. The mathematical model is illustrated through numerical example and sensitivity analysis is conducted for important model parameters. For future research work, the possible extensions of this proposed model could be multi stage production system, partial back ordering, machine failure, inspection errors, and sampling inspection policy.

6. REFERENCES

1. Barzoki, M. R., Jahanbazi, M., & Bijari, M. (2011). Effects of imperfect products on lot sizing with work in process inventory. *Applied Mathematics and Computation, 217*(21), 8328–8336.

2. Ben-Daya, M., & Noman, S. M. (2008). Integrated inventory and inspection policies for stochastic demand. *European Journal of Operational Research*, *185*(1), 159–169.
3. Ben-Daya, M., Noman, S. M., & Hariga, M. (2006). Integrated inventory control and inspection policies with deterministic demand. *Computers and Operations Research*, *33*(6), 1625–1638.
4. Biswas, P., & Sarker, B. R. (2008). Optimal batch quantity models for a lean production system with in-cycle rework and scrap. *International Journal of Production Research*, *46*(23), 6585–6610.
5. Boucher, T. O. (1984). Lot sizing in group technology production systems. *International Journal of Production Research*, *22*(1), 85–93.
6. Cárdenas-Barrón, L. E. (2007). On optimal manufacturing batch size with rework process at single-stage production system. *Computers and Industrial Engineering*, *53*, 196–198.
7. Cárdenas-Barrón, L. E. (2008). Optimal manufacturing batch size with rework in a single-stage production system - A simple derivation. *Computers and Industrial Engineering*, *55*(4), 758–765.
8. Cárdenas-Barrón, L. E. (2009). On optimal batch sizing in a multi-stage production system with rework consideration. *European Journal of Operational Research*, *196*(3), 1238–1244.
9. Darwish, M. A., & Ben-Daya, M. (2007). Effect of inspection errors and preventive maintenance on a two-stage production inventory system. *International Journal of Production Economics*, *107*(1), 301–313.
10. Eroglu, A., & Ozdemir, G. (2007). An economic order quantity model with defective items and shortages. *International Journal of Production Economics*, *106*(2), 544–549.
11. Goyal, S. K., & Cárdenas-Barrón, L. E. (2002). Note on: Economic production quantity model for items with imperfect quality - A practical approach. *International Journal of Production Economics*, *77*(1), 85–87.
12. Goyal, S. K., Huang, C.-K., & Chen, K.-C. (2003). Production Planning & Control : The Management of item for vendor and buyer A simple integrated production policy of an imperfect item for vendor and buyer, *14*(April 2013), 37–41.
13. Gupta, T., & Chakraborty, S. (1984). Looping in a multistage production system. *International Journal of Production Research*, *22*(2), 299–311.
14. Harris, F. W. (1990). How Many Parts to Make at Once (Reprinted from Factory the Magazine of Management, Vol 10, Page 135-136, 1913) 77. *Operations Research*, *38*(6), 947–950.
15. Jamal, A. M. ., Sarker, B. R., & Mondal, S. (2004). Optimal manufacturing batch size with rework process at a single-stage production system. *Computers & Industrial Engineering*, *47*(1), 77–89.
16. Krishnamoorthi, C., & Panayappan, S. (2012). An EPQ Model with Imperfect Production Systems with Rework of Regular Production and Sales Return. *American Journal of Operations Research*, *2*(June), 225–234.
17. Liu, J. J., & Yang, P. (1996). Optimal lot-sizing in an imperfect production system with homogeneous reworkable jobs. *European Journal of Operational Research*, *91*(3), 517–527.
18. Ojaha, D., Sarker, B. ., & Biswas, B. (2007). A note on: an optimal batch size for an imperfect production system with quality assurance and rework. *International Journal of Production Research*, *45*(14), 3191–3214.
19. Rosenblatt, M. J., & Lee, H. L. (1986). Economic Production Cycles with Imperfect Production Processes. *IIE Transactions*, (May 2013), 37–41.
20. Salameh, M. K. and M. Y. J. (2000). Economic production quantity model for items with imperfect quality, Int. J. of Production Economics, vol.64, pp.59-64, 2000. *Int. J. Production Economics*, *64*, 2000.
21. Sarkar, B., Cárdenas-Barrón, L. E., Sarkar, M., & Singgih, M. L. (2014). An economic production quantity model with random defective rate, rework process and backorders for a single stage production system. *Journal of Manufacturing Systems*, *33*(3), 423–435.
22. Sarker, B. R., Jamal, A. M. ., & Mondal, S. (2008). Optimal batch sizing in a multi-stage production system with rework consideration. *European Journal of Operational Research*, *184*, 915–929.
23. Taft, E. W. (1918). The most economical production lot. *The Iron Age*, *101*(18), 1410–1412.
24. Ullah, M., & Kang, C. W. (2014). Effect of rework, rejects and inspection on lot size with work-in-process inventory. *International Journal of Production Research*, *52*(8), 2448–2460.
25. Zhang, X., & Gerchak, Y. (1990). Joint Lot Sizing and Inspection Policy in an EOQ Model with Random Yield. *IIE Transactions*, *22*(October 2014), 41–47.

TOWARDS IMPLEMENTATION OF SLAUGHTER HOUSE AS INDUSTRIAL SECTOR IN PAKISTAN

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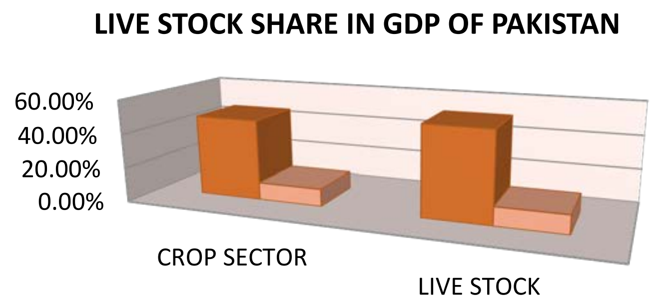
ABSTRACT

As a global economic driver, entrepreneurship adds real value to economy through the creation of new business opportunities. According to the Economic Survey of Pakistan; the livestock sector contributes about inestimable value added in the agriculture sector, amounting to nearly 11% of Pakistan's GDP, which is more than the crop sector. These animals produce million tons of milk, meat, wool, hair, skins and hides. Now time is to set the trend of utilizing these sources of slaughtered livestock for making valuable by products as a source of business that can contribute in hefty amount in the GDP of country. This research includes a case study of Hyderabad, Pakistan. The study focuses on animals products as industry. The study investigates the innovations introduced the management of these material so as to make it efficient and competitive within the industry. It will also looks at the innovations implementation of selling them to the companies & exporting in future, by the management so as to create a competitive advantage for the economy of Hyderabad. The case study explains the role of entrepreneurship regarding these exporting materials in the development of country’s economy.

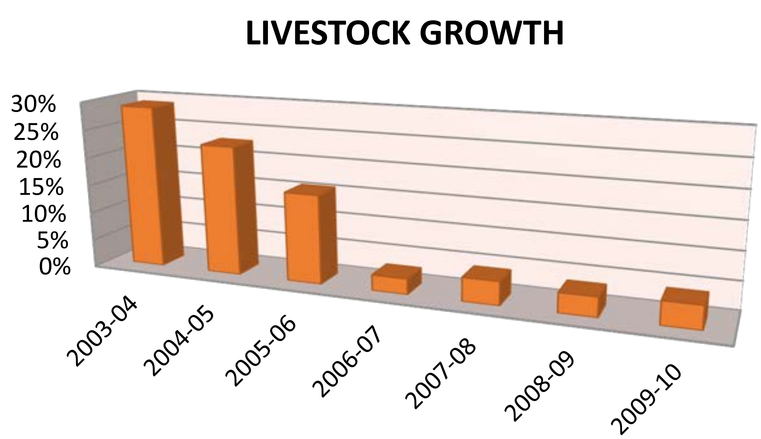
1. INTRODUCTION

Being rich in livestock growth, Pakistan has a sound name not only in delivering the meat but in usage of wastage as the by-products. These include bones, hides, hooves and viscera from the cattle, goat & sheep. Livestock provides many different products and services to people, such as food, income, manure, draft power, a store of wealth, and socio-cultural values (Muzari 2016). The slaughterhouses in Pakistan according to a report of SBI slaughter more than 1 million goats & sheep and 0.5 million cows per day. This means we get a budget of skin and hide / day which can be utilize for the leather industry promotion in Pakistan and can be utilize for the interested countries to make the export of Pakistan strong which will help in making the GDP healthy. Pakistan welcomes several new business and slaughterhouse can also coordinate with the entrepreneurship on national and international level through export of byproducts. The appalling issue of waste management need not be explained by any data or spreadsheet for our eyes seems to be the best judge in this case. The newspaper Jang (2014) says that on national level herds consists of, 26.3 million buffaloes, 24.2 million cattle, 24.9 million sheep, 56.7 million goats and 0.8 million camels. In addition to these there is a vibrant poultry sector in the country with more than 530 million birds produced/yr. which produce 29.472 million tons of milk (Pakistan is the 4th largest producer of milk in the world) 0.740 million tons of mutton, 0.416 million tons of poultry meat, 8.528 billion eggs, 40.2 thousand tons of wool, 21.5 thousand tons of hair and 51.2 million skins and hide & 1.115 million tons of beef. Being rich in livestock is a blessing which tends to increase if managed properly, so the time is to set the trend of utilizing the hides, blood and bones of livestock for economy of Pakistan's entrepreneurship. Fig. 1 highlights the livestock share in the GDP of country. This study has focused on slaughterhouses of Pakistan. The economic analysis is done for two major slaughterhouses of Hyderabad, Sindh. The proposed research offers a business overview of the organizations, their formation and their management structure. The analysis examines the philosophical management of innovative idea for the usage of hides, bones & blood, it also investigates the management of these material so as to prove it competitive & efficient within the industry. It also looks at the innovations implementation by the management so as to create a competitive advantage for the economy.



	CROP SECTOR	LIVE STOCK
SHARE IN AGRICULTURE SECTOR	47.40%	52.60%
PAKISTANS GDP	10.30%	11%

Fig.1: Live Stock Share in GDP of Pakistan.



	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
LIVESTOCK GROWTH	29%	23%	15.80%	2.80%	4.20%	3.50%	4.10%

Fig. 2: Livestock Growth Rate from 2007-2012.

Fig. 2 shows the growth ratio of livestock through past years which is increasing quite significantly which means the byproducts which we will get from cattle will also increase and the industrial sector of slaughterhouse will also increase.

2. LITERATURE REVIEW

Entrepreneurship plays a vital role in the perspective of national advantage since it can be considered as one of the major factors in boosting up national economic growth. It is primarily imperative for bringing innovations and for increasing competition (M.A. Carreea and A.R. Thurika 2002). The relationship between unemployment and entrepreneurship is full of complexity and apparently can be seen as enigmatic. The stimulation of entrepreneurial activity due to unemployment, which has been termed as “refugee effect”, is suggested by a part of literature on the one hand. On the other hand, a very different concept of the reduction of unemployment, resulting from higher levels of entrepreneurship, exists which has been termed as “Schumpeter effect”.
Recently, the significance of waste recycling for entrepreneurship and job creation has grabbed heaps of attention in the developing countries (Christian M. Rogerson) The potential opportunities offered by the informal economy of waste are particularly as focus of growing attention. The experiences of cities across the developing countries indicate the importance of waste economy for the purpose of informal entrepreneurship. One example of utilizing waste products to realize small businesses, in order to produce recycling goods for poor communities, comes from India. There was a program catalyzed by ILO in Delhi whereby, instead of being thrown to a garbage dump, more than 10,000 old shoes are put back into use every month (Prasad and Furedy, 1992).

Waste materials are collected and processed for producing economic goods for low income communities. Such stuff can also serve as raw material input for formal industry. The wrongful release of blood and creature dung into stream may bring about oxygen-consumption and in addition supplement over advancement of getting framework which can bring about increment in rate of poison aggregation which can hurt sea-going life, human life and cause serious infections (J. Fearon at el, 2014). Jan Willem Swanepoel found that abattoirs can spare cash by producing their own particular power, have a method for disposing of waste, working up carbon focuses and also doing their part in backing off, halting or notwithstanding turning around an Earth-wide temperature boost (Jan Willem, 2014).

The physico-concoction parameters comes about clarify that the negative effect of profluent from slaughterhouse on the stream, in this way water rendering is of useless incentive to people. More over slaughterhouses critically needs treatment office for emanating to decrease the health hazard. Quick mediation by the administration and different partners by setting up emanating treatment offices to treat squanders from abattoirs in Minna and additionally appropriation of cleaner advances will go far to control the ecological wellbeing dangers postured by these risky effluents from abattoirs (O Chukwu, at el, 2011)

Table 1: Study of Slaughterhouse Wastage in Different Countries

SERIAL #	AUTHOR & COUNTRY	FINDINGS
1	Jan willem swanepoel (South Africa)	Findings include that the Cattle manure and urine are good sources of phosphorous, nitrogen and potassium. The processing of blood into meal creates another avenue of income by means of waste processing into a product. The installation of traps to collect residual solids like fat and coagulated blood is one method of preventing contamination when conventional sewage backs up. Horns and hooves can be sold or processed to have financial benefits. Abattoir waste showed to have different potentials including bio-gas and plasma.

2	J. Fearon, at el (Ghana)	The study suggest that the volume of effluent generated at the abattoir is a potential resource, can be utilized to enhance operation as well as serve other sectors of the economy. For instance DeCo an NGO operates decentralized composting plants in the Northern region of Ghana using various kinds of biodegradable waste materials. The abattoir waste materials are entirely organic that can either be composted or recycled and used for various activities.
3	M. N. Amin (Khulna city, Bangladesh)	Author concluded that, it is sure that the waste quantity produced from slaughter houses could be use for biogas production. In contrast, the sludge comes after gas production could be use as fertilizer after aeration.
4	O Chukwu, at el (Minna, Nigeria)	Author suggested that There should be extensive use of compost and biogas produced from waste decomposition in the generation of electricity for the abattoir and the environment at large.

3. PROBLEM STATEMENT

The slaughtering wastage of animals is wasted and rinse off in water bodies while from several documentaries it was unfold that these wasted part of cattle can be utilize for further industries. The animals which become our dining table part are the part of our daily life, and they are useful after slaughtering. The blood, skin, hooves, viscera become the part of land and water pollution while being useful for the economic growth they are increasing another problem of pollution because of lack of utilization of these materials by our management teams daily we waste and rinse off the inestimable value added materials in the agriculture sector which can be utilize for the healthy growth of GDP.

4. AIM & OBJECTIVES OF RESEARCH

Aim of study is to promote the wastage of animals from slaughterhouse as byproducts to run a new business.
To achieve this aim the objectives include

- To utilize animal viscera as a byproduct for several industries.
- To provide techniques & methods for utilization of wastage of slaughterhouse.

5. MATERIAL AND METHODS

This study involved surveys of slaughterhouses, questionnaire survey, and unstructured interview with the experts, with the owners of slaughterhouses and with the workers of slaughterhouses. The cross sectional study involved multi-stages of random time survey and interviews from veterinary doctors. This study focuses slaughterhouses of Pakistan. Total five slaughterhouses from over all Pakistan were visited. These were Bara Qamaila and Chhota Qamaila Hyderabad, Karachi city abattoir Landhi, PAMCO Lahore and Parati Bakar Mandi Lahore. These slaughterhouses were chooses due to their high patronage by meat consumers including public and commercial uses. Small survey for the sake of wider approach towards entrepreneurship was conducted which includes the examination of the area and features & business trend of by product especially in Hyderabad regarding livestock and meat dealing & other products in the city. Survey includes the whole procedure from where an animal is bought how it grows up butchered and sold to become the part of our dinning. Several interviews were conducted from labor and expertise that enfold the issues regarding the byproducts and wastage of cattle. For internationally meeting the new business we go through the documentaries in order to know about the different practices in different area regarding the rendering of blood and usage of byproducts of anima as a source of healthy income.

6. RESEARCH FINDINGS AND DISCUSSSIONS

Fig. 3 enlisted the average wastage (viscera) which then bifurcated into several types of meats and other products. The wastage includes viscera, bones & hooves having several edible and inedible products which are in listed below with their usage.

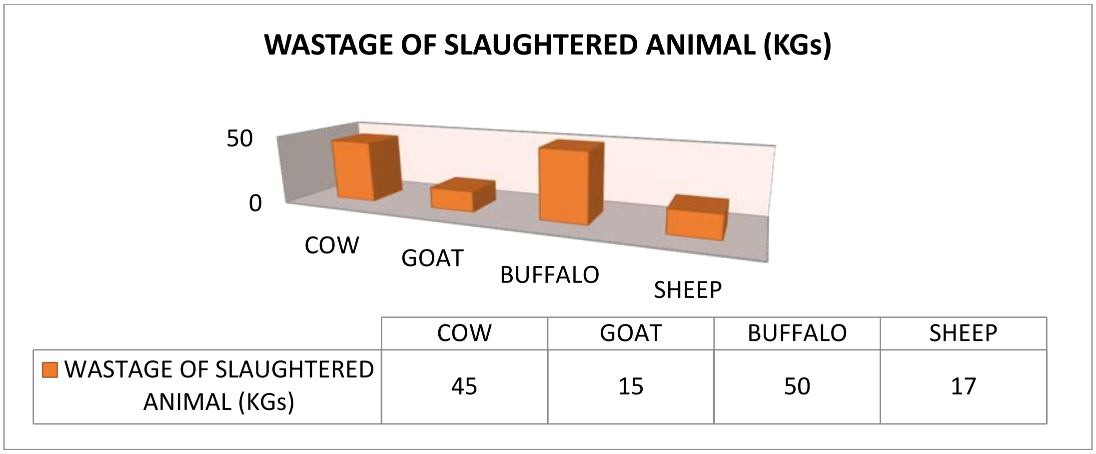


Fig. 3: Average Wastage of Slaughtered Animal.

Table 2 enlisted the edible by products which we get from cattle and further can be used for many industrial sectors.

Table 2: Categories of Edible By-Products.

SERIAL #	**EDIBLE BY-PRODUCTS**
1	variety meats
2	liver, kidneys, brains, tripe, sweetbreads, and tongue
3	Fats (oleo stock and oleo oil)
4	Intestines
5	Gelatin (bones & skin)

Table 3 enlisted all the byproducts which are not edible but can be used for other purposes. The purposes along with products are listed in same table.

Table 3: In Edible By-Products.

S #	**PRODUCTS**	**USAGES**
1	Bones horns, and hooves	Buttons, bone china, piano keys, glues, fertilizer, and gelatin for photographic film, paper, wallpaper, sandpaper, combs, toothbrushes, and violin string, jewelry, serving wear, utensils, Dog treat, and keratin protein.
2	Fatty acids	Chemicals, biodegradable detergents, pesticides, and flotation agents, automobile tires run cooler
3	fats	Industrial oils and lubricants, tallow for tanning, soaps, lipsticks, face and hand creams, some medicines, and ingredients for explosives

4	hide	Leather, base for ointments, binders for plaster and asphalt, base for the insulation material, foot balls
5	hairs	Art brushes
6	lungs	Heparin, an anti-coagulant
7	Adrenal gland	Steroids
8	pancreas	Insulin
9	intestines	Tennis racket string
10	Gallstones	Aphrodisiacs
11	Bone charcoal	Steel ball bearings

6.1 Blood Rendering

Rendering is a process that converts waste animal tissues into stable, value-added materials. If we focus only on Hyderabad slaughterhouses, on daily basis we rinse a large amount cattle blood, which can be utilize after rendering. Fig 4 enlisted the quantity of blood we get from cattle which will help in developing blood rendering plant capacity of per day.

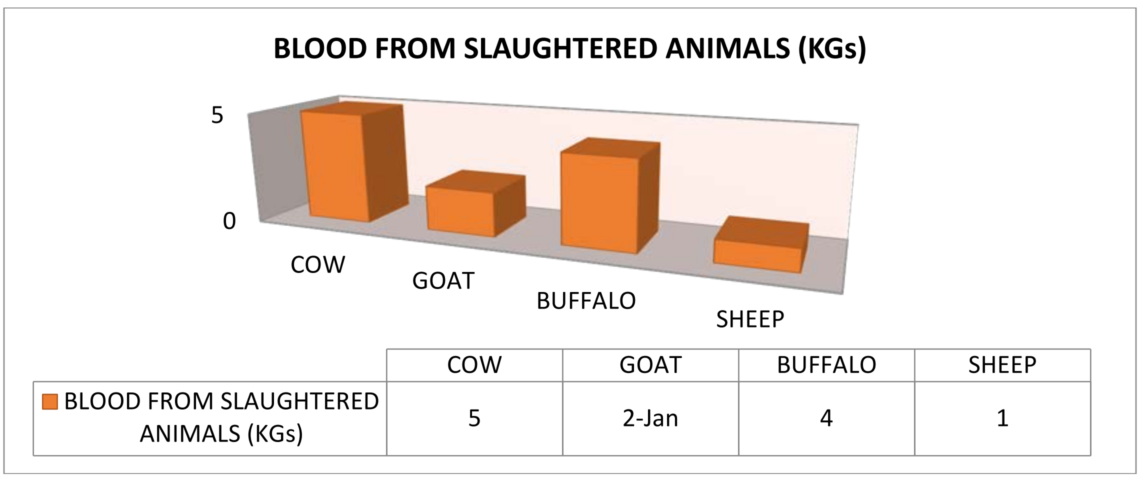


Fig. 4: Blood at the Time of Slaughtering.

Table 4 enlisted the blood by products, source of blood and those countries which will help in making our business more efficient.

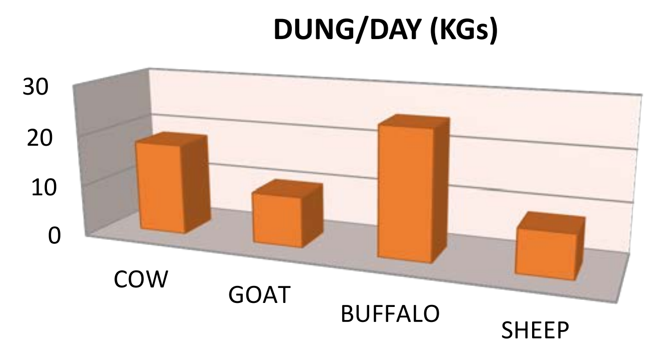
Table 4: Blood By-Products.

S #	OUTCOME	COUNTRY	ORIGIN OF BLOOD	EXPLANATION	USE
1	Fibrimex®	Netherlands	Cattle	Thrombin and fibrinogen protein isolate	For meat based products work as a cold set binder
2	Plasma Powder FG	Netherlands	Cattle	Plasma with increased fibrinogen concentration	For meat based products work as a cold set binder
3	Harimix (C, P or P+)	Netherlands	Cattle	Stabilized hemoglobin	For meat products work as a coloring agent
4	Hemoglobin	Netherlands	Cattle	Frozen or powder hemoglobin	for meat Base products Natural source of coloring
5	PP	Netherlands	Cattle	Frozen or powder plasma	For meat based products ,heat set binder
6	Prolican 70	Chile	Cattle	Spray-dried bovine plasma concentrate	In meat-based products Emulsifier, gelling and binding agent, fish-based products, pasta & bakery products
7	Myored	Chile	Cattle	Natural colorant obtained from the red pigments of blood	Use for enhancing the color of meat & for increasing the fat meat contrast
8	Immuno Lin®	USA	Cattle	Bovine serum concentrate	Supplement for Immune system
9	B7301	USA	Cattle	Spray-dried bovine red bloodCells	Color and iron Enhancer Work as a supplementary material for meat based products
10	Aprofer 1000®	Spain	Cattle	Heme iron polypeptide	Iron supplementary product
11	Proferrin®	USA	Cattle	Heme iron polypeptide	Iron supplementary product
12	Vepro 95 HV		Cattle	Globin (hemoglobin with	In meat products work as an emulsifier

		Belgium		the heme group removed)	
13	Plasma		Cattle	Liquid, powder, frozen or flaked plasma	Gelling and binding agent in meat products

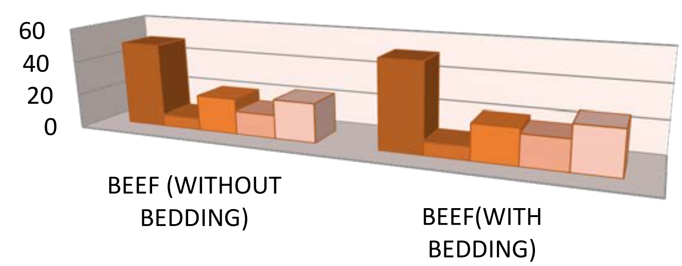
6.2 Manure Usage

Manure is a valuable fertilizer for any farming operation and has been used for centuries to supply needed nutrients for crop growth. Fig 6 shows the species of animal and there average daily basis manure which is utilizes as a fertilizer for agriculture industry instead of wasting it, we can utilize it as an organic fertilizer.



	COW	GOAT	BUFFALO	SHEEP
DUNG/DAY (KGs)	18	10	25	8.5

Fig 5: Average Manure Produced By Animal / Day.



	BEEF (WITHOUT BEDDING)	BEEF(WITH BEDDING)
DRY MATTER (%)	50	52
AMMONIUM-N (lbs/ton)	7	8
TOTAL Na (lbs/ton)	21	21
P2O5 (lbs/ton)	14	18
K2O (lbs/ton)	23	26

Fig 6: Chemical Composition of Cattle's Manure.

6.3 Estimated Earning From Hyderabad Slaughterhouses

Table 5 enlisted the total quantity of Cow's products from slaughterhouse of Hyderabad.

Table 5: Quantity and Unit rates of Cow's Wastage from Hyderabad slaughterhouses.

S#	PRODUCT	CURRENT USAGE	QUANTITY/ANIMAL	ANIMAL SLAUGHTERD / DAY	TOTAL QUANTITY	RATE (Rs.)
1	HIDE	Leather	25 kg	200	200 HIDES	8000 (till 2015) now 800
2	TAIL	100 % Wasted	2 kg	200	200 TAILS	-
3	BLOOD	100% Wasted	5 kg	200	1000 KG	-
4	FAT	100% Wasted	15 kg	200	3000KG	-
5	INTESTINES	100% Wasted	10 kg	200	2000 KG	-
6	BONES	75% Wasted	40 kg	200	8000 KG	100 -150 / KG
7	SKULL	70% Wasted	8 kg	200	1600 KG	400 / skull

For the sake of an estimation of cost , author visited slaughterhouses and have data regarding how much wastage is produced from slaughterhouses of Hyderabad then an un-structured survey for unit rates of these material was conducted in order to calculate how much we can earn from these materials/ day, the data regarding the quantity of slaughterhouse wastage and by-product (COW slaughterhouse) is shown in Table: 05 & the estimated earnings from slaughterhouse of (COW only) is listed as per the material in Table: 06

Table 6: Estimated Earning from Hyderabad Slaughterhouse (Cow's).

S#	PRODUCT	EARNING/DAY (Rs.)
1	HIDE	800 X 200 = 160,000
2	TAIL	25X 200 = 5,000
3	BLOOD	75 X 1000 =75,000
4	FAT	70 X 3000 =210,000
5	INTESTINES	20X 2000 =40,000

6	BONES	100 re. X 8000 =800,000
TOTAL ESIMATED EARNING(PER DAY)=Rs. 1,290,000/-		

Table 7: Quantity and Unit rates of Goat's Wastage from Hyderabad slaughterhouses.

S#	PRODUCT	CURRENT USAGE	QUANTITY/ANIMAL	ANIMAL SLAUGHTERD / DAY	TOTAL QUANTITY	RATE (Rs.)
	HIDE	Leather	15 kg	600	600 HIDES	5000 (till 2015) now 500
	TAIL	100 % Wasted	2 kg	600	600 TAILS	-
	BLOOD	100% Wasted	2 kg	600	1200 KG	-
	FAT	100% Wasted	8 kg	600	4800 KG	-
	INTESTINES	100% Wasted	5 kg	600	3000 KG	-
	BONES	65% Wasted	15 kg	600	9000 KG	100/ KG
	SKULL	70% Wasted	5 kg	600	3000 KG	450 /skull

Same data collection was done for the Goat's slaughterhouse & f or the sake of an estimation of cost , author visited slaughterhouse of Hyderabad which was dealing in CHOTA GOSHT and collected data regarding how much wastage is produced from Goat's slaughterhouse of Hyderabad then an un-structured survey for unit rates of these material was conducted in order to calculate how much we can earn from these materials/ day, the data regarding the quantity of slaughterhouse wastage and by-product (GOAT slaughterhouse) is shown in Table: 07 & the estimated earnings from slaughterhouse of (Goat only) is listed as per the material in Table: 08

Table 8: Estimated Earning from Hyderabad Slaughterhouse (Goat's).

S#	**PRODUCT**	**EARNING/DAY (Rs.)**
1	HIDE	500 X 600 = 300,000
2	TAIL	25X 600 =15,000
3	BLOOD	75 X 1200 =90,000

4	FAT	70 X 4800 =336,000
5	INTESTINES	20X 3000 =60,000
6	BONES	100 X 9000 =900,000
7	SKULL	450 X 600 =270,000
TOTAL ESIMATED EARNING=Rs. 1,971,000/-		

Total estimated earnings from two slaughterhouses **=** 1,290,000 + 1,971,000= Rs. 3,261,000/-

7. CONCLUSION

Slaughter houses are the places from where people get the meat for human consumption but the time is to utilize the all those stuff which is supposed as wastage or garbage in international level to increase the GDP's rate from livestock. For the sake of this data, a questionnaire survey among people was conducted regarding the usage of these materials. The questionnaire results concluded that these are valuable materials but due to lack of management and industrial mind slaughterhouses of the Hyderabad city cannot utilize those materials. The research focused on slaughterhouses of Hyderabad city. The research includes the wastage from the slaughterhouses and their proper utilization in to produce several byproducts.

At the end this research also included the total wastage produced from the Hyderabad slaughterhouses and the total expected income that can be generated from these slaughterhouses. This research also proposed a well mechanized blood rendering plant and by product utilization in several industrial sectors which will increase the employment too.

The research suggest to utilize all the wastage of slaughtered animals to run a new business in Pakistan. The expected earnings are only calculated for Hyderabad City. However the study can be widen to entire country and the expected earnings can be calculated.

The research will attract the stakeholder to pay attention in this new sort of business that can earn in large amount if maintain properly.

8. REFERENCES

- Abha Lakshmi Singh*, Saleha Jamal and Shanawaz Ahmad Baba, Md. Manirul Islam, 2014.
- Christian M. Rogerson "The Waste Sector and Informal Entrepreneurship In Developing World Cities."
- Chukwu, at el, "Abattoir wastes generation, management and the environment: a case of Minna, North Central Nigeria", International Journal of Biosciences (IJB), 2011.
- Dr. Veena Sharma, RRMK Arya Mahila Mahavidyalya (2014), Waste Water Management: Inaction No Longer an Option, Pathankot- 145001, India, july 2014.
- J. Fearon, at el, "Abattoir operations, waste generation and management in the Tamale metropolis: Case study of the Tamale slaughterhouse", Journal of Public Health and Epidemiology, January 2014.
- Jan Willem Swanepoel, Waste Management At Free State Abattoirs, November 2014.

- M.A. Carreea and A.R. Thurika (2002) , “The Impact of Entrepreneurship on Economic Growth”, Erasmus University Rotterdam bEIM Business and Policy Research, Zoetermeer Faculty of Economics and Business Administration, University of Maastricht.

- Markus Larsson (2012) “Environmental Entrepreneurship in Organic Agriculture in Järna”, Sweden, Journal of Sustainable Agriculture, 36:2, 153-179, DOI: 10.1080/10440046.2011.620225.

- Muzari (2016) Interactions of Biophysical and Socioeconomic Factors and Outputs in Mixed Crop-Livestock Smallholder Farming Systems in Africa South of the Sahara, Washington Muzari, January 2016.

- Prasad, R.M. and Furedy, C., 1992: Small businesses from urban wastes - Shoe renovation in Delhi, Environment and Urbanization,

- Sindh Board of Investment
- *www.dairymax.org*

HEALTH & SAFETY CONCERNS OF MAUFACTURING INDUSTRY WORKFORCE

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Abstract: Occupational health and safety is a matter of concern that all the manufacturing industries are facing now a days. Accidents at a production site are increasing day by day. In addition to this health hazards inside office building are also increasing, thus both white collar and blue collar workers are not shielded from constituents that damage their health. The study incorporates awareness from prevention of elements that affect workers' health and safety which otherwise can lead to accidents at site. This research includes interviews form workers of manufacturing industry about their awareness regarding health and safety such as ; noise, electricity, fire, ventilation and gas leaks, emergency exits, air pollutants, chemical pollutants, lack of knowledge and personal protection equipment, working hours, Blood Borne Viruses, improper insulation, heat etc. Thus this research will be helpful in minimizing the accidents at site and in creating safe and secure workplace for workforce.

Keywords: Health & Safety; Accidents; Manufacturing Industry; Workforce.

1. INTRODUCTION

Health and safety at workplace is defined as the identification, prevention, evaluation and control of potential hazards, elements, factors that adversely affects workers health and safety also taking into account impacts on natural environment. It is generally related to welfare, safety and health of people at workplace. Industries which disregard health and safety may lose staff; increases product costs thus have less profit. As a finding of a review (Lamm, Massey, Perry, 2006) there is expanding and convincing proof that giving a solid and safe workplace can increase labor productivity and enhances business profits. Health and safety issues are vital part of risk management, quality management and corporate social responsibility (CSR).Workers are indulged in exceptionally hazardous employments like construction and mining, and some are more exposed to harmful radiations and pollution. A well developed health and safety framework is not just a duty of couple of representatives. It is a mutual commitment of every single worker and, therefore, every one of them will be profited from a protected workplace. The International

Labor Organization (ILO) assessed that every year universally, around 2.2 million individuals die from work related mishaps and sicknesses, while 270 million experiences non fatal wounds and diseases. In addition the ILO surveyed that the 4 percent of the world's GDP is added up from cost utilized on such health and safety issues. (HESAPR0-april 2013).

The scope of health and safety has increased steadily and constantly in light of Monetary, Technological, political, and social change. In the world of work, Globalization of the world's economics has seen as the major force for change, it affects a worker in both positive and negative ways for example by working irregular and extended hours, as worker gets more money by working more hours then normally but this affects his social life along with severe negative impacts on his health. This guide presents the establishment on which health and safety frameworks may be built.

In this paper different Potential hazard, factors and labors awareness which adversely affects human health and safety were distinguish through literature review and by meetings with workers and high profiled field experienced health and safety experts. Severities of health affecting factors were analyzed on the basis of the knowledge of field experienced health and safety experts.

2. LITERATURE REVIEW

The arrangement of health and safety has become a critical factor in industries, it affects socially and economically to both employer and worker. Health and safety conditions can be enhanced by recognizing potential hazards which significantly reduces the safety and health risks. Research proposes that perils and dangers rely on numerous factors, for example these factors varies from county, business, exposure timing and rate, and financial stability etc. (Seixas et al. 2008) has identified fungi, bacteria and viruses as biological and dusts, fumes, heavy metals and smoke as chemical where as temperature, mechanical vibrations, radiations and noises as physical factors affecting health and safety of workforce. Encyclopedia of Occupational Health and Safety (1998) has identified repetitive motion, force, and mechanical vibrations and, lengthen awkward posture etc as health affecting factors. According to a survey conducted by Government of Pakistan in 2013 that Pakistan contains 54.9 million workforce and 41 workers out of 1000 receive injuries every year in occupational accidents. A large portion of the Pakistan workforce is not cleared about the proper use of the protective equipments; they have limited awareness and information regarding health, safety, emergency and preventive measures.

Modernization in technology and economic development has also increased the occupational injury rate (Gumber 1997). According to (Manuele, 2003) theory occupational injuries are caused when dangerous conditions are consolidated with hazardous activities that start from the deficiencies of people due to lack of knowledge regarding hazards. All deaths, injuries, diseases and non fatal wounds caused due to poor health and safety framework significantly damages national economy and industry reputation. According to a study conducted by (Lamm, Et al 2006) proposes that healthy and safe workplace with very low potential hazards significantly improves workers efficiency and industry reputation and profits. Another study conducted by (De Greef and Van Broek 2004) also proposes that company productivity increases when health, safety, precautionary measures and workforce working conditions are improved.

It is evident that noise plays a very important role in affecting worker health at workplace. Noise is an unnecessary, unwanted sound which adversely affects listener health. Noise has both chronic and acute effects on listener health. Noise now a days has become attention seeking issue due to its potential hazards on human health and environment. (Martin et al. 2006). Noise in a manufacturing industry is generated from the process of cutting, shearing, pressing, and riveting of metal products and Molding, and motors, fan, transformers, impact noise, bearings and gear, grinders and impact wrenches, generators, air compressors, air and steam leaks, heat exchangers, furnaces, compressors and pumps (Bugliarello et al 1976). Noise causes noteworthy hazards on human health and environment such as headaches, hypertension, heart attacks, behavioral disorders and depression. Better quality of work and productivity requires complete attentiveness but due to noise worker cannot focus on their work, hence they spends more time and efforts to complete their jobs, which indirectly leads them to suffer from stress and headaches (Ziaran 2001). Long term exposure to noise leads workers to suffer from permanent or temporary deafness. Due to increase in productivity demand and competitive environment, worker experiences extra workload which leads them to suffer from stress and depressions. (Kaminski 2001; Zacharatos et al. 2005).

Some particular ergonomic issues also exist in the majority of the businesses which incorporate treatment of machines, hand apparatuses, materials handling by hands, job dissatisfaction and discomfort, problems related to heat, humidity and dust (Shikdar 2003). It is observed in a study that workforce is more exposed to perils as compare to other people. For example take an example of a worker who carry loads by hands and works in awkward posture may experience backbone and physiological problems, a worker may experience severe respiratory problems due to dust and smoky workplace conditions. Workforce is more exposed to harmful radiations and heavy metals which increases their vulnerability to cancer and reproductive problems (Shannon Et al 2001). It founds in a study conducted by (NIOSH 2007) that 82% hearing impairment cases were reported from workforce in manufacturing industries. According to (Journal of Occupational and Environmental Medicine, June 2004) the worker who smokes cigarette at workplace, doubles the severity of different hazards affects, because some of the poisonous constituents are found in cigarette tobacco (e.g benzene) which may interact with toxic elements found at workplace while doubling its severity then alone exposure (e.g., asbestos). The heat produce by burning tobacco may also enhances the reactivity and toxicity of other chemicals inhaled. It is found in a study that white collar workers are more exposed to hazards and problems caused by burning tobacco then blue collar workforce (NIOSH May 2012).

It was observed in a research survey conducted in a manufacturing industry by Kimberly-Clark Professionals in 2008 that 89% of the workers were not aware about the proper use of personal protection equipment 6 % were reluctant to use PPE which greatly put their lives in danger. According to The National Institute for Occupational Safety and Health (NIOSH), Working in a place where ventilation is poor or at place where temperature is high, can also be a health hazard. Working in high heat zone can lead workers to suffer from serious illnesses, heat strokes, skin rashes, heat cramps, fatigue and dehydration in workers body which is fatal in most cases (Biping Song 2012).

3. RESERCH METHODOLOGY

The study is aimed to determine potential hazards that affect health and safety of labors in manufacturing industry and also the awareness of workforce in same industry. The author initially reviews the literature and various national and international health and safety Standards and guideline including Occupational Safety and Health Administration (OSHA). From the literature and Safety standards various critical factors related to health and safety were identified. The factors were then discussed with various highly profiled field experienced Health and safety experts.

After reviewing the literature and safety standards, first questionnaire was designed for the health and safety representatives, which was based on the severity and criticalness of factors affecting health and safety, on the basis of the results from first questionnaire, second questionnaire was designed for the workforce to determine awareness about health and safety.

4. DATA COLLECTION AND ANALYSIS

90 questionnaires were distributed among workforce and 40 questionnaires to health and safety experts. A scale was adopted for experts questionnaire as 1= Not severe; 2 = slightly severe; 3 = moderately severe; 4 = severe; 5 = extremely severe and for workforce questionnaire scale was adopted as 1 = yes and 2 = No. Factors severity were measured with Statistical Software Package SPSS, after analyzing in the software both the average index value (AI) and rank of each factor were found as shown in table 1.

Table: 1 Average Index and Rank of Factors.

No	Factors	AI	Ranking
1	Improper PPE use	4.8333	1
2	Operating machines that are poorly maintained	4.5100	2
3	Long term exposure to high intensity noise	4.5000	3

4	Blood borne viruses	4.3333	4
5	Working extended hours	4.2112	5
6	Lack of knowledge	4.1667	6
7	Working near naked electrical wires	4.1667	6
8	Smoking cigarette in poor ventilated or close room	4.1555	7
9	Stress due to workload	4.1000	8
10	Exposure to heavy metals	4.0200	9
11	Exposure to carbon monoxide	3.8233	10
12	Working irregular hours	3.8111	11
13	Exposure to radiations	3.6667	12
14	Exposure to arsenic	3.5222	13
15	Operating high voltage devices	3.5000	14
16	Fire hazards	3.4322	15
17	Gas leakages	3.3411	16
18	Slips and trips	3.3333	17
19	Exposure to highly reactive compounds	3.2220	18
20	Exposure to poisonous chemical	3.2220	18
21	Exposure to radioactive material	3.1667	19
22	Exposure to smoke	3.1555	20
23	Mercury hazards	3.1400	21
24	Improper ventilation in industry	3.1203	22
25	Wielding without putting PPE on eyes	3.0000	23
26	Lifting and carrying heavy loads by hands	2.8344	24
27	Handling flammable substances	2.8342	25
28	Work in a bent, twisted and awkward work posture	2.8223	26
29	Exposure to volatile organic compounds	2.8222	27
30	Working in a confined space	2.8001	28
31	Working in a high heat zones	2.6667	29
32	Work load due to demand and deadlines	2.5571	30

33	Smoking cigarette inside manufacturing zone	2.4320	31
34	Mechanical vibrations and shocks during working hours	2.5000	32
35	Inhaling dusts and fumes	2.5000	32
36	Working in highly polluted air zone	2.5100	33
37	Smoking cigarette in open environment	2.1667	34
38	Asbestos	2.1422	35

5. RESULT AND DISCUSSION

On the basis of average index the top 10 critical factors according to average index are shown in table 2.

Table: 2.Crfitical factors of Health & Safety in Manufacturing Industry.

N0	Factor	Ranking
1.	Improper PPE use	1
2.	Operating machines that are poorly maintained	2
3.	Long term exposure to high intensity noise	3
4.	Blood borne viruses	4
5.	Working extended hours	5
6.	Lack of knowledge	6
7.	Working near naked electrical wires	6
8.	Smoking cigarette in poor ventilated or close room	7
9.	Stress due to workload	8
10.	Exposure to heavy metals	9
11.	Exposure to carbon monoxide	10

5.1 Worker's Awareness about Critical Factors

It is found by the study that 60.9 % workers were not aware about the PPE and 52.2 % workers were lacking the knowledge regarding proper use of PPE and 69.6% workers were not cleared about the directions and importance of Emergency exit gates. 78.3 % workers were not clear about the meaning of different health and safety symbol posted in an industry. 73.9% workers said that there is no safety risk in operating poorly maintained machines. 69.6% workers were not aware about the potential health and safety hazards of high intensity noise. 87% workers were lacking the knowledge about blood borne viruses; they didn't know how blood borne viruses spread and damage their health. Only 13% workers said that working extended hours can have negative impacts on their health while 87% workers were not aware about the hazards.69.5% workers said there is no safety risk in working near naked wires. 95.7% workers were lacking any information related to carbon monoxide and its hazards. 95.7%

workers don't have any knowledge regarding heavy metals.91.3% workers said smoking cigarette in a close room cannot affect other workers while 83.9% said that smoking cigarette in a industry cannot enhance the effects of other pollutant.21.7% workers agreed with the point that work related stress can cause severe health problems while 78.3% weren't aware about the stress and its hazards.87% workers said lack of knowledge regarding the duties can +lead to accident but 13 % said lack of knowledge cannot cause any harm.

6. CONCLUSION AND FUTURE RECOMMENDATION

Occupational health and safety is a matter of concern that all the manufacturing industries are facing now a days. Accidents at a production site are increasing day by day. This study incorporates initially the potential factors that affects labors health and safety issue in manufacturing industry and then awareness in workforce about factors that severely affects health and safety was determined through questionnaire and interviews with labors. The key factors affecting health and safety were identified through literature reading and brainstorming sessions with high profiled health and safety experts. On the basis of results from the literature reading and discussions with experts a questionnaire was drafted for health and safety experts to analyze the severity level of factors, after that another questionnaire was designed for the workforce to analyze their awareness about the factors affecting health and safety. It was observed in a study that majority of workforce was lacking the knowledge about the key factors affecting their health and safety, which significantly put their lives in danger.

This research has only focused on identification of factors however necessary measures can be identified regarding potential hazards determined in this study. The awareness of the labors can be increased by giving necessary training. Hence study can be conducted to highlight this phase.

REFERENCES

1. Baron (2013), "The development of a knowledge based system for the process of risk assessment in the workplace". In: Applied Mechanics and Materials: ICMCE 2013: No. 446-447 p. 1314-1320. ISBN 978303785908-7
2. Biping Song (2012)."Occupational heat stress and health impact assessment at a shoe factory in China"
3. Bugliarello et al(1976)"The Impact of Noise Pollution: A Socio Technological Introduction"
4. De Greef Et al (2004) "Healthy Employees in Healthy Organisations" European Network for Workplace Health Promotion '
5. Gumber (1997).ABurden of injury in India. Economic and Political Weekly., 1478-1491.
6. Jeanne MagerStellman "Encyclopedia of Occupational Health and Safety 4th edition"(1998)
7. Journal of Occupational and Environmental Medicine, June 2004
8. Kaminski, M. (2001). Unintended consequences: organizational practices and their impact on workplace safety and productivity. Journal of Occupational Health Psychology, 6, 127–138.
9. Lamm Et al (2013) " the link between productivity and health and safety at work" Hesapro background research paper
10. Manuele (2003) "Journal of safety, Health & environmental Research"
11. Martin et al (2006), "Environmental Noise Pollution Monitoring and Impacts On Human Health in Dehradun City, Uttarakhand, India."
12. Nasrullah Et al (2008) "Occupational Injuries in Pakistan: Incidences and Economic Impact"
13. Seixas Et al (2008) "Occupational Health and Safety Experience "American journal of industrial medicine 51:399–406
14. Shannon Et al (2001) "Creating safer and healthier workplaces: role of organizational factors and job characteristics". American Journal of Industrial Medicine, 40, 319–334.
15. Shikdar (2003) "The relationship between worker satisfaction and productivity in a repetitive industrial task"
16. The National Institute for Occupational Safety and Health (NIOSH May 2012)
17. Ziaran (2001) "Human Protection against noise and vibration (in Slovak), STU SjF v Bratislave, ISBN 80-2271607
18. Zacharatos, Et al (2005) "High-performance work systems and occupational safety. Journal of Applied Psychology, 90, 77–93

OVERLY WEIGHTED ANALYSIS FOR INDUSTRIAL WASTE WATER TREATMENT PLANT THROUGH GIS IN KOTRI CITY

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Abstract: The industry has a crucial role in the development of economy for the city. However, it has negative impacts on the ecosystem because of industry contributes to higher levels of natural resource exploitation and increased levels of pollution and waste. Industrial unit in Kotri Site area Jamshoro has been dumping its effluent of industries in Karachi canal without treatment. and Karachi canal is the main source of domestic fresh water for Kotri city. So this research research is best on to find out the suitable location for waste water treatment plant in Kotri city for industries in Kotri Site area. to find suitable location Overly weighted analysis was carried out. For suitability analysis criteria was selected on the bases of expert choice and imaginary map was got by SAS planet 160707 stable. Criteria was weighted and overly analysis was carried out through Arc GIS 10.2. results are helpful for Kotri Association of Trade and Industry to install new treatment plan so that the residents of Kotri have fresh water for their use.

Key words: GIS land Suitability Industrialization Industrial waste water and water treatment plant

1. INTRODUCTION

The industry has a crucial role in the development of economy for the city. However, it has negative impacts on the ecosystem because of industry contributes to higher levels of natural resource exploitation and increased levels of pollution and waste [1]. In Sindh province of Pakistan, industries are developed in an around the urban centers on such (Kotri assessment). Kotri Jamshoro is among such urban centers which considered as the fast-developing town and distinct headquarter of Jamshoro. [2]. Kotri covering an area of 1875 acres and 167 numbers of plots established in 1968. Out of 78 units, 68 are operational. These units include Textile (Spinning and Dyeing), Soap and Detergent, Electrical cables, Paper and Pulp, Ghee Plants, Flour mills, Particle size hard board, Tobacco and Cigarette, Cotton wastes and Electrical Conductors etc. [3] Industrial wastewater is mostly containing load of metals, therefore requires proper treatment and filtering before its discharge into water bodies [4] Like other SITE areas of the Sindh province, there is no any treatment plant and appropriate disposal system exists; therefore, wastewater generated by all of the Industrial units is ultimately being disposed off in the water ways without any treatment [5] According to the report, Kotri Site dump effluents in the canal. Out of 68 working units, 32 release poisonous liquids and only 14 of these have installed in-house waste treatment plants. [6] Chemical waste of Kotri Industrial area is entering in to Karachi Canal (Kalri Baghar Canal) at Kotri, while water tankers which supply water to Kotri town are also taking water from the same canal [7]. The people of Jamshoro and Kotri are being given a slow poison through this canal, [8]. SEPA has taken serious notice of disposal of untreated industrial wastewater from various industrial units of Kotri sites into natural environment which is causing significance pollution to make water unfit for human consumption. The action is taken against offenders who are releasing untreated wastewater into the environment. but after a survey it was seemed that still industries dumped there effluent in canal [5] The Commissioner Hyderabad, has directed the officers concerned to identify a suitable site for waste water treatment plant [3] So, this research is significant in the scenes, that it helps Taluka Municipal Officers to select such suitable site where the waste water of Kotri could easily be treated through treatment plant.

2- Material and Method

Kotri was chosen for this study, which can be considered as the fast-developing town and distinct headquarter of Jamshoro. The total area of Taluka Municipal Administration (TMA) Kotri was 1, 845sq.kms [2].
The research study area is located at an altitude 25° 20' 41.39" N and longitudinal 68° 16' 33.46" E as shown in figure 1.

Figure no 1. Location Map of Kotri Site Area

In Kotri 167 numbers of plots established in 1968. Out of 78 units, 68 are operational. These units include Textile (Spinning and Dyeing), Soap and Detergent, Electrical cables, Paper and Pulp, Ghee Plants, Flour mills, Particle size hard board, Tobacco and Cigarette, Cotton wastes and Electrical Conductors etc.

Table no. 01 Industries in Kotri Site Area

S.N.	Category of Industrial Unit	Number of Industrial Units
1	Textile (Spinning & Dye)	49
2	Paper and Pulp	08
3	Cigarettes and Tobacco	05
4	Atta Chaki/Flour Mills	08
5	Wood Work	03
6	Vegetable Oil	02
7	Oil Mills	04
8	Soap and detergents	02
9	Ice Factory	03
10	Steel Pipes	01
11	Cotton Ginning	01
12	Cotton waste	07
13	Electrical wires and conductors	02
Total		**87**

The table no. 1 represents the industrial unites in Kotri Site area the total number of industries in the Kotri site area are 87. These industries included Textile (Spinning & Dye), Paper and Pulp, Cigarettes and Tobacco, Atta Chaki/Flour Mills, Wood Work, Vegetable Oil, Oil Mills, Soap and detergents, Ice Factory, Steel Pipes, Cotton Ginning, Cotton waste, Electrical wires and conductors.
These industries generate waste water that is being thrown in Karachi canal without treatment [3]. and this waste water in form of effluent make the canal water polluted. When this canal is the main source of fresh water for the residents of Kotri city. So this research is focused on the suitability analysis of the treatment plant for effluent treatment.

2.1 Methodology for suitability analysis

The Methodology for the suitability analysis was sated on the three steps. In first step the criteria for suitability analysis was decided. Criteria was sat through literature and Expert Choice. the criteria were selected as the treatment plant should be away from the residential units and rivers and near to the service road and industrial units as shown in table no 02.

Table no. 02 Suitability Criteria

S. N	Criteria Name	Distance (m)	Weight (%)
01	Residential Units	500 to 800	50
02	Industrial Units	300 to 500	30
03	Road	300 to 500	15
04	Rivers	100 to 300	5

Further the table no. 02 shows the distances of the criteria. Distance from residential units is 500 to 800 meters, distance from industrial units is 300 to 500 meters. Distance from road is 300 to 500 meters and distance from rivers is 100 to 300 meters. Furthermore, the table no. 02 also represents the weight of each criterion. That is 50 percent of residential units, 30 percent industrial units, 15 percent Roads and 5 percent rivers.
In second step the Spatial data was collected. For digitizing the layers of the criteria (described in table NO. 02), the spatial imaginary map was needed. To get the imaginary map SAS planet 160707 stable was used. The

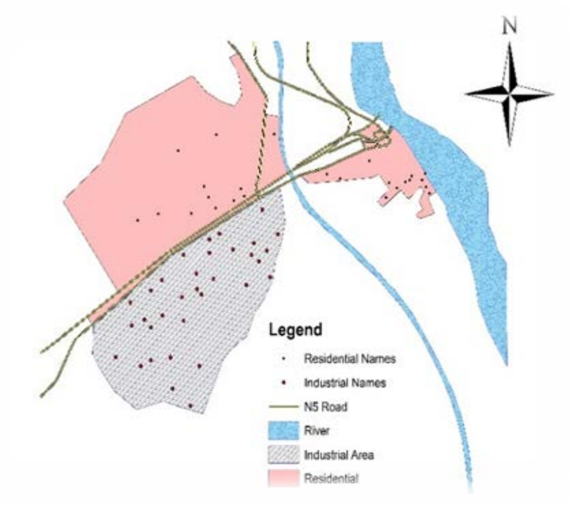

Figure no. 02 Digitized Criteria Layers

Residential units, industrial unites, rivers and roads are shown in the figure no. o2. That represent the criteria of the suitability for treatment plant.

In third step the data was analyzed by using overly weighted method using Arc GIS map 10.2. for overly analysis first multiple buffer was given to residential units, industrial units, Roads and Rivers. Afterward these criteria were ranked as scale of weighted criteria. Scale was consisting on three points in which 1 represent the Most suitable 2 represent the more suitable and 3 represent the suitable. In last a final overly analysis was created combining all the layers in one feature class and was weighted as in table no 02.

3- Results and Discussion

The result of the multiple buffer for residential in figure no. 03, shows the restricted area for the treatment plant on the basis of rank. The yellow colored is the suitable, while the pin k colored are more suitable and outer edges are the most suitable.

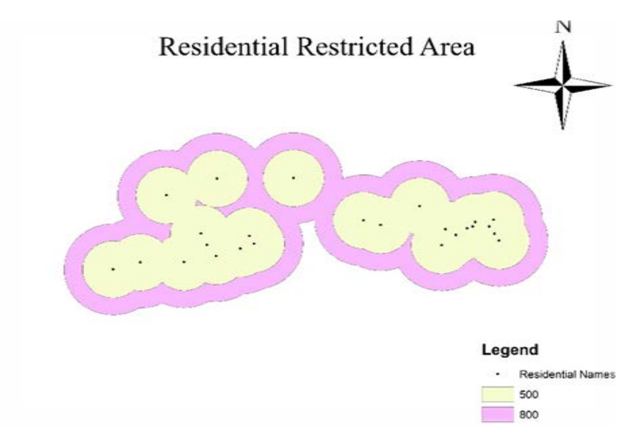

Figure no. 03 Residential Restricted Areas

The figure no 04 shows the industrial limits for suitable area in which area that have 300-meter buffer lies in the most suitable area and those have 500- meters lies in more suitable and outer edges shows suitable areas

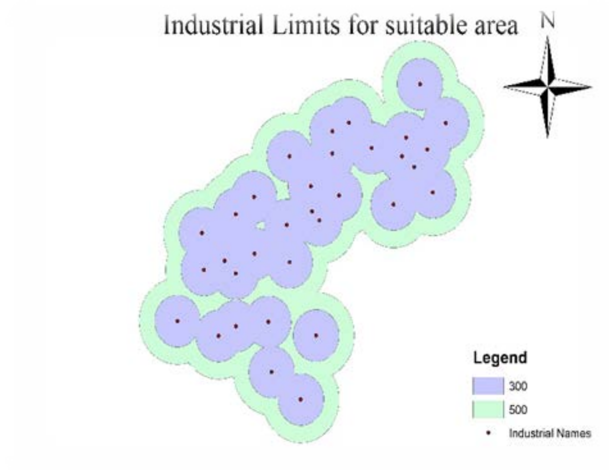

Figure no 04 Industrial Limits For Suitable Areas

The figure no 5 represents the road limited areas for treatment plant. The area that have 300-meter buffer is ranked as 1, area having buffer 500 meter ranked as 2 and other areas ranked as 3.

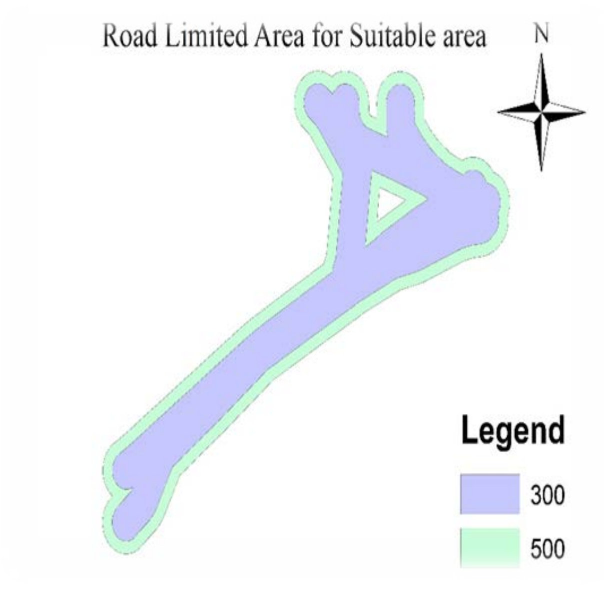

Figure no. 05 Road Limited Areas For Suitability

The figure no 06 represent the multiple buffers of 100 meters and 300 meters. Which are ranked according to the criteria as 100 meters are ranked as 3, 300 meters are ranked as 2 while away from 3 hundred meters are 1.

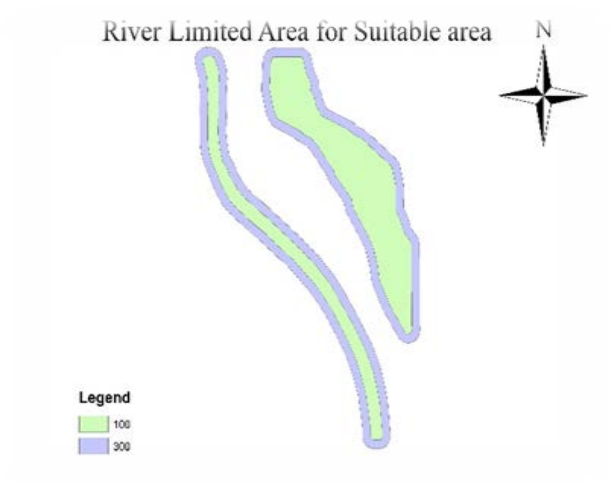

Figure no. 06 River Limited Area for Suitability

The figure no 07 is the result of overall suitability for the treatment plant. It represents the single class feature of all the ranked criteria layers and weighted as 50 percent of residential units, 30 percent of the industrial units and 15 percent of the roads and the 5 percent of the rivers.

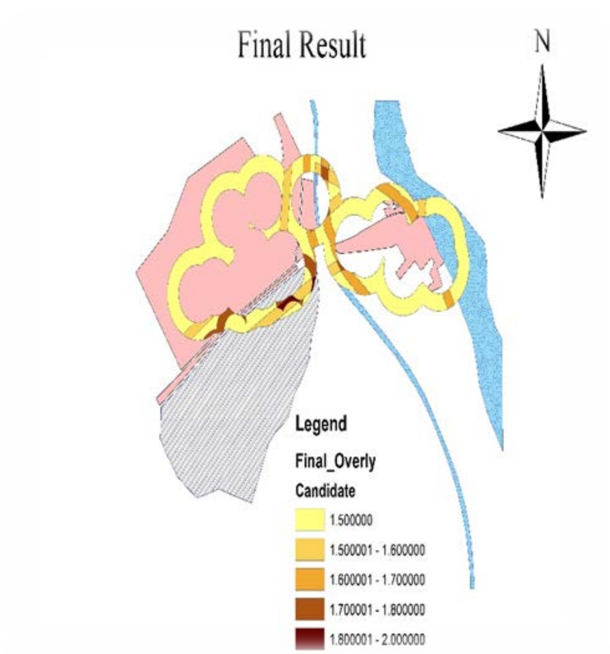

Figure no. 07 Land Suitability Layer for Treatment Plant

4- Conclusion

The aim of the paper was to determine the suitable land for the treatment plant on the base of defined criteria. The aim was achieved successfully. Only 20 percent of the total area is suitable. The results are beneficial for installments of the new treatment plant. This study is also helpful for Kotri Association of Trade and Industry for the installment of treatment plant.

5. Acknowledgment

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References

1. Abida B., Ramnaiah M., Harikrishna, Khan I., Veena, "Heavy Metals pollution and chemical profile of Cauvery river water, E-J. Chem. 6 (11): 47-54 (2008).
2. Ahmed, A., (2007). "Report on Tranche Condition D.(i), 2nd ADF, Utilization of Conditional Grants in Accordance with agreed eligibility Criteria" Consultant F&G, Specialist Local Support Unit Jamshoro- Sindh Devolved Social Services Program.
3. White Paper on Environmental Management Policy, Department of Environment Affairs and Tourism, (1997).
4. http://photos.thenews.com.pk/e_image_detail.asp?catId=2&date=6/6/2014&albumId=0&page=2&picId=86615
5. http://www.dawn.com/news/125125/industrial-waste-causes-disease-in-kotri-area
6. http://nation.com.pk/karachi/17-Jan-2013/waste-disposal-in-kenjhar-lake-a-serious-threat-to-karachiites-kwsb
7. http://tribune.com.pk/story/841539/slow-poison-toxic-waste-still-present-in-kalri-baglihar-feeder-says-sep
8. http://www.dawn.com/news/1237427/nooriabad-kotri-hyderabad-industrialists-told-to-comply-with-sepa-order

ASSESSMENT OF CRITICAL FACTORS AFFECTING START OF PERSONAL CONSTRUCTION BUSINESS

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Abstract: Nowadays, unemployment is the foremost problem worldwide. Pakistan being developing country also badly suffering from same issue. Unemployment rate of the country has touched around 6 % of total population. So this is not a good sign, as the burden of unemployed people is hard for a developing country to bear as less people will contribute in GDP of the state. Fresh graduates Architects and Engineers can start their own business as construction industry is occupied with numerous business opportunities. In this research critical factors related to initiation of personal business in construction sector are identified from literature review, unstructured interviews and through questionnaire from experts of field. At the end research concludes important parameters that one keep in mind to start up personal construction business. This research can be helpful to create various jobs opportunities especially for fresh Architects and Engineers also will add in the GDP of country.

Keywords: Entrepreneurship, Unemployment, Fresh Architect & Engineers; Construction Industry; Pakistan.

1. INTRODUCTION

Unemployment is a major issue nowadays that increases rapidly due to lack of resources and various economical issues globally. As we know population rises day by day that affects directly the economy of every country. The whole world is facing this problem especially the developing countries like Pakistan. Pakistan is ranked as 4th largest country of Asia by population (increasing at the average annual growth rate of 2%) and faces more economical problems already due to unemployment. Pakistan needs to increase its economical scale because it is impossible for a country to do anything without a stable economy. The percentage of unemployment in Pakistan has decreased form 7.8% to 6% in the course of previous years and 5.9% unemployment rate is recorded in January 2016 and it can be further decreased by introducing new business concepts which would provide jobs to the fresh graduates.

The construction industry raised by 11.3% in the fiscal year 2013-14 against the set target of 5.7%. It added the share of the industry in GDP mounted at 2.4% in the year. The rising demand of infrastructure activities is making this sector profitable enough. Architects and Engineers are the main personalities of construction industry but this sector also suffers unemployment. The freshly graduated architects and engineers suffer more because they have lack experience, lack of critical thinking skills, professional connection and this leads them to think that they are not ready to start their own business.

Construction industry is a field where lot of job opportunities can be created. The new stakeholders of construction industry are less interested in the construction business due to several issues. Also to start a new construction business is again a challenge for fresh graduates as it requires lot of experience, financial resources and other skills and facilities.

This problems can be resolved if necessary step are taken in terms of entrepreneurship. Several business opportunities can be opened worldwide as construction industry is nexus of various businesses. The students related to construction engineering has a lot of potential to do the business but the thing is to motivate them and to provide the suitable facilities.

This research provides suggestions to architects and engineers and would help them to step up as an entrepreneur. Also the second major part of the study is concern with the barriers that creates hurdles in the construction industry business. The research mainly focuses on the factors which are essential to start a new business and barriers to start the same. This study will provide the guidance to fresh architects and engineers to startup their new business so that when fresh graduates are come in the industry, they should not be job seekers but the job providers.

2. LITERATURE REVIEW

To start-up a fresh business on your own resources requires a thorough study of the factors which would prove to be the favors and hurdles in the way of the process. Extensive literature is available related to the work which is described below.

(Christian M. Rogerson 2000) studied the aspects of the comparative experience of partnership and conflict between the local state and the informal sector then concluded that potential or skill of a person is the core aspect in startup business. (Sandra L. Fielden et.al. 2000) discussed about small and micro businesses and promoted small businesses over large industries because it has shorter communication line that make it much easier to focus attention on a clear goal and being small makes it possible to respond quickly and flexibly to new opportunities but he found some influences on the success of new small businesses, including the effects of opening size on growth, the entry process, customers and innovation.

(C. Mirjam Van Praag 2001) did an analysis of business survival amongst young white (self-employed) and concluded that ability of survival of the firm throughout the competitions plays an important role because the longer time, the more successful is the small business owner. (Michael Frese 2002) conducted a cross-sectional interview based study of psychological characteristics and found out that opportunistic planning strategy entrepreneurial orientation such as autonomy, aggressiveness, risk and innovative orientation are strongly related aspects for an entrepreneur. (Gavin Cassar 2002) surveyed the impact of start-up business size, asset structure, organization type, growth orientation and owners and examined that one of the important implications for the operations of the business are finance, risk of failure, firm performance, and the potential of the business to expand.

(Nader Abdul-Hadi Et al. 2005) focused on business process re-engineering (BPR). BPR is risky and could be tragic if not properly approached that why he investigated barriers such as lack of resources (time, money, enough manpower etc.), knowledge about construction, right idea and concept and decision making ability of owner to increase success chances. (Henry Mwanaki Alinaitwe 2009) focused on successful lean construction means minimizing waste in the construction process that changes the construction industry needs. And experienced some problem to startup this type of business such as lack of understanding of the needs of customers, a lack of management leadership, poor communication, inadequate teamwork, ill-defined focus, Lack of capability of a team to maintain alignment with other teams and a lack of continuous improvement in owner.

With the progress of time and advancement in technology, the researchers also discovered more factors which affected the start-up of a new business. (Lars -Erik Gadde and Anna Dubois 2010) compared the features of business and high involvement relationship of contractor with sub-contractor and client and concluded that efficient partnering is very beneficial for construction industry enterprises. The partnered projects achieved superior performance in controlling costs, technical performance, and in satisfying customers compared with projects managed in other ways.

(Markus Larsson 2012) did research on sustainable economic development and concluded through his research that corporation, collaboration, trust and engagement between the members of the firm are the main element of social capital that enables teamwork strong and lowers the contract cost. Trust is central in creating an entrepreneurial society and according to the World Bank (2006) social capital is critical for development to be sustainable. (Magnus Lofstrom et al. 2013) studied the causal relationships between the financial and human capital resources of would-be entrepreneurs and their chance of new-venture entry and concluded that qualification, educational background or professional knowledge, wealth holding are the substantial aspects in free enterprise. Advanced education often facilitates entrepreneurial entry by providing needed skills for successful business operation. (Siti Fahazarina Hazudin Et al. 2015) found that “life security, finance, innovation and risk taking ability of firm owner” are the key business success factors into which male and female entrepreneurs differ in terms of motives to start business.

(Jose Antonio Porfirio et al. 2016) focused on how hard and soft conditions affect entrepreneurship. These conditions are created by the hard and soft skills of an entrepreneur. Hard skills (e.g., business maturity, entrepreneurs' qualification) directly relate to technical skills and capabilities and usually result from previous knowledge. Soft skills derive mostly from and personality characteristics (Robinson & Stubberud, 2014). The hard and soft skills are usually inter related and prove to be the input for a positive outcome in entrepreneurship such as good knowledge, better understanding, bonding etc. (Johanna Gast et al. 2017) researched on sustainable entrepreneurship and found out that entrepreneurship promotes economic conditions but market failures also give birth to negative environmental effects. So researchers also considered the scholars advice that entrepreneurs should balance economical and environmental sustainability goals. Researchers came up with the conclusion that working with a proper strategy is a bonus point in the field as risky as entrepreneurship. (Virgilio Faillaa et al. 2017) worked on “entrepreneurship promotes job stability”. Although entrepreneurship is considered a very unstable career but when compared with the wageworker’s job stability, it is proven to be far more stable. The author analyzed different factors and found out that there are three factors which prove the entrepreneurship as a stable and more productive career, which are: job matching, labor market value and personal commitment.

Extensive literature is available for starting a new business. This research focuses on both the favors and hurdles in the way of starting up a new construction business on your own. The factors are divided into motives (favors) and barriers (hurdles) which affect the process positively and negatively.

3. METHODOLOGY

The research initiated with the problem identification which is unemployment in constructional industry. To approach a proper solution of this problem, a step by step methodology was adopted where the factors which are significant in the startup of a new business were studied from literature. The identified factors then divided into two parts; motives (factors that motivates owner to startup his own business) and barriers (obstacles for owner in the beginning to start own business). After reviewing the literature, the author conducted unstructured interview with the field experts mainly those who are engaged in their personal construction business. The more factors had been added from the views of experts and finally a questionnaire was designed on the basis of views of experts and literature.

The designed questionnaires were floated to two major categories of respondents i.e. Field Experts and Fresh Graduates. The factors were then analyzed in Statistical Packages for Social Sciences (SPSS), using average index techniques. Then the most critical factors from the analysis were taken as critical factors in both categories. Finally the study highlights the motives and barriers related to business in construction industry and the results of study are discussed in terms of opinions of Fields experts and fresh graduates.

4. DATA COLLECTION AND ANALYSIS

The data was collected through a questionnaire survey. Field experts and Fresh graduates were the targeted respondents of this survey. Total 100 questionnaire were distributed among targeted respondent, fifty in each category. The response of questionnaire is given in figure 1.

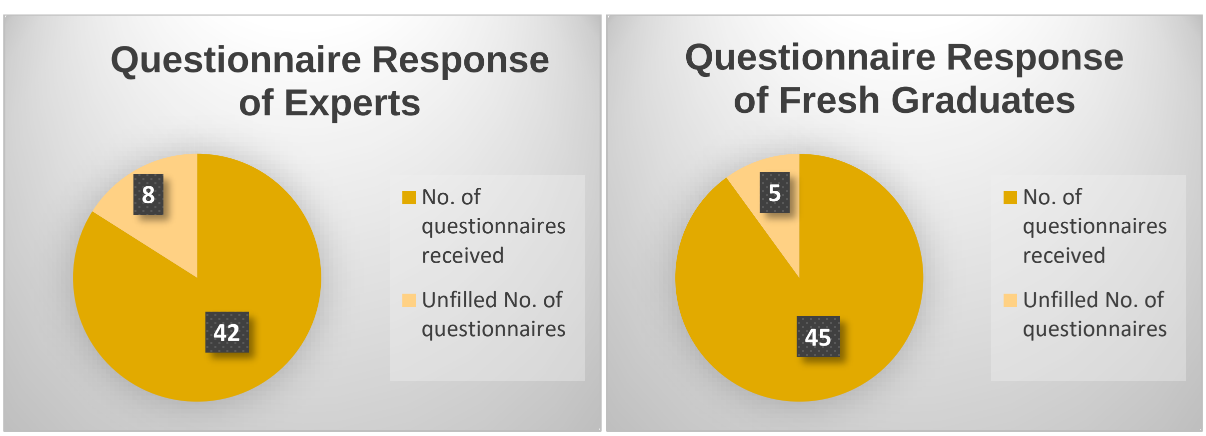

Figure: 1. Questionnaire Response

To analyse the data, a five point likert scale was adopted as mentioned below.

1 = Not Important (NI); 2 = Slightly Important (SI); 3 = Moderately Important (MI); 4 = Very Important (VI); 5 = Extremely Important (EI). The level of significance were assessed with Statistical Software Package SPSS using Average Index (AI) method calculated with formula adopted from Memon, A.H et al. AI is calculated by using the following formula. The ranking of all factors are shown in following tables.

$$AI = \frac{\sum(1X1 + 2X2 + 3X3 + 4X4 + 5X5)}{\sum (X1 + X2 + X3 + X4 + X5)}$$

Where;
X1 = Number of respondents for scale 1
X2 = Number of respondents for scale 2
X3 = Number of respondents for scale 3
X4 = Number of respondents for scale 4
X5 = Number of respondents for scale 5

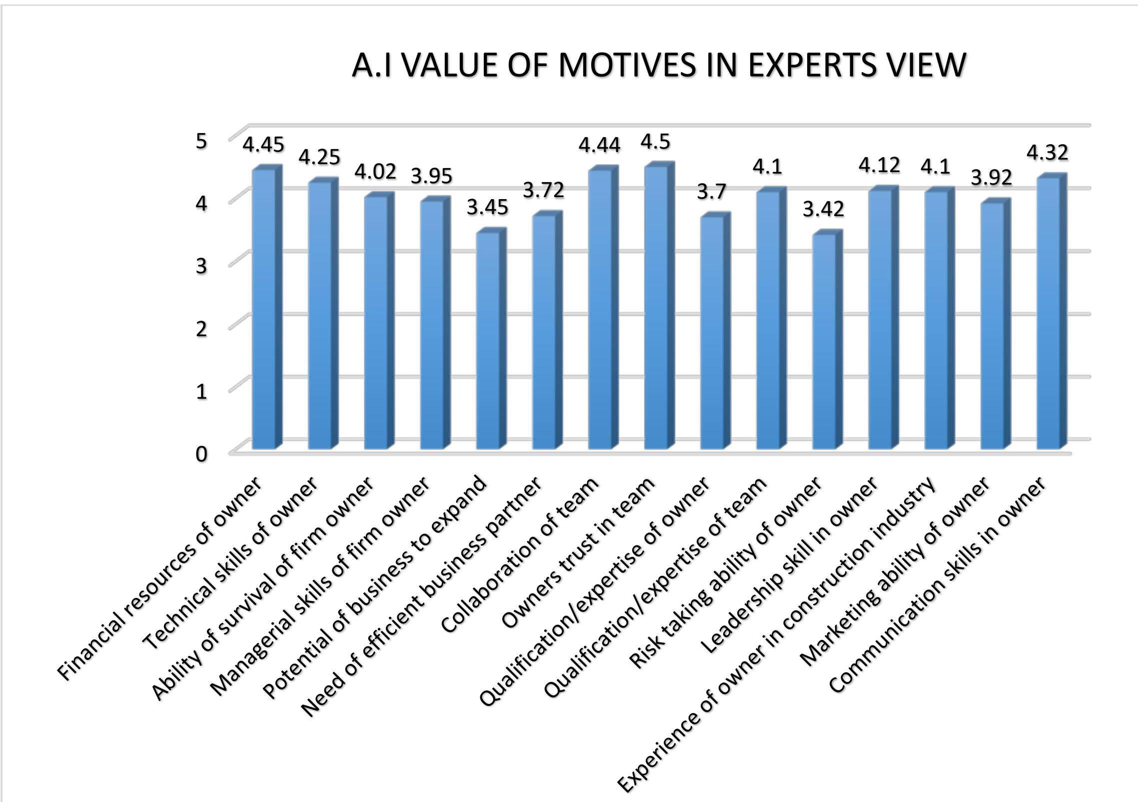

Figure: 2a. Average index (A.I) Values of Motivating Factors (In Experts Views)

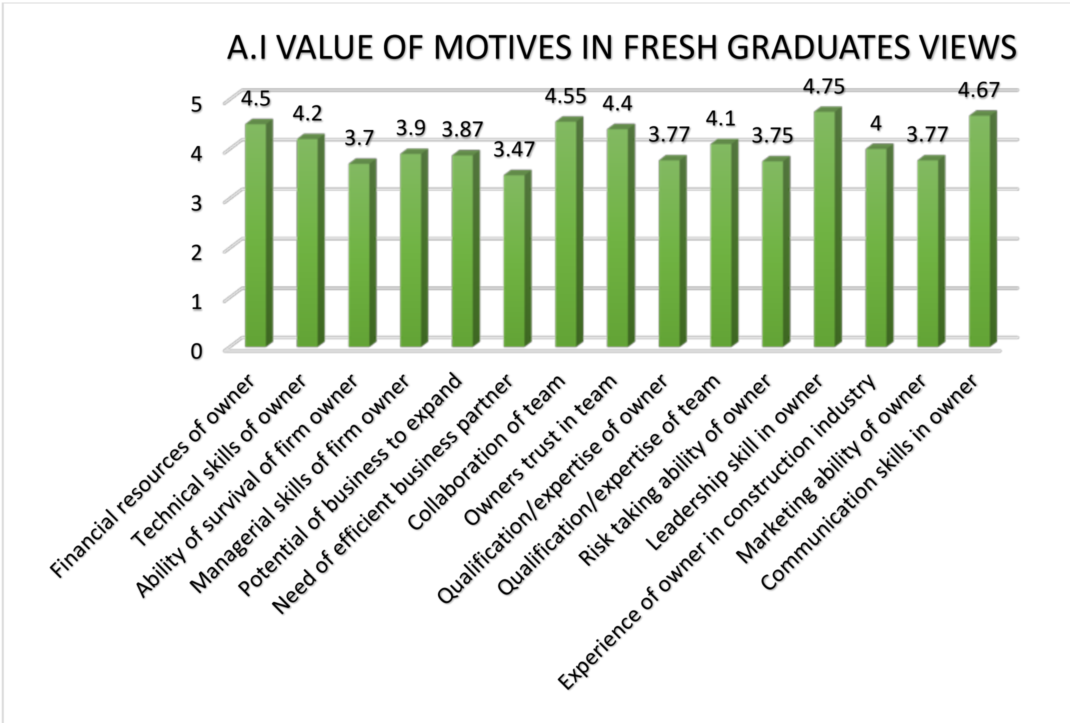

Figure: 2b. Average index (A.I) Values of Motivating Factors (In Fresh graduates Views)

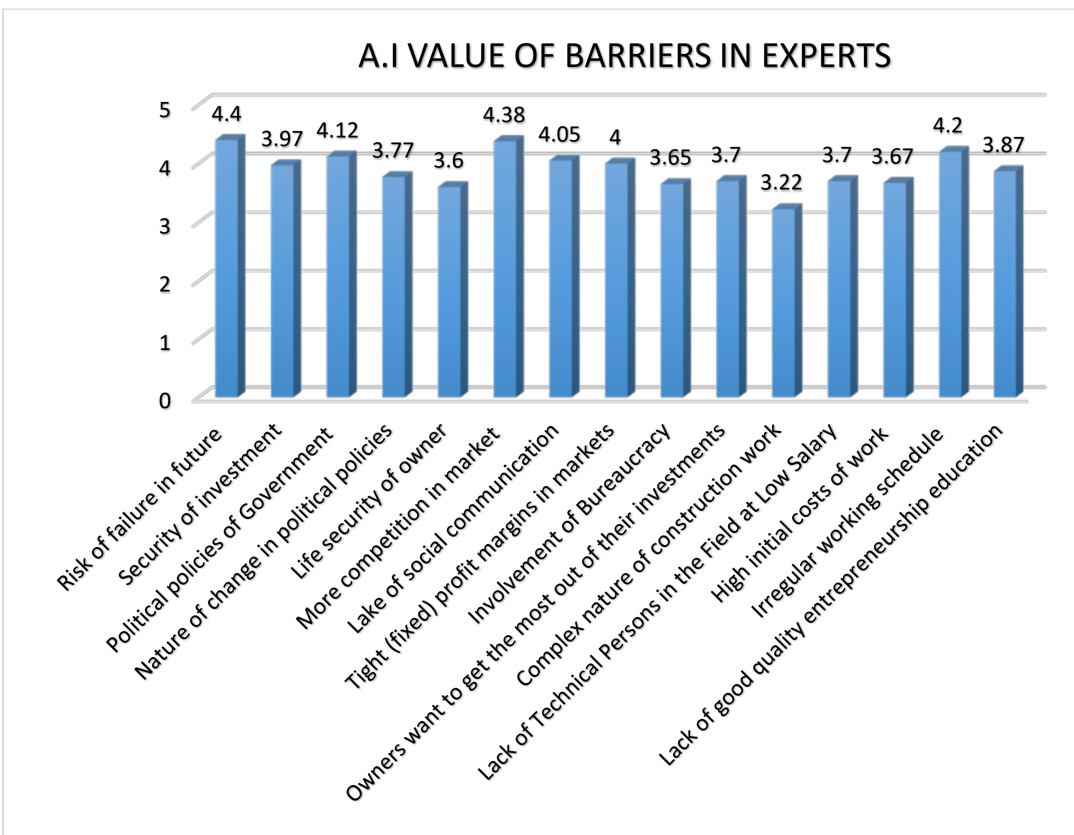

Figure: 3a. Average index (A.I) Values of Barriers Factors (In Experts Views)

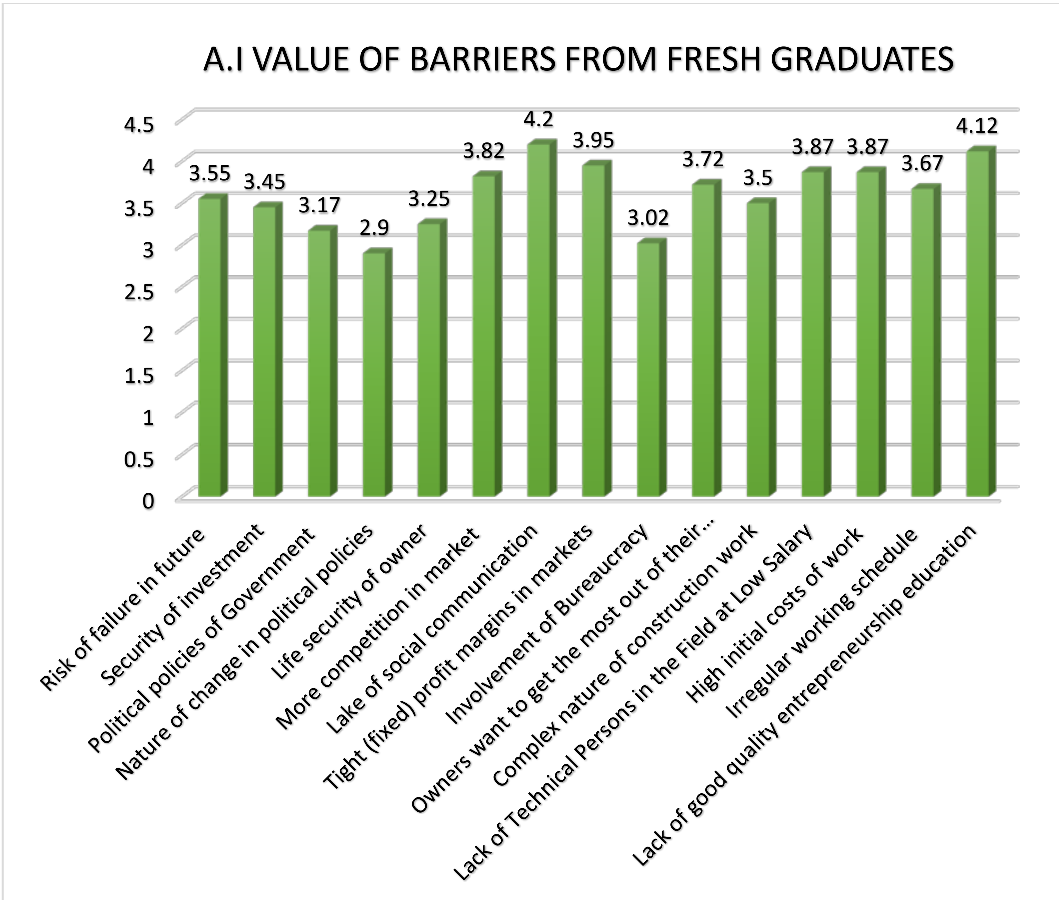

Figure: 3b. Average index (A.I) Values of Barriers Factors (In Fresh Graduates Views)

5. DISCUSSION

On the basis of average index the top three motives and top three barriers from experts and fresh graduates are as follows.

Table: 1. Top three factors (motive and barrier) of experts and fresh graduates.

FACTORS	RANK	EXPERTS VIEWS	FRESH GRADUATES VIEWS
TOP THREE MOTIVES	1	Financial resources of owner	Leadership skill in owner
	2	Collaboration of team	Communication skills in owner
	3	Communication skills in owner	Collaboration of team
TOP THREE BARRIERS	1	Risk of failure in future	Lake of social communication
	2	More competition in market	Lack of good quality entrepreneurship education
	3	Irregular working schedule	Tight (fixed) Profit margins in markets

4.1 Discussion on Motivating Factors

Motivating factors are the positive points which are required for a certain task to be successful. The study highlights the top three factors as critical factors of the study. Firstly talking about experts suggestion, the 1st ranked factors in the opinion of experts is “financial resources of the owner”, well the experts might have given it most priority because while working in the construction industry they might have experienced that finance is a major issue as construction projects require large amount of budget to carry out the business. The 2nd ranked factor is “collaboration of team”, because this is very difficult for a business owner to run a mega business separately without collaboration of his team. The 3rd ranked factor of the study is “communication skills”, because in order to run any business, its owner should have good potentials in terms of communication skills.

Moving to the results of the motivating factors by the fresh graduates, the research found that top 1st ranked factor is “leadership skill in owner”, the newly graduates are high spirited and believe in the leadership skill. As per fresh graduates opinion leadership skills are more important than finance. The 2nd ranked factor is "communication skills", which is 3rd by the experts so almost opinion of both categories is same here. The 3rd ranked factor is "collaboration of team" again the views of both the respondents are almost same.

4.2 Discussion on Barrier Factors

Barrier factors are the negative points or hurdles in the way of a task being successful. The results of the barriers were also divided in two parts i.e. the results by experts and the results by fresh graduates. Beginning with the ranking by experts the research found that 1st ranked factor is "risk of failure in future". The construction industry is full of risks as unlike manufacturing industry there are several issues of cost and time overrun, quality issues etc. The 2nd ranked factor is "more competition in market" which is very well understood by everyone that competition is really stressful. The owners of the firm wants to have maximum benefits but the main hurdles in it is high market competition. The 3rd ranked factor is "irregular working schedule". As construction works requires continues monitoring by the owner. So as per most of the experts this is one of the barrier that can cause hurdle to have their own construction business.

Now discussing the results by the fresh graduates, that 1st ranked factor is "Lack of social communication", as believed by the inexperienced people the key to success. The fresh graduates believe that this is most critical rather than the top ranked factor by the expert i.e. "risk of failure in future". Because it might be the reason that the fresh graduates have no any experience in the construction industry so they are not familiar with the risk of the industry. The 2nd ranked factor is "Lack of good quality entrepreneurship education" of course no person can start a new business on their own without enough guidance and the fresh graduates without experience and without good guidance related to business find it as a great hurdle. The 3rd ranked factor is "Tight (fixed) profit margins in markets". This factor can be considered by the graduates as a challenge because fixed rates might prove to be really unbeneficial for them in their newly setup business.

6. CONCLUSION & FUTURE RECOMMENDATIONS

The disease of unemployment is wide spreading in the world and especially in the developing countries like Pakistan. The government of Pakistan has taken many measures to reduce the rate of unemployment in the country and no doubt the rate dropped down in the last few years but still there are several unemployed people out there who are way much talented but don't get the opportunity to expose that talent and specifically talking about the sector of construction industry. The opportunities could be provided by introducing strategies to start up new constructional business so that efficient employment could be conducted. The purpose of this study is to point out the main motivating factors in starting of a new constructional business and also to point out the main barriers which prove to be the hurdles in the way of the startup of a constructional business on your own. The study highlights the motives and barriers from the literature and from unstructured interview with the experts the data was collected through a designed questionnaire. The targeted respondents were selected in two major categories i.e. Field Experts and Fresh graduates. The data was analyzed in SPSS and the results were discussed in the light of Field experts and Fresh graduate's opinion. However the study is only limited to motives and barriers factors from literature and views of related experts in construction industry of Pakistan. The results are purely based upon the choice of expert's opinion about the construction industry business.

The authors suggest to enhance the study further. The top ranked factors can be compared with the previous studies available in different regions of world. There can be a descriptive research in order to know the motives and barriers of construction industry business with any other business like Manufacturing Industry etc. The determined factors can again be discussed with experts and business personnel to know their suggestions in order to reduce the barriers and to increase the attention of new business owner to participate in construction industry. The study is helpful to enhance the construction business globally.

7. ACKNOWLEDGMENT

Firstly the author would like to express her heartiest gratitude towards ALLAH ALMIGHTY, without His help certainly nothing is possible. Author would also like to thanks all the respected teachers and friends for their help during research. The author is thankful to Mr. YASEEN MEMON for his continues guidance during the work.

8. REFERENCES

1. A.H. Memon et al. (2013), "The Way Forward in Sustainable Construction: Issues and Challenges. International Journal of Advances in Applied Sciences. 2(1): p. 15-24.
2. Christian M. Rogerson (2000), "The Waste Sector and Informal Entrepreneurship in Developing World Cities", URBAN FORUM.

3. C. Mirjam van Praag (2001), “Business Survival and Success of Young Small Business Owners”, Economic Faculty University of Amsterdam Roetersstraat 11, 1018 WB Amsterdam the Netherlands. Small Business Economics 21: 1–17, 2003.
4. en.wikipedia.org/wiki/List_of_Asian_countries_by_population
5. F. Michael. Et al. (2002), “The Role of Strategy, process, Entrepreneurial orientation and Environment”. Psychological success factors of small scale businesses in Namibia. Business Premium Collection. pg. 259, Journal of Developmental Entrepreneurship.
6. Gavin Cassar (2000), “The financing of business start-ups”. Journal of Business Venturing 19 (2004) 261–283.
7. Gibb, A (2004). “Effective policies for small business. A guide for the policy review process and strategic plans for micro, small and medium enterprise development”. Paris, France: OECD/UNIDO.
8. Henry Mwanaki Alinaitwe (2009). “Prioritizing Lean Construction Barriers in Uganda's Construction Industry”, Journal of Construction in Developing Countries, Vol. 14, No. 1, 2009.
9. Johanna Gast et al. (2017). “Doing business in a green way: A systematic review of the ecological sustainability entrepreneurship literature and future research directions”. Journal of Cleaner Production (Received in revised form 9 January 2017, Accepted 11 January 2017).
10. Jose Antonio Porfirio et al. (2016). “Entrepreneurship in different contexts in cultural and creative industries”. Journal of Business Research (Received in revised form 1 March 2016, Accepted 1 April 2016).
11. Lars-Erik Gadde and Anna Dubois (2010). “Partnering in the construction industry - Problems and opportunities”. Journal of Purchasing & Supply Management 16, 254–263.
12. Larson, E (1995), “Project partnering: results from a study of 280 construction projects”. Journal of Management in Engineering 11 (2), 30–35.
13. Magnus Lofstrom et al. (2014) “Why are some people more likely to become small-businesses owners than others: Entrepreneurship entry and industry-specific barriers. Journal of Business Venturing 29 [2014] 232–251.
14. Markus Larsson (2012). “Environmental Entrepreneurship in Organic Agriculture in Järna, Sweden”, Journal of Sustainable Agriculture, 36:2, 153-179, DOI: 10.1080/10440046.2011.620225.
15. Nader Abdul-Hadi Et al. “Prioritizing barriers to successful business process re-engineering (BPR) efforts in Saudi Arabian construction industry”, Construction Management and Economics [March 2005] 23, 305–315.
16. Robinson S. & Stubberud H. A. (2014). “Teaching creativity, team work and other soft skills for entrepreneurship”. Journal of Entrepreneurship Education, 17,186–197.
17. Sandra L. Fielden et al. (2000), “Barriers encountered during micro and small business start-up in North-West England”, Journal of Small Business and Enterprise Development.
18. Shane, S.A. (2003) “A General Theory of Entrepreneurship: The Individual-Opportunity Nexus”. Edward Elgar, Cheltenham [2003].
19. Siti Fahazarina Hazudin et al. (2015) “Discovering Small Business Startup Motives, Success Factors and Barriers: A Gender Analysis”. INTERNATIONAL ACCOUNTING AND BUSINESS CONFERENCE 2015, IABC.
20. Virgilio Faillaa Et al. (2017). “Entrepreneurship and employment stability — Job matching, labour market value, and personal commitment”. Journal of Business Venturing (Received in revised form 2 January 2017, Accepted 4 January 2017).
21. www.thenews.com.pk/print/16028-construction-sector-expected-to-grow-in-2015.
22. www.tradingeconomics.com/pakistan/unemployment-rate

STATISTICAL PROCESS CONTROL USING SIX SIGMA

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Abstract: Six Sigma for process improvement is an emerging topic among many academics and researchers over the past two decades. Very few studies have been reported about the successful applications of Six Sigma in Steel industries. The purpose of this project is to provide an analysis of Six Sigma implementation in Steel industries. This project illustrating the effective use of Six Sigma to reduce variations and improve the quantity of the output for the selected grade of steel taking the process capability into consideration and there is a need for the process optimization. It describes in detail how the project was selected and how the Six Sigma methodology was applied. It also shows how various tools and techniques within the Six Sigma methodology have been employed to achieve substantial benefits diffusing Innovate phase into the conventional DMAIC.

1. Introduction

Industries in KPK do not focus on process performance and quality issues as it is considered that much capital is needed to perform this study. Increase in process performance reduces the scrap rate of the process. Process performance study allow us to earns higher profit margins for the organization in long runs. Project is aimed to enhance the process performance of a selected steel bar manufacturing process by six sigma DMIAC. Increase in performance and decrease in process variation lead to defect reduction.

FF STEEL Ltd is located in Peshawar Hayatabad Industrial State Peshawar. Recently it is the largest and fastest re-rolling mill in Pakistan in terms of Rolling speed and production Quantity. Steel Industry concentrate on customer satisfaction and keep Quality level high by the purchasing the Raw material which is in the form of billets from Pakistan Steel Mills (PSM) they have installed in house material testing laboratory where product is checked regularly. FF Steel has own the Enercon Award for being the most energy efficient company in Pakistan. Now days their goal is to produce Grade 60 and Grade 75 steel bars in 2007 the company became first steel mill in Pakistan produce steel bars as per ASTM 706. It is the only mill in Pakistan which is licensed by Pakistan Standards and Quality Control Authority(PSQCA), Govt. of Pakistan to produce ASTM 706 steel bars.

2.Problem statement

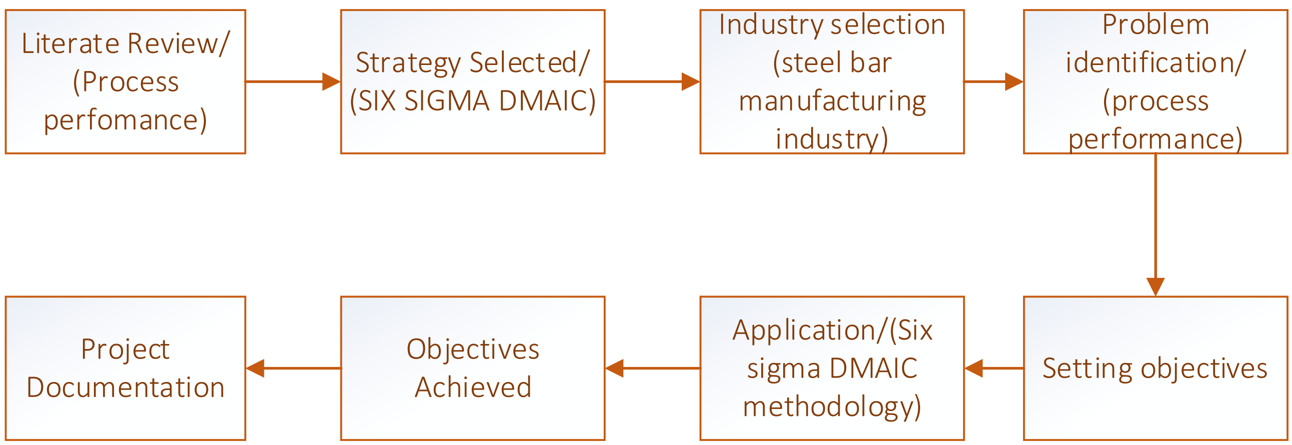
The problem which we are facing in industry is the large amount of waste material is produced in different areas of industry and the waste is in the form of product which is finished and have defects and the raw material which is more than its requirement, so our project is to minimize the waste and to improve quality.

DMAIC Methodology:
This methodology consists of the following five steps.
Define --> Measure --> Analyze --> Improve -->Control
Define: Define the problem or project goal that needs to be addressed.

Measure: Measure the problem and process from which it was produced.
Analyze: Analyze data and process to determine root causes of defects and opportunities.
Improve: Improve the process by finding solutions to fix, diminish, and prevent future problems.
Control: Implement, control, and sustain the improvements solutions to keep the process on the new course.
which allow us to Generates sustained success
Sets a performance goal for everyone
Accelerates the rate of improvement

3. Figures and tables

1)Methodology



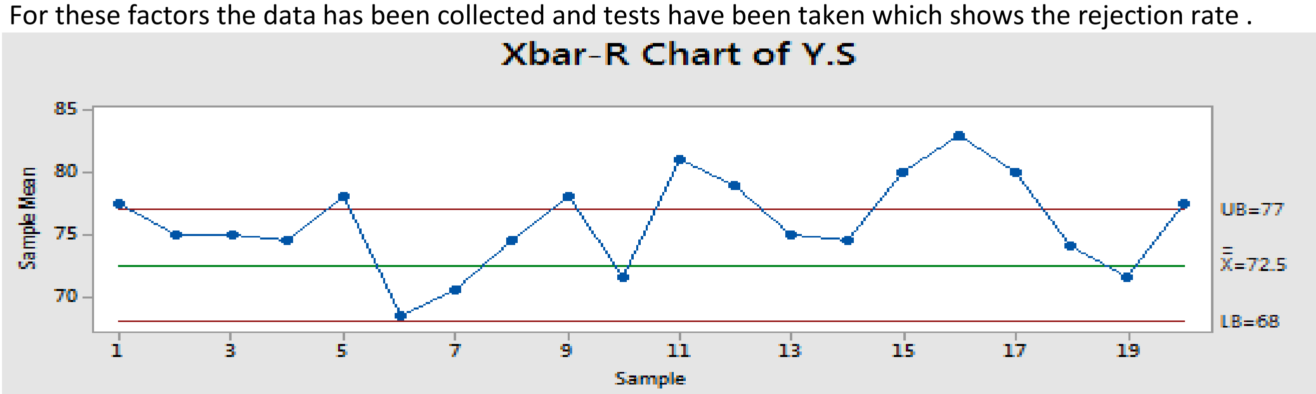
Figure, 1 Flow chart.

2)Control chart

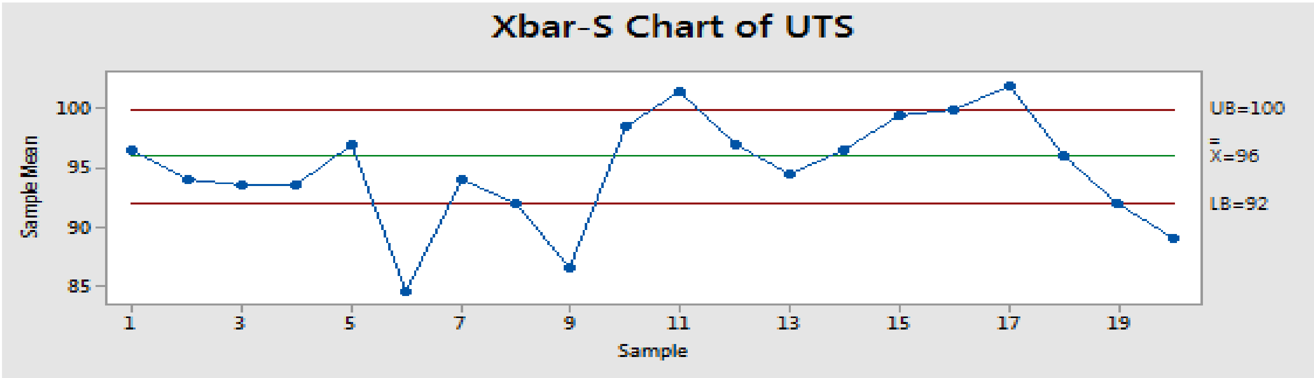
The factors affecting the efficiency of steel bar manufacturing process are identified are as follows,

- Temperature of heating furnace
- Cutting blades
- Material composition
- Water pressure

For these factors the data has been collected and tests have been taken which shows the rejection rate .



Figure, 2 Yield Strength.



Figure, 4 Ultimate Tensile Strength.

4. References

1)Pyzdek T, Keller PA (2009), —The Six Sigma handbook‖, 3rd Edition McGraw-Hill, New York
2) Prof. Dr. Vidosav Majstorović 1, M.Sc. Tatjana Sibalija 1, —Application of Six Sigma Methodology in Serbian Industry(2015)
3) Craigh Gygi, Neil DeCarlo, Bruce Williams (2005), —Six Sigma for Dummies‖, published by Wiley publishing Inc., Indiana police, Indiana
4) Kunal Ganguly, (2012) —Improvement Process for Rolling Mill through the DMAIC Six Sigma Approach‖, International Journal for Quality Research Vol 6, No. 3, pp 221-231
5) Joshua Chan Ren Jie, Shahrul Kamaruddin and Ishak Abd Azid (2014), —Implementing the Lean Six Sigma Framework in a Small Medium Enterprise (SME) – A Case Study in a Printing Company‖, Proceedings of the 2014 International Conference on Industrial Engineering and Operations Management Bali, Indonesia, January 7 – 9, 2014, pp 387-396
6)Hsiang-Chin Hung and Ming-Hsien Sung, (2011), —Applying Six Sigma to Manufacturing Processes in the Food Industry to Reduce Quality‖ Scientific Research and Essays Vol. 6(3), pp. 580-591
7)Dr. Rajeshkumar U. Sambhe, (2012), —Six Sigma Practice for Quality Improvement – A Case Study of Indian Auto Ancillary Unit‖, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) ISSN: 2278-1684 Volume 4, Issue 4 (Nov-Dec. 2012), PP 26-42

Environmental sustainability analysis of construction industry

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Abstract: Construction industry is one of the most fragmented industries. Its interdependence on other industrial sectors is very much high. Construction raw material sometimes may include toxic gases, material or dangerous activities. The usage of such materials disturbs not only the local eco system but might have affects globally. Around the globe sustainable construction is one of the key term associated with lean construction and green construction. In Pakistan environmental aspect of the construction is rarely studied. This paper will focus on the environmental sustainability of the construction industry.

1. INTRODUCTION

Sustainability is an ability or capacity of something to be maintained or sustain itself. The word Sustainability was first used in 1972 in British book by Charles V. Kidd (Butlin, J. 1989). The term sustainable development can be described as enhancing quality of life and it allowing people to live in a healthy environment. Sustainability is a very broader term. Environmental protection is an important issue throughout the world. Construction industry is a main source of environmental pollution (Goodland, R. 1995).

There are many organizations in Pakistan working on sustainability, e.g. Healthy Building Network, U.S. Green Building Council, World Green Building Council etc., but still there is no policy for the sustainable construction. So Pakistan needs to devise a policy for sustainable construction. Even the United Nation have announced that it will focus on sustainable development in coming years (United Nations, 2016).

Constructions have a massive direct and indirect impact on environment. Construction process may include harmful gases, noise, dust, and solid, and liquid waste, which can cause different diseases. Objective of the project is to assess the construction industry. The other aims of this project are the following:

- Identify the factors that affect the sustainability in construction
- Finally identify the significant factors of environmental aspects

The research includes data collection and statistical analysis. It does not include any mathematical modeling or expert system development. It is general sustainability analysis for Pakistan construction industries, especially for KPK projects.

2. LITERRATURE REVIEW

Construction is the activity of building something or translation of design into reality (George Norman 1993). The design usually consists of drawing and specification, usually prepared by design team including architect, civil engineers, mechanical engineer, electrical engineers, and planning consultants etc.

According to National Association of Corrosion Engineers (NACE), Construction sector is divided into the following larger subsectors (Ugwu & Haupt 2007)

- Construction of buildings
- Civil engineering (Construction of roads and railways, construction of utility projects, construction of other civil engineering projects)
- Specialized construction activities (Demolition and site preparation, electrical, plumbing and other construction installation activities)

Every organization focuses on sustainability. Sustainability has been commonly defined as “*Economic and social development that meets the needs of the current generation without compromising the ability of future generations to meet their own needs*" Butlin, J. (1989).

The construction industry is involved in creating the physical assets which are the basis of virtually every aspect of development, and thus in the creation of much of the world's man made capital. But the industry, together with the building materials industries which supply it, is also one of the largest exploiters of natural resources, both mineral and biological. The activities cause irreversible transformations of the natural environment; and it adds to the accumulation of pollutants in the atmosphere. The construction industry thus contributes significantly to each of the areas of environmental stress (Spence, R., & Mulligan, H. (1995)).

Environment Sustainability Indicators (ESI), are made by Yale center with regard to Environmental Law as well as policy in 2005, ESI had been aimed to help in measurement as well as evaluation of environment effect for various geographies. ESI is developed being an index made of six policy categories that are further classified into 21 other primary factors totaling in order to 68 indicators which means that the ESI value calculated for any country or region may be the average of 68 indicators within 21 elements. (De Sherbinin, A. (2005)).

International Standard organization (ISO), International standard organization developed a typical namely ISO 14031 that directed companies to build up and maintain their very own indicator set for that measurement of environmental performance when it comes to sustainability. The annexure from the ISO 14031 classified manufacturing into 3 main classes' i.e. operational performance from the firm, performance of management and finally environmental conditional with regard to manufacturing. (Rodríguez-López, F. (2010)).

Table 1 categories the environmental indicators identifies via literature review. The indicators are sub classified as well. Non renewable and non recyclable materials are very much common in construction environment. So is the use of substandard fuel and other pollution oriented energy processes.

Table 1 Environmental indicators related to construction industry

	Indicators	Sub-indicators
Environmental factors	Materials	Nonrenewable material used in construction
		Does your industry include any recyclable processes
	Energy	Satisfaction of Resource utilization (Water, Fuel Land).
		Energy from recycled materials is used for construction processes
	Emissions	Emissions during the construction
		Air Pollution by dust during construction
	Effluents and Waste	Waste/ ton is produced by construction processes
		Impact of waste on environment
		Hazardous wastes generated on environment.
	Environmental Grievance Mechanisms	Total number of grievances resolved about environmental impacts
		People effected in last six month by construction process
	Soil	Process contribution to Soil pollution.
		Construction processes results land degradation
	Water	Effect of planned water discharges on environment
	Transport	How much transporting products, material and other goods effect environment?
		Impact level of construction processes on wild life?

Table 1 shows the sustainability breakdown structure. The pillar are further classified into factors, e.g. The environmental factors are soil, water, atmosphere, resources, and energy etc. Pareto principle, which states that 80% of problems come from 20% of causes, 80% of sustainability goals can be achieved with 20% of indicators or factors of sustainability identified with the proposed methodology (Akhtar, R., &Haq, I. U. (2015)).

3. METHODOLOGY

Worldwide construction industry contributes to 9 % of country's GDP whereas in Pakistan it is around 2.4 %. Recently United Nation dedicated the coming years for sustainable development. With so much gap in GDP percentage the sustainability analysis of Pakistan construction industry is necessary to evaluate and assess the different factors associated with the construction industry and identify the weak areas. Figure 1 shows the general methodology adopted to evaluate and assess the environmental sustainability gap.

A comprehensive literature review lead to indicators and sub-indicators. The indicators were verified and discussed with construction practioners and academic experts. A questionnaire was designed targeting the identified indicators along with their sub-indicators. A pilot study was conducted and the errors were removed and adjustable suggestions were incorporated in the final questionnaire. The questionnaire was then shared with around 70 top contractors of KPK. The list was taken from Pakistan Engineering Council (PEC). Upon receiving 40 questionnaires, the incomplete ones were discarded. So a total of 30 responses were analyzed with the measures of central tendency.

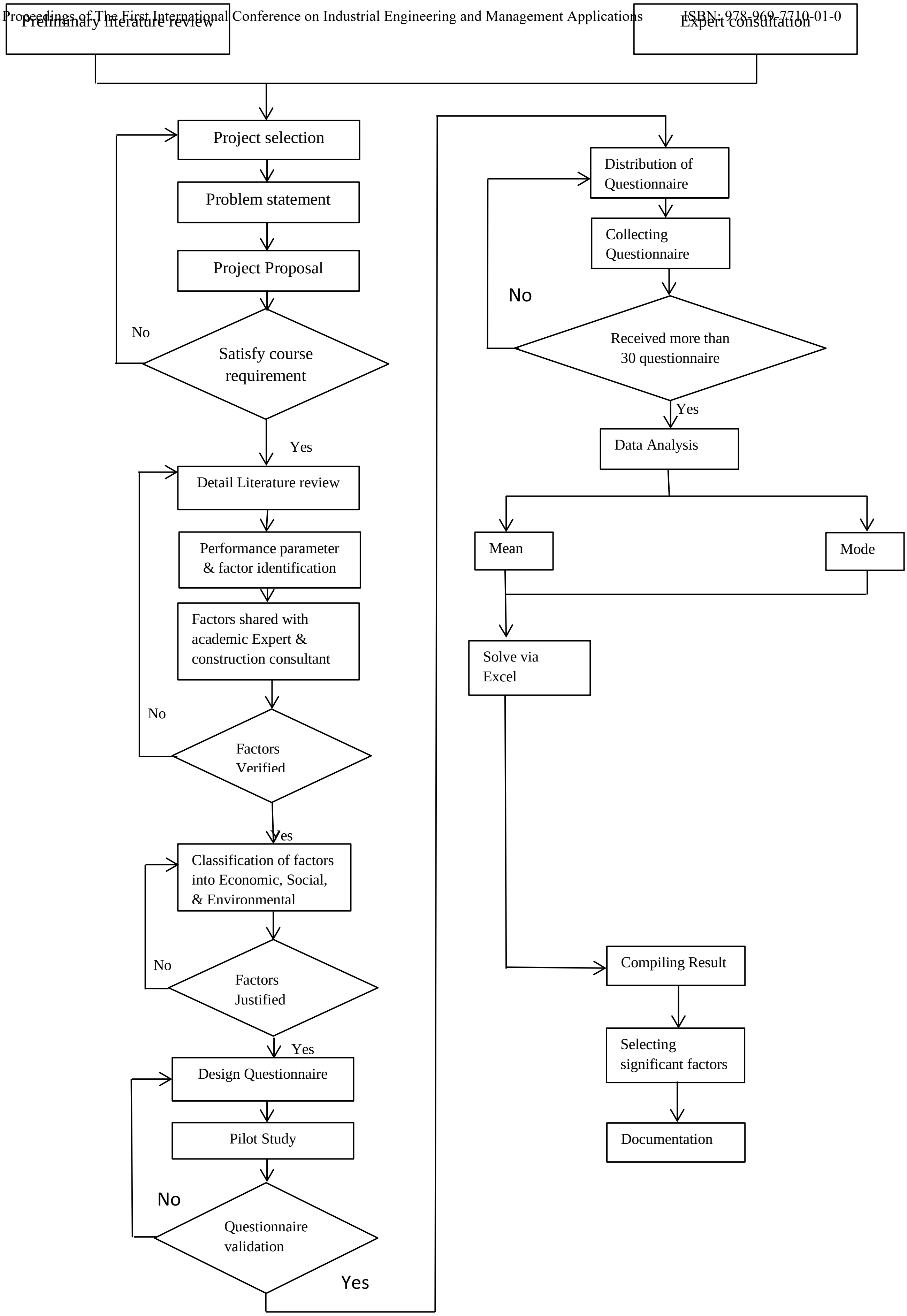

Figure 1. Methodology flow chart

Literature review highlights the issue of availability of valid data related Pakistan construction industry. A questionnaire was designed which is divided in to three sections;

- The first section contained information about the respondent profiles.
- The second section contained the company and organization information.
- The third section contained series of questions related to environmental sustainability indicators. These questions were given weights based on scale from 0 to 5 (highest). As shown in Table 2.

Table 2 sixteen different questions

S.NO	INDICATORS	Very High (5)	High (4)	Moderate (3)	Low (2)	Very Low (1)	N/A (0)
1	Hazardous wastes generated in environment.						
2	Impact level of construction processes on wild life?						
3	How much waste is produced by construction processes?						
4	How much impact of waste on environment?						
5	How much transporting products, material and other goods effect environment?						
6	Emissions during the construction?						
7	Number of grievances/complaints resolved about environmental impacts?						
8	People effected in last six month by construction process?						
9	Effect of planned water discharges on environment?						
10	How much energy from recycled materials is used for construction processes?						
11	Does your industry include any recyclable processes?						
12	Air Pollution by dust during construction?						
13	Do construction processes result land degradation?						
14	Nonrenewable material used in construction?						
15	Process contribution to Soil pollution.						
16	Satisfaction of Resource utilization (Water, Fuel Land).						

Sample or prototype survey are necessary to involve participants and tries to conduct survey in a more efficient way. To increase number of responses the questions are designed in such a way that the participants interest increases in the survey. To avoid any potential conflicts in data collection and after carefully considering the different angles of the research theme, only Pakistan constructions industries were considered for the survey.

The data was collected by distributing the questionnaire. In distribution process questionnaire was sent to different industries either by post or by mail and some questionnaire was distributed by hand.

In the item analysis an indicator named as Cronbach's Alpha is used for validation process. Data will be valid if Cronbach's Alpha is equal to or greater than 0.7 otherwise data will not be valid (Akhtar, R., &Haq, I. U. (2015)).

Minitab software was used to check the environmental data validity. As shown in Table 3. C2, C3…C31 represents 30 different responses. After conducting an item analysis, overall Cronbach's Alpha value is calculated which is greater than 0.7, so data collected is accepted and validated.

Table 4 (Item Analysis for Environmental factor)

Cronbach's Alpha = 0.9475					
Omitted item statistics					
Omitted Variable	Adj. Total Mean	Adj. Total st Dev	Item-Adj. Total corr	Squared Multiple Corr	Cronbach's Alpha
C2	69.19	22.72	0.776598	*	0.943956
C3	69	22.7	0.788184	*	0.943826
C4	68.88	22.77	0.758299	*	0.944181
C5	69.44	23	0.438387	*	0.948107
C6	68.94	22.82	0.681451	*	0.944936
C7	69.63	23.19	0.460866	*	0.947064
C8	69.44	23.34	0.349485	*	0.948038
C9	69.13	22.76	0.749869	*	0.944243
C10	68.94	23.69	0.01941	*	0.953462
C11	69.19	22.72	0.776598	*	0.943956
C12	69.94	23.86	-0.11143	*	0.950553
C13	70.44	23.16	0.693619	*	0.945399
C14	70.44	23.46	0.347006	*	0.947718
C15	70.19	23.62	0.157882	*	0.949066
C16	70.06	23.7	0.101984	*	0.949033
C17	69	22.28	0.896889	*	0.942268
C18	69.25	22.36	0.805086	*	0.943482
C19	69.13	22.5	0.855871	*	0.942942
C20	69.38	22.4	0.792224	*	0.943642
C21	70.31	23.92	-0.14987	*	0.951819
C22	69.13	22.54	0.776674	*	0.943826
C23	69.81	23.37	0.309513	*	0.948448
C24	69.25	22.77	0.832663	*	0.94363
C25	69.44	22.86	0.89096	*	0.943578
C26	69.44	22.94	0.874219	*	0.943922
C27	69.69	23.07	0.951448	*	0.944261
C28	69.63	22.98	0.94018	*	0.94386
C29	69.38	22.88	0.87473	*	0.943701
C30	69.19	22.97	0.742683	*	0.944664
C31	69.56	22.91	0.922981	*	0.943623

3 DATA COLLECTION

The data is collected for the research objective through the designed questionnaire as shown in Table 2.. The respondents completed the questionnaire at their own convenience.

In comparison of cost, time, and response rate among the various modes of data collection; we concluded that questionnaire is good mode of data collection having minimum cost and high response rate compared to other modes like interview, direct observation etc. And the data collected through questionnaire is simple and can easily be analyzed. In Pakistan, different construction industries, consultants and contractors that were surveyed for data collection for the research project. The list of companies is shown in table 5.

Table 5 List of Companies

Company Name	Address	Type of Industry
Habib-Rafiq (PVT Ltd)	Bahria Town Ph-7 Rawalpindi	Construction & Consultant
Five Ways Builders	7-wahid Market Old Shujabad Road Multan	Contractor & Construction
Tameer Associates Builders and Civil Contractors	UBL Bank Road, Sadder Rawalpindi	Contractor & Construction
Gul Haider & Sons Company	House No 09, St-No 29 F10/1 Islamabad	Contractor & construction
Shah Zaman PVT Ltd	Near PWD Office G-9 Islamabad	Construction
Masood Enterprises	Suit # 8 Shawez Center F8 Markaz Islamabad	Construction
Pro-Belt Construction Company	Phase 2 Near Defense Residency Islamabad	Construction

Anwar Construction Company	P/O Chorlaki, Tehsil & Distt; Kohat	Construction
Muhammad Khel Construction Company	Moh-ShinwariMaidan Chowk Jungle Khel Kohat	Construction
Frontier Work Organization	Moh- Khaliq ShinwariShrewilla Kohat	Construction
Qavi Engineers(PVT) Ltd	Basharat Plaza 1-9/4 Islamabad	Contractor
Khwaja and Company	H-No151, St No, 01 Model Village ChakShahzad Islamabad	Contractor
Khattak Allied	Moh-Seydan Jungle Khel Kohat	Contractor
Alpha Engineer's	GPO Road, Sadder Rawalpindi	Consultant
Allied Engineering Consultant	Near Old Emergency Airport Distt; Tank	Consultant
EA Construction Company	113, Silver Oaks Sector No F-10/4 Islamabad	Consultant

These companies, consultants and contractors are selected because these are the best due to their reputation and most of the government projects are done by them. In these companies questionnaires were sent through mail and in some cases by hand.

After questionnaire design, around 70 questionnaires were distributed with different respondents. 60 questionnaires were sent through Post in which 40 were received. Of these 40, 10 were rejected because of their response was incomplete. 10 questionnaires were shared by hand being discussed in meetings. Of these 10, 5 were completed and 5 were left due to their business schedule. The Figure 2, with the help of pie chart graphically summarizes the responses from different organizations.

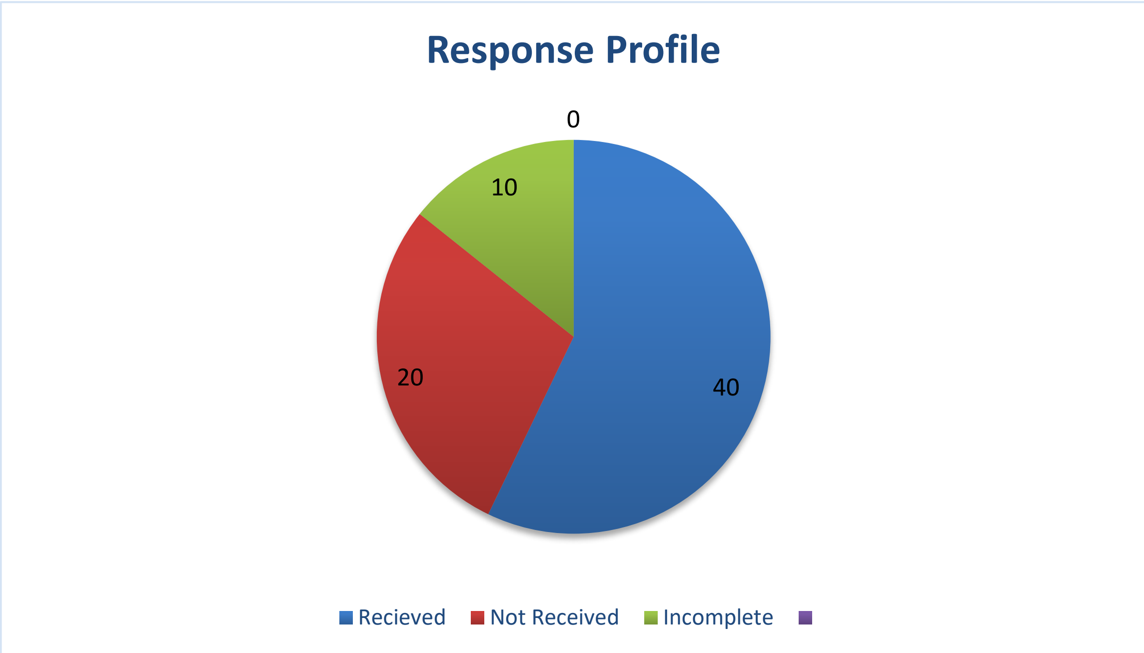

Figure 2 Statistics of Distributed Questionnaire

There are 16 factors and its representation is shown in Table 1 & 2. Table 6 shows the data being collected for environmental factors. Each respondent gives weight age based on his experience. A total of 30 responses are shown in table below.

Table 6 Questionnaire Data for Environmental Factors

S.N	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28	C29	C30
1	3	4	4	3	4	3	3	3	3	3	1	2	2	2	2	5	4	4	5	1	4	3	3	4	3	3	3	4	4	3
2	3	3	3	4	3	3	4	3	4	3	1	2	1	1	1	2	2	4	5	1	3	2	2	2	3	2	2	2	3	3
3	0	0	0	5	0	4	4	0	5	0	2	2	2	2	2	0	0	0	0	3	0	2	1	1	1	1	1	1	2	1
4	3	3	3	3	3	2	2	3	3	3	2	1	1	2	1	3	4	3	3	2	3	4	2	2	4	2	2	2	3	3

5	5	4	4	4	4	3	3	5	4	5	2	2	2	2	2	4	4	4	3	0	3	1	3	4	3	3	3	4	3	3
6	2	3	3	1	3	2	2	3	1	2	1	1	0	1	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	1
7	0	0	0	0	0	0	0	0	5	0	3	0	2	3	3	0	0	0	1	2	0	3	1	1	1	1	1	1	1	1
8	2	2	3	2	2	3	3	2	3	2	3	2	2	2	2	2	0	1	2	2	2	2	3	2	2	2	2	2	2	2
9	4	4	4	3	4	2	2	4	3	4	3	3	2	1	2	4	3	3	3	2	3	3	3	3	3	3	3	3	3	3
10	2	2	3	1	2	1	2	2	1	2	2	0	0	0	2	3	3	3	1	3	4	0	2	2	2	2	2	2	2	2
11	3	3	3	0	4	1	2	3	0	3	1	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1
12	3	4	4	3	4	3	3	3	5	3	1	2	1	2	2	4	5	4	4	0	4	3	4	3	3	3	3	3	3	3
13	4	4	4	5	4	4	4	4	3	4	1	2	1	1	1	4	4	4	4	2	3	3	4	3	3	3	3	4	4	3
14	2	2	2	3	2	2	2	2	5	2	3	1	2	3	2	3	4	3	0	0	4	0	2	3	2	2	2	3	2	2
15	3	4	4	0	4	0	0	3	0	3	2	1	2	2	2	4	3	4	3	2	4	3	4	2	2	2	2	3	5	2
16	4	4	4	2	4	3	3	4	2	4	3	2	3	3	3	5	4	4	4	3	5	2	5	4	4	3	4	3	3	4

4 .DATA ANALYSIS

The data collected is analyzed via mean and mode and are ranked in descending order in Table 7 and 8 respectively. Mean is calculated via eq (1).

$$Mean = \frac{\sum(Data\ in\ a\ column)}{Total\ number\ of\ elements\ in\ that\ column} \quad (1)$$

Table 7 Ranking of Environmental Factors based on Mean

Rank	Environmental Factors	Mean
1	Satisfaction of Resource utilization (Water, Fuel Land).	3.50
2	Do construction processes result land degradation?	3.23
3	How much transporting products, material and other goods effect environment?	3.20
4	Hazardous wastes generated in environment.	3.17
5	Air Pollution by dust during construction?	3.07
6	Effect of planned water discharges on environment?	3.00
7	Impact level of construction processes on wild life?	2.57
8	How much impact of waste on environment?	2.57
9	Process contribution to Soil pollution.	2.50
10	Nonrenewable material used in construction?	2.23
11	People effected in last six month by construction process?	2.10
12	Emissions during the construction?	1.90
13	How much energy from recycled materials is used for construction processes?	1.83
14	How much waste is produced by construction processes?	1.40
15	Does your industry include any recyclable processes?	1.07
16	Number of grievances/complaints resolved about environmental impacts?	1.00

The above table 7 shows the factors in descending order, that affect the environment. Here the factor satisfaction of resource utilization got the maximum importance with mean of 3.50 following by the land degradation with mean value 3.23, and the number of complaints with a mean of 1 is the lowest rank factor.

One of the other important measure is to rank the factors on the basis of mode. Those values are selected which gets highest repetition in a collected data. The environmental factors analysis based on mode are shown in Table 8. The factors are sorted from highest to lowest mode with transportation, land degradation, and resource utilization are ranked at the top where as waste produced, complaints, and recyable processes are ranked at the lowest.

Table 8 Ranking of Factors affecting Environment based on Mode

Rank	Environmental factors	Mode
1	How much transporting products, material and other goods effect environment?	4
2	Do construction processes result land degradation?	4
3	Satisfaction of Resource utilization (Water, Fuel Land).	4

4	Hazardous wastes generated in environment.	3
5	Impact level of construction processes on wild life?	3
6	How much impact of waste on environment?	3
7	Effect of planned water discharges on environment?	3
8	Air Pollution by dust during construction?	3
9	Emissions during the construction?	2
10	People effected in last six month by construction process?	2
11	How much energy from recycled materials is used for construction processes?	2
12	Nonrenewable material used in construction?	2
13	Process contribution to Soil pollution.	2
14	How much waste is produced by construction processes?	0
15	Number of grievances/complaints resolved about environmental impacts?	0
16	Does your industry include any recyclable processes?	0

5 RESULTS AND DISCUSSIONS

Figure 3 summarizes the overall results. Each factor is plotted with respect to mean as well as mode. The factors which are lowest are plotted at the top where as the significant factors as per the respondents are plotted at the bottom.
General public also have limited interest in lodging complaints regarding environmental pollutions. The contractors and practioners for own suitability can use any process irrespective of the pollutants attached to it. Moreover most of the construction practioners both private and government organizations have any number related to the waste produced.

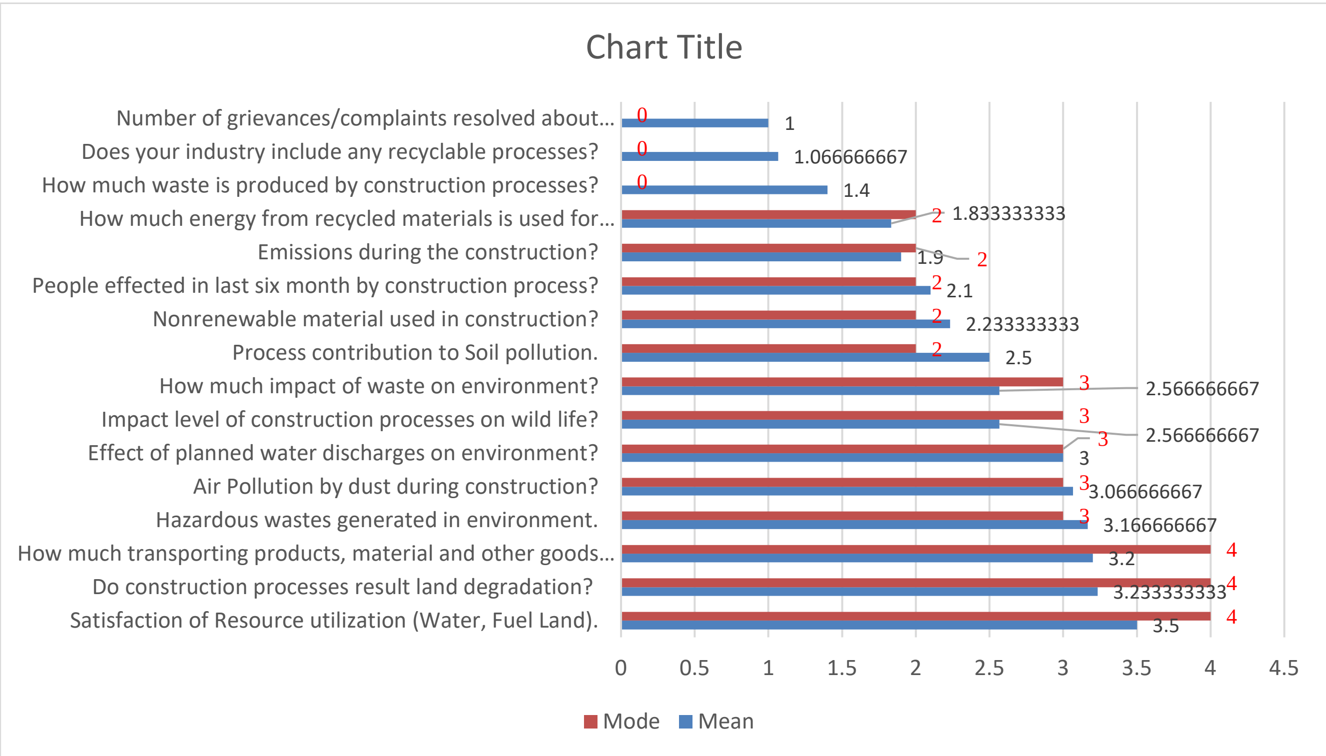

Figure 3 Ranking of Environmental Factors Based on Mean & Mode

The factor satisfaction of resources utilization is highly significant factor with a mean value of 3.5 and mode 4. The practioners are very much satisfied with the utilization of resources including raw material, land, water, and electric power etc. Land degradation is second significant factor with the mean value of 3.23 and mode 4 is the second most significant factor. It is viewed as any change or disturbance to the land perceived to be deleterious or undesirable. The soil degradation is caused primarily by overgrazing, agricultural activities, deforestation, and overexploitation of land to produce fuel wood, and industrialization. Transport product and other goods have also significant impact on environment with the mean value of 3.20 and mode 4. The products like Bricks, Sand, and also the employees are considered in this group who are carried from one station to another.

With a mean value of 3.16 and mode 3, the hazardous wastes is the fourth most significant factor. These are the wastes which badly affects people, animals, plants, and atmosphere. Hazardous. Air pollution with a mean value of 3.07 and mode 3 is the fifth most significant factor. Construction machines are mostly diesel driven which is the major cause of air pollution. Secondly dust is very much common in construction projects. Good project managers plan water discharge for rain water and waste water in a proper way. As per the respondent's little consideration is given to this factors which effects not only the project performance but also the eco system.

Construction projects, whether commercial developments, housing estates, infrastructure or public-sector projects, all have the potential to damage natural habitats, threatening wildlife and plant species. Construction waste including fuel waste and tar coal waste and materials have harmful impact on the environment. Soil contamination or soil pollution as part of land degradation is caused by the presence of human-made chemicals or other alteration in the natural soil environment. It is typically caused by construction industrial activity, agricultural chemicals, or improper disposal of waste.

Contractors are usually least bothered by the quantity and type of emissions and renewable materials. No activity/process has been reported regarding renewable material and emission control. Recycle products are very much ignored in construction environment. Although the waste generated is very much high but contractors usually discard them instead of utilizing it somewhere else.

6 CONCLUSIONS

Although identifying and ranking the indicators does not protect the environment but it leads to the discussion of how to safeguard the environmental interests. The regulatory authorities should first focus on educating public, workers and construction practioners. A contractor alone cannot improve the sustainability. Environment protection should be the aim of every citizen.

In order to compete with the international market, construction should be sustainable in all aspects. Finding the significant factors which contributes in overall sustainability of any construction industry becomes important. These factors have been found on the basis of environmental fronts which is the main pillar of sustainability.

The overall conclusions are the following:

- Data have been collected via questionnaire. A comprehensive questionnaire originated on the basis of guidelines selected from literature review and through consulting academicians.
- The significant factors are identified, which are contributing to the overall sustainability. Government and industrialists must take proper care of these factors in order to improve sustainability.
- So in order to make these industries sustainable they must be focus on the significant factors that are identified in this research paper.

7 REFERENCES

1. Butlin, J. (1989). Our common future. By World commission on environment and development.(London, Oxford University Press, 1987, pp. 383£ 5.95.)
2. Behm, M. (2008). Construction sector. Journal of safety research, 39(2), 175-178.
3. Esty, D. C., Levy, M., Srebotnjak, T., & De Sherbinin, A. (2005). Environmental sustainability index: benchmarking national environmental stewardship. *New Haven: Yale Center for Environmental Law & Policy*, 47-60.
4. Fernández-Sánchez, G., & Rodríguez-López, F. (2010). A methodology to identify sustainability indicators in construction project management—Application to infrastructure projects in Spain. *Ecological Indicators*, *10*(6), 1193-1201.
5. Flanagan, Roger, and George Norman, 1993. Risk management and construction. Wiley-Blackwell.
6. Goodland, R. (1995). The concept of environmental sustainability. Annual review of ecology and systematics, pg. 1-24.
7. Omair, M., Noor, S., Hussain, I., Maqsood, S., Khattak, S. B., Akhtar, R., &Haq, I. U. (2015). Sustainable development tool for Khyber Pakhtunkhwa's dimension stone industry. *Technical journal, University of Engineering and Technology, Taxila*, *20*, 160-165.
8. Ortiz, Oscar, Francesc Castells, and Guido Sonnemann (2009). "Sustainability in the construction industry: A review of recent developments based on LCA". Construction and Building Materials 23.1 28-39.

9. Spence, R., & Mulligan, H. (1995). Sustainable development and the construction industry. *Habitat international*, *19*(3), 279-292.
10. Saaty, T.L (1980) the Analytic Hierarchy Process, New York: Mc Graw Hill. International, Translated to Russian, Portuguese, and Chinese, Revised editions, Paperback.
11. Ugwu, O. O., & Haupt, T. C. (2007). Key performance indicators and assessment methods for infrastructure sustainability—a South African construction industry perspective. Building and Environment, 42(2), 665-680.
12. United Nation (2016) , http://www.un.org/sustainabledevelopment/sustainable-development-goals/

Sustainable Buildings: A Review of World Sustainable Building Rating Tools and Status of Pakistani Buildings Sustainability

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Abstract: Housing unit is among the basic needs of human beings. In Pakistan all the people do not have homes. It is due to higher population growth rate than the housing construction rate, high inflation rate, low income and high poverty in the country. Construction of building needs energy, finance, materials and resources. In the long run to make these housing units more economical, environment friendly and beneficial to the society the concept of sustainability has to be adopted for building sector in Pakistan. Building sector is one of the big consumers of energy and green house gases emitter to the environment throughout its life cycle. In order to find the sustainability of the buildings some sort of ratings tool is required to be used. This paper discusses some prominent building rating tools of the world and the existing status of the sustainability in building sector of Pakistan.

Keywords: Building Sector, Sustainability, LEED, BREEAM, GBTool

1. Introduction

Pakistan is suffering from power, water shortages and environmental issues. The power and water is consumed by different sectors; like industries, agriculture, residential and commercial buildings etc. Peshawar and Rawalpindi cities are at 6th and 7th ranking respectively; according to the WHO's most polluted cities of the world (Wikipedia, WHO). Building sector is one of the big consumers of power, water and green house emitter to the environment throughout its life cycle. Buildings consume about 40% of all energy used in the United States and emit 40% of global CO2 to the environment (Azhar, Brown et al. 2009). To measure the performance of housing with respect ot environmental, economical and financial aspects of the buildings the concept of the sustainability is used. According to Brundtland's Commission sustainable development is one which meets the needs of the present without compromising the ability of future generations to meet their own needs (Glavič and Lukman 2007, Saunders 2008).

The impact of the industrial sectors, including the building sector on environment was recognized in the 1990s. Major changes were required to alleviate the environmental impact of building sector. The design, construction and operation of the building sector were focused. This was due to public policy and the growing market demand for environmental friendly products and services. When considering reducing environmental impact, an index for measuring environmental performance was required. The precise definition of the phrase "building performance" is difficult, since different actors in the building sector have different interests and requirements. Investors are mostly interested in economical performance of building, whereas the tenants are generally attracted by health and comfort related issues (Haapio and Viitaniemi 2008). In order to find the building performance different countries have developed different assessment tools. This paper highlights some of the prominent assessment tools for buildings in the following sections. Before discussing the assessment tools, some basic definitions are discussed.

2. Basics of Assessment Tools for Buildings

Some basic definitions have been defined by (Hamedani and Huber 2012): A ***Criterion*** is the main detail and specifications of required objectives. The ***Rating System*** shows the specific boundaries of classification, the assessment method (quantitative or qualitative) for the measurement of indicators. The important factor for the criterion, and the lower level of requirement should be carefully identified for the rating system. According to (Mitchell 2010), ***Building Codes*** is performance based rather than specifying what methods or material should be used. In order to get certain specific objectives and functional statements, it sets out performance requirements for building materials, components, design factors and construction methods. Building codes sets minimum technical requirements for building types. ***Neighbourhoods*** are the building blocks of cities, which have their own cultural, architectural, and economic systems. According to United Nation's 2011 report half of the world population lives in cities and this rate is growing every year by an average of 1.85% (Reith and Orova 2015). ***Indicator*** is a measurable and quantitative description of the criterion. An ***indicator*** is a sustainability-parameter measurement; it works as a tool for the quantification of a system requirement. The key characteristic of indicators is their capability to focus and sum up a complex issue into one measure (Singh, Murty et al. 2009). ***Municipal by-laws*** are basically public regulatory laws which pertain to a specific area. The by-law is made by a non-sovereign body, which takes its supremacy from another governing body, and can only be applied on a limited range of matters. It is a shape of delegated legislation (Wikipedia). A set of technical definitions, specifications and guidelines can be considered as a ***standard***. The standard works as instructions for designers, manufacturers, operators, or operator of equipment. A standard tells about the materials, process, designs, structure, etc. In short, standards tell how to perform something. A standard becomes a code when a standard has been adopted by governmental bodies and has the force of law. A ***code*** is a set of rules that experts in the field suggest people to pursue; it is a model. Though it is not a law, it can be converted into law. A code tells what requirements to be prepared, but it doesn't explain the working procedures. Some examples of Codes include International Building Code (pediaa).

Buildings are significant CO_2 emitters and add considerably to climate change. This dispute is derived from the environmental footprint of buildings, particularly the high dependency on resources due to increased use of air conditioning and heating. It has been acknowledged that the worth of a building can be associated to the building's perceive level of sustainability, where the stakeholders can be building owners, tenants and property valuers. The problem is how to differentiate the level of sustainability in a building which will make it easy to compare each building. This is the sustainability rating tools which can play a major role.

In various cases the tools mark criteria and standards which go further than the building codes and regulations in the countries in which they are applied. But it is also probable to link the tools to governmental policies and regulations, for example certification and labels; and incentive initiatives. In practical shape the EU Energy Performance Directive is a good example. Lastly, on an individual building level the implementation of assessment tools improve management of property and prioritization of operational and maintenance needs to boost sustainability. (Reed, Wilkinson et al. 2011). In the coming section some of the world prominent sustainability rating tools for building are discussed.

3. Assessment Tools

There are approximately more than 600 rating tools measuring economical, social and environmental dimensions of sustainability (Reed, Wilkinson et al. 2011). These tools are limited to some specific location of the world and can't be used directly. Each location of the world has its own sustainability issues and priorities for which a single source of tool cannot be used. Some of the prominent sustainability tools are discussed below.

3.1. BREEAM

For building certification BREEAM (Building Research Establishment Environmental Assessment Method) was the first environmental certification scheme for UK's buildings. Initially it was established in 1990 only for offices. BREEAM is an independent, third-party assessment certification standard (Sharifi and Murayama 2013). According to (Parker 2012) half of the surveyor responded that that using BREEAM incurred extra cost to their project. BREEAM has an 80% market share in EU.

3.2. Green Star

This tool has been tailored in accordance to the climatic conditions and local building standard and regulation of Australia. It is based on BREEAM and LEED system. This tools is used for the design of new buildings or refurbishment buildings for their environmental issue, it does not take into consideration the operation phase of a building (Mitchell 2010).

3.3. CASBEE

In 2004 CASBEE (comprehensive assessment system for built environment efficiency) was developed by the Japan Sustainable Building Consortium (JSBC), this consortium was consisting of academic, industrial, and government sectors and its family covers housing scale, building scale, and urban scale (Sharifi and Murayama 2013). CASBEE-UD uses weights to nested categories of criteria. The total score is the aggregation of the weighted scores of sub-criteria. In this way it eliminates the chance of significant difference among the impacts of various criteria on the final score. in addition, the weighting coefficients are also determined by making a questionnaire survey of experts related to the use of CASBEE on the urban scale and using the Analytic Hierarchy Process (AHP) (Sharifi and Murayama 2013). CASBEE is an integrated approach of governmental, academic and industrial sector used in Japan. Energy efficiency, resources efficiency, local environment and indoor environment are the main four aspects of CASBEE which contain a total of 80 sub-criteria which are further subdivided into two main groups: Q (Quality), and L (Loadings) (Alyami and Rezgui 2012).

3.4. DGNB

German Sustainable Building Council created and developed a certification system focusing on economical, ecological and social cultural aspects in planning, construction and operation phase of buildings in Germany. These certification systems are different from building codes. The codes provides the minimum requirements construction and development but the certificates assess the buildings and projects as per predefined criteria and quality; and they can present the maximum (Hamedani and Huber 2012).

3.5. ECC

In 2003, a certification system for sustainably planned and constructed communities by the Urban Land Institute Atlanta District Council, Greater Atlanta Home Builders Association, Atlanta Regional Commission and South-face launched the Earth Craft Communities (ECC) program. ECC is a developer certified and verified by third party program that recognizes correctly designed and constructed communities in the Southeast. It is a locally-specific tool employed by land developers and local government agencies to encourage smart growth, sustainable land development practices, and healthier communities (Sharifi and Murayama 2013).

3.6. ISO/TS 21929-1:2011

This is a standard and not a certification system which gives a framework, formulates recommendations, and provides guidelines for the selection and development of proper sustainability indicators for building sectors. When considering the economic, environmental and social impacts of a building ISO/TS 21929-1:2011 defines the process that shall be pursued when addressing using a common framework and a set of indicators. This part of ISO/TS 21929-1:2011(iso.org):

1. Adapts general principles of sustainability for buildings
2. Consists of a framework for the evaluation of economic, environmental and social impacts of buildings
3. Demonstrates indicators as examples
4. Demonstrates how to exercise sustainability indicators with regard to buildings and illustrate the process of applying sustainability indicators
5. Maintains the process of choosing indicators
6. Bears the development of assessment tools
7. Illustrates the conformity with this specification

Six tools has been discussed by (Haapio and Viitaniemi 2008) in their research paper which are mainly focusing on the environmental assessment of building sectors. These tools are applicable to European and North American buildings. These tools can be bought, only BEES is free of cost available software.

3.7. LEED

LEED (Leadership in Energy and Environmental Design) is a vastly used rating tool for building. It was developed by US Green Building Council. Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Innovation in Design are the main categories which LEED is taking into account. It has four certification levels: Platinum, Gold, Silver and Certification.

3.8. BEAT

BEAT 2002 (building environmental assessment tool) is an assessment tool for buildings which is based on life cycle assessment inventory. It was developed at the Danish Building and Urban Research. Its first version was released in 2000. This tool is mostly used by building material producers, researchers, architects and engineers, technical schools and municipalities. It can be used for new as well retrofitted buildings (Petersen 2002).

Table 1 presents the comparison of eleven different sustainable building rating systems (SBRS) with respect to its country, climatic conditions, regulating body, assessment criteria, scope of building types and rating ranking systems.

Table 1 Comparison of prominent International Sustainable Building Rating System (SBRS) (adopted from (Yusoff and Wen 2014)

SBRS (sustainable building rating system) Country	Climates	Regulating body	Assessment criteria	Building types covered	Rating ranks
GBI (green building index) MALAYSIA	Tropical without extremely high temperature	GBI Accreditation Panel (GBIAP)	Energy Efficiency Indoor Environmental Quality (IEQ) Sustainable Site Planning Management (SM) Materials & Resources (MR) Water Efficiency (WE) Innovation (IN)	I. Residential II. Non-residential	Certified Silver Gold Platinum

LEED UNITED STATES	Temperate; Tropical; Arctic; Arid & Semiarid	U.S. Green Building Council (USGBC)	Sustainable site development Water savings Energy efficiency Materials Selection Indoor environmental quality Innovation in Design	I. Homes II. New Commercial Construction and Major Renovations III. Existing Building IV. Commercial Interiors V. Core and Shell development VI. Neighborhood Development VII. Schools VIII. Retail	Certified Silver Gold Platinum
BREEAM UNITED KINGDOM	Variable climate changing from day to day. Overall climate is Temperate Maritime.	The BRE Group (BRE and BRE Global)	I. Management II. Ecology III. Energy use IV. Health and well-being V. Pollution VI. Transport VII. Land use VIII. Materials IX. Water	I. Courts II. Homes III. Industrial IV. Multi-Residential V. Prisons VI. Offices VII. Retail VIII. Schools IX. Bespoke–system for buildings that fall outside the standard BREEAM categories	Pass Good Very Good Excellent
CASBEE JAPAN	Temperate; Subarctic & Subtropical	Industry-academic and government collaboration with the support of the Ministry of Land, Infrastructure , Transport and Tourism	I. Indoor environment II. Quality of services III. Outdoor environment on site IV. Energy V. Resources and materials VI. Reuse and reusability, and avoidance of CFCs and halons VII. Off-site environment	I. Office II. School III. Retail shop IV. Restaurant V. Assembly place VI. Hospital VII. Hotel VIII. Housing complex IX. Factory	S A B+ B- C
NABERS Australia	Temperate; Tropical; Arctic; Arid & Semiarid	New South Wales (NSW) Department of Environment, Climate Change and Water	I. Energy use and greenhouse emission II. Water use III. Waste IV. Indoor environment	I. Office buildings II. Hotels III. Shopping centers IV. Homes	1star 2star 3star 4star 5star
GREEN GLOBES CANADA	Tundra; Subarctic; Humid-continental & Semiarid	Green Building Initiative (GBI)	I. Site II. Energy III. Water IV. Resources V. Emissions, Effluents and	I. Attraction II. Business (whole sale/retail) III. Congress center IV. Meeting venue V. Events	1Globe 2 Globe 3 Globe 4 Globe 5 Globe

			other impacts VI. Indoor Environment	VI. Golf course VII. Hotel & resort VIII. Transportation (Mass transportation, bus company, limousine service, car rental) IX. Organization X. Restaurant XI. Health centre XII. Travel industry	
HQE France	Temperate Maritime; Continental ; Mountain dimate where temperatures are influenced mainly by altitude & Mediterranean	HQE Association	I. Econ-construction II. Econ-management III. Comfort IV. Health	Covers all building types	Very Good Good Basic
HK-BEAM Hong Kong	Humid subtropical	BEAM Society	I. Site considerations II. Material usage III. Energy aspects IV. Water consumption V. Indoor environment quality VI. Innovations	I. Residential II. Commercial institutional buildings III. Mixed use complexes IV. Both new and existing	Bronze Silver Gold Platinum
GREEN MARK Singapore	Tropical wet	Building and Construction Authority (BCA) of Singapore	I. Energy efficiency II. Water efficiency III. Site project development & management(building management & operation for existing buildings) IV. Good indoor environmental quality & environmental protection V. Innovation	I. Residential buildings II. Non-residential buildings III. Existing buildings, overseas projects IV. Office interior V. Land house VI. Infrastructure VII. New & existing parks & district	Certified Gold Gold Plus Platinum
GB Tool International	Tropical; dry; moderate; continental and polar	International Framework Committee for the Green Building Challenge	I. Site selection II. Project planning & development III. Environmental loadings IV. Energy & resource consumption V. Indoor environmental	Broad range of building types	1 2 3 4 5

			quality VI. Functionality VII. Long-term performance VIII. Social & economic aspects		
GREEN STAR AUSTRALIA	Temperate; Tropical; Arctic; Arid & Semiarid	Green Building Council of Australia	I. Environmental management II. Indoor environment quality III. Energy use IV. Transport access V. Water use VI. Use of materials VII. Land use & ecology VIII. Emissions IX. innovation	I. Commercial offices II. Retail centers III. Education facilities IV. Other buildings (health care, multi-unit residential etc.)	1Star 2 Star 3 Star 4 Star 5 Star 6 Star

4. Current status of Sustainability in Building Sector of Pakistan

Presently SGS (world's leading inspection, verification, testing and certification company) is providing its services about Green Buildings in Pakistan (SGSgroup). These services include:

1. Conducting feasibility studies for the assessment of basic designs
2. Providing Green building consultancy and facilitation for Leadership in Energy and Environmental Design (LEED) and other green building certification systems
3. simulation and modeling for building's energy and lighting
4. Basic and enhanced third party commissioning
5. Building sustainability and carbon services, including carbon footprint analysis and other services such as 'life cycle assessment' and 'remaining lifetime predictions'
6. Conducting Indoor air quality sampling and testing, including biological investigation using second generation ATP-metry technology
7. Providing Energy management services
8. Testing of Green building material performance
9. Energy Management Systems and Certification - EN16001 and ISO 50001

5. Sustainability Rating Tool for Pakistani Buildings Sector

Currently there is not a single sustainability rating tool for the Pakistani buildings sector which takes the local sustainability issues into consideration. Pakistan Green Building Council (PGBC) is working in Pakistan under the umbrella of World Green Building Council (WGBC). Pakistan Green Building is working on the development of Pakistan specific Green Guidelines to deal with the issues caused by conventional building techniques. According to GBCP, the transportation, and construction industry are the main causes of environmental pollution in Pakistan. The concepts of sustainability and green construction are a very hot topic of this country, and very significant efforts have been made. Yet, these efforts are mostly made by individuals who themselves cannot really impact the global market in a positive way. There is need of coordination among the different individuals and organizations that are operating on this attempt, there is discrepancy in legislation and regulations, and there is a vast division among the different stakeholders that often play adversaries roles. A reference framework for sustainability is not present. Methodology and system is not present to assess the sustainability of the projects or build environment. There is a break in knowledge and understanding about sustainable development and especially sustainable construction. Documentation of sustainable projects or the technologies and techniques used for the assessment of sustainability of buildings in the country is not present (GBCP). The sustainability rating tool for Pakistan can be developed by following the methodology given in the coming section.

6. Methodology

To find the sustainability ratings of the residential buildings in Pakistan there is a great requirement of rating tool to be developed which takes the local sustainability categories and issues into consideration. In order to find the sustainability categories and issues a methodology is presented in Figure 1.

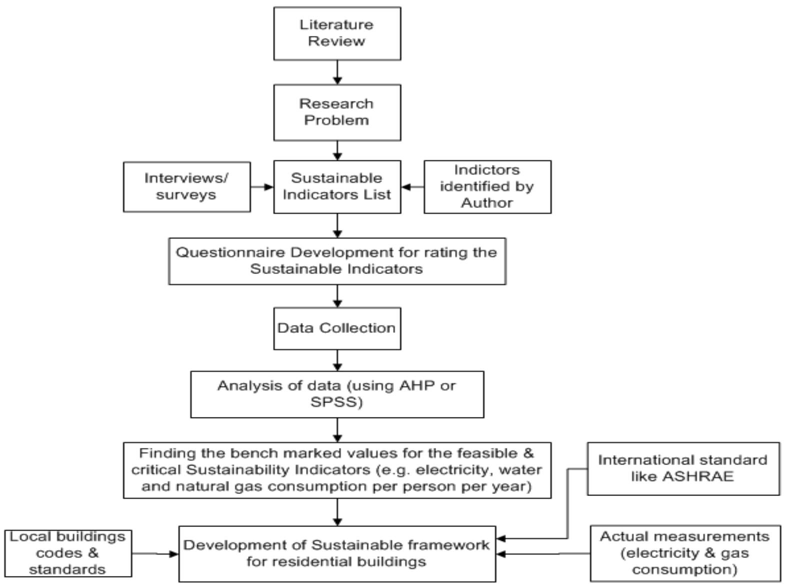

Figure 1 methodology for developing a sustainability rating tool

Figure 1proppose a methodology for the development of the sustainability rating tool. The sustainability categories/issues and indicators can be extracted from the literature review, interviews/surveys and also by the author itself. Once the indicators are discovered, then the next stage is the data collection and its analysis. This data analysis will result in critical or more important sustainability categories/issues and indicators which can be used for benchmarking. This benchmarking can use local and international codes and standards for the development of sustainability rating tool for building sector.

7. Conclusions:

This paper provides a brief history about the different sustainability rating tools for buildings. These tools are mostly compatible to some specific locality of the world and cannot be directly used at other localities without modifying them. Pakistan Green Building Council (PGBC) under the umbrella of World Green Building Council is providing its services to Pakistani buildings. But Pakistan has its own social, economical and environmental issues with respect to building industry. PGBC does not provide any guidelines about the sustainability issues of Pakistan. There is a great need for the development of sustainability rating tool suitable for Pakistani building sector.

8. References:

1. *Alyami, S. H. and Y. Rezgui (2012). "Sustainable building assessment tool development approach." Sustainable Cities and Society **5**: 52-62.*
2. *Azhar, S., et al. (2009). BIM-based sustainability analysis: An evaluation of building performance analysis software. Proceedings of the 45th ASC Annual Conference.*
3. *Glavič, P. and R. Lukman (2007). "Review of sustainability terms and their definitions." Journal of Cleaner Production **15**(18): 1875-1885.*

4. *Haapio, A. and P. Viitaniemi (2008). "A critical review of building environmental assessment tools." Environmental Impact Assessment Review* ***28****(7): 469-482.*
5. *Hamedani, A. Z. and F. Huber (2012). "A comparative study of DGNB, LEED and BREEAM certificate systems in urban sustainability." The Sustainable City VII: Urban Regeneration and Sustainability* ***1121****.*
6. *Mitchell, L. M. (2010). "Green Star and NABERS: learning from the Australian experience with green building rating tools." ENERGY EFFICIENT: 93.*
7. *Parker, J. (2012). "The Value of BREEAM." BSRIA BG* ***42****: 2012.*
8. *Petersen, E. H. (2002). BEAT 2002—an LCA based assessment tool for the building industry. proceedings of the Sustainable Building Conference.*
9. *Reed, R., et al. (2011). A comparison of international sustainable building tools–An update. The 17th Annual Pacific Rim Real Estate Society Conference, Gold Coast.*
10. *Reith, A. and M. Orova (2015). "Do green neighbourhood ratings cover sustainability?" Ecological Indicators* ***48****: 660-672.*
11. *Saunders, T. (2008). "A discussion document comparing international environmental assessment methods for buildings." BRE, March.*
12. *Sharifi, A. and A. Murayama (2013). "A critical review of seven selected neighborhood sustainability assessment tools." Environmental Impact Assessment Review* ***38****: 73-87.*
13. *Singh, R. K., et al. (2009). "An overview of sustainability assessment methodologies." Ecological Indicators* ***9****(2): 189-212.*
14. *Yusoff, W. Z. W. and W. R. Wen (2014). "Analysis of the international sustainable building rating systems (SBRSS) for sustainable development with special focused on green building index (GBI) malaysia." Journal of Environmental Conservation Research* ***11****: 11-26.*
15. Iso.org http://www.iso.org/iso/catalogue_detail?csnumber=40436 visited on 24th Nov 2016, 21:15 PM
16. GBCA https://www.gbca.org.au/uploads/194/36034/List%20of%20Credits_v1.1.pdf visited on 27th Nov 2016, 12:30 AM.
17. GBCP http://pakistangbc.org/pgb-expo/events/green-guidelines-launch visited on 2nd Dec 2016, 9:00 AM.
18. https://en.wikipedia.org/wiki/List_of_most_polluted_cities_in_the_world_by_particulate_matter_concentration visited on 21st May 2016, 11:10 am.
19. SGSgrouphttp://www.sgsgroup.pk/en/Logistics/Quality-Health-Safety-and-Environment/Sustainability/Infrastructure-Building-Services/Green-Building.aspx visited on 8th Dec 2016, 9:15 PM.
20. Wikipedia https://en.wikipedia.org/wiki/By-law visited on 12th Dec 2016, 12:00 PM.
21. Pediaa http://pediaa.com/difference-between-code-and-standard/ visited on 12th Dec 2016, 12:20 PM.

INVENTORY MANAGEMENT SYSTEM IN PUBLIC SECTOR UNIVERSITIES OF PAKISTAN

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Abstract: Management of inventory is one of the challenging areas in every organization which needs more focus to minimize wastes. Higher Education is a fast growing sector where cost of consumable and non-consumable items is increasing. Management of such inventory can improve the overall performance of the sector. Taking a case study of one of the public sector universities, there are more than 700 different items purchased by the university but there is no suitable inventory management system which results in wastes in various forms. This research will be focused to analyze the existing inventory system and design a new system with proper classification of inventory items for right amount and schedule their work order right time. The available storage space will be redesigned in line with standard practice and code with suitable storage and retrieval strategies. An information system will also be developed which help users to access the store and manage quantity, space, and time in an efficient and effective manner.

INTRODUCTION:

Inventories plays a key role for the successful and smooth functioning of many organizations especially in manufacturing and retailing organization. Importance of inventory is similar as the blood in body, excess or shortage of inventory has deep impact on foundation of the organization. Inventory may be in the form of Raw material, work-in-process (WIP), Spares parts and finished goods. Whatever may be the inventory items, they need an efficient management system, as major portion of the funds are invested in them. Inventories often represents as much as 40% of total capital in industrial organizations (Moore, Lee and Taylor, 2003:321) also there are different costs associated with inventory, the holding or carrying cost when inventory comprises of raw-material, work-in process or finished goods and the ordering cost or the cost of replenishing inventory. These cost are the major one, apart from these, other costs are also associated with inventory like stock-out cost and opportunity cost etc. Inventory should be effectively and efficiently utilized in such a way that the main purpose of inventory is fulfilled i.e. with minimum investment and availability at the right time and place when required. **INVENTORY IS DEVIL** is said in many organizations although no one can go for zero inventory but there is a need to optimize the level of inventories and every organization tends toward achieving this goal. So there's a crucial need of good inventory management system to ensure organizational growth and profitability.
As mentioned in the abstract, dealing of inventories in the education sector is also very challenging and need proper management system. In our first visit to the UET inventory store, we found that there over 700 different categories items were stored but neither the items were categorized nor placed in their correct places, also there were no proper storage system due to which finding of

items were really difficult for store personnel which results in wastes in various forms. Most of the time items were present in the store but due to the absence of proper inventory management system they were misplaced and lost in the bulk of inventory, so store personnel were kept ordering the same things they had in the store. This paper will focus mainly on developing an inventory management system by applying Industrial Engineering techniques for public sector universities to not only keep record of all items but help management for maintaining right amount of items at right time, price and place and to manage their store related inventories.

LITERATURE REVIEW:

Like many industries and firms, Education sector are now also working on the proper management of their inventories and most of them share their experiences in the form of research paper and case studies. Thus, the increasing trend of managing the inventories in education sectors indicate the need of the proper Inventory management system by which personnel can work easily and efficiently and also maintain accurate record of purchasing and issuing of each and every item.
A proper inventory management system helps out in building customer satisfaction which is one of the major aspect in every business. The availability of product and the completion of demand in time is the way in which an inventory management system attempts to create customer satisfaction. According to Robert Spector, a retail historian, "If you have what they want when they want it, they are happy. If you don't they are not". As a result of this, it is important to establish a linkage between customer satisfaction and bottom-line results. Nwandu, (2006:171) defines inventory management as a form of administration control that is particularly essential in all manufacturing, wholesale and retail organizations. The essence of inventory according to Nwandu is, "to have the right goods quality and quantity, at the right place and time". Nweze (2004:423), defines inventory control as a means of ensuring that actual flow of inventory in an organization conforms to plan. Inventory management therefore has been defined in many ways by many authors. Therefore from the analogy, inventory management system is to ensure the availability of the right amount of product at the right time, price and place and also to keep monitoring the levels of inventory in warehouse and storages.

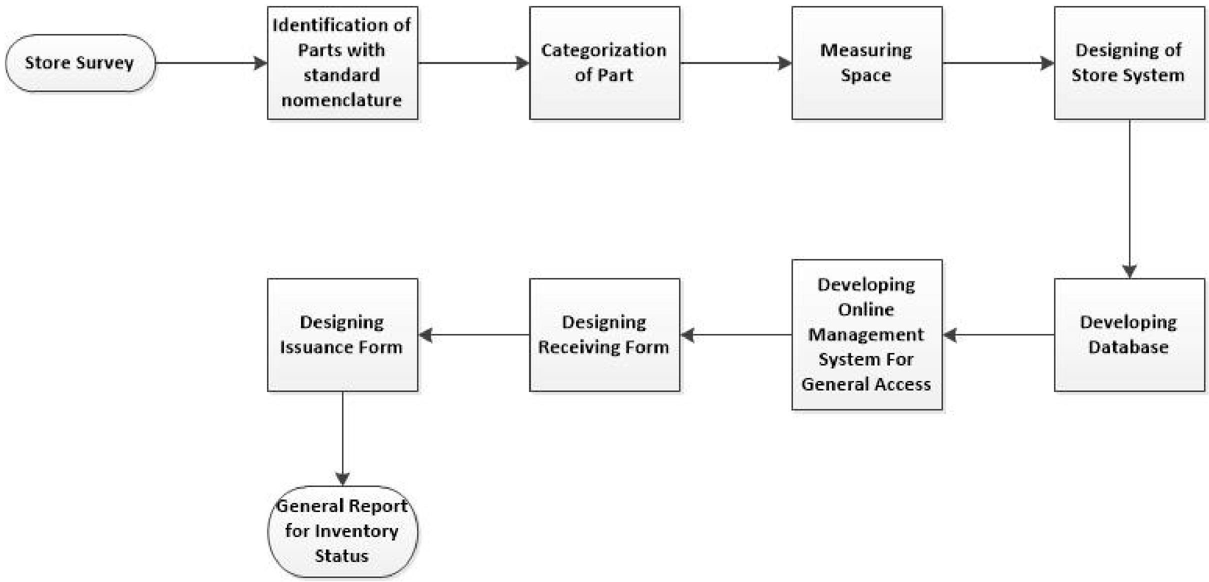
OBJECTIVES:

The objectives of the project are as follow:

- Identifying the store problems (UET Peshawar store).
- Designing rack based storage system.
- Categorization of items.
- Coding of items.
- Developing database.
- Develop a proper inventory management system
- Designing and developing a web page that any department can only see the inventory in store before placing an order (Inventory Management System).

METHODOLOGY

The methodology that is followed for this project given by flow chart



Store visit

The methodology starts with the store survey, the visiting of store is planned to see the current status of the store. To observe the current system of storing the items in store, how the demand is managed, meeting with store personnel and discussing the current service level is done. Seen the routine work by making 8 to 10 visit to store, also observed the present method placing and exiting of items from store.

Figure 1: items Placed in store

Identification of parts

Item identification is the most important element of the codification system because it establishes a unique identification for every item of supply. The identification consists of the minimum data required to establish clearly the essential characteristics of the item, i.e., those characteristics that give it a unique character and differentiate it from all others. So, after visiting of store, the next is identify the nature items that is placed in the store. All the items that is kept in store has been identified. There are more than 700 hundred items that is kept in store. Some of the parts are usually small in sizes just like marker, ballpoint foot print paper etc.

Items	Items (Standard Nomenclature)
Steel Barma	Drill Bits
Karrandi	Darby
Neel Large Size	Robin
Tatkai	Tams

Table 1: Some items name

Classification or categorization of parts

Categorization is the process in which ideas and objects are recognized, differentiated, and understood. Categorization implies that objects are grouped into categories, usually for some specific purpose. Ideally, a category illuminates a relationship between the subjects and objects of knowledge. Categorization is fundamental in language, prediction, inference, decision making and in all kinds of environmental interaction. It is indicated that categorization plays a major role in computer programming. After identification of all the items, it is necessary to categories all the items on the basis of their frequency of use, or due to same class items. Basis on the class, all the items that is keep in store are classified to the following categories

Sanitary items

Hardware items

Electric items

Paint items

All tools

Measuring space

Knowing how to accurately measure a room will help with many home improvement projects, such as flooring and painting. Depending on the reason that you are measuring the room, different measurements need to be taken. To measure your rectangular room, use a tape measure, pencil and paper to record the length and width of the room. Once you have these two measurements recorded, multiply them to get the total area of the room. For this purpose, measure the total area occupied by the store. For this purpose, a measuring tape is taken and store is measured and the draw the drawing of store with dimension in AutoCAD. The drawing shows the dimension of store.

Figure 2: Dimension of store

Designing of store

A design approach is a general philosophy that may or may not include a guide for specific methods. Some are to guide the overall goal of the design. Other approaches are to guide the tendencies of the designer. After measuring space and calculation of volume required, it is necessary to develop such a design that fulfil the constraints. The constraint here is to provide the required space for placing the items and which is easily accessible to all type of items. Keep in mind all the constraint the, the store is design on rack base storage system to place each class of items in specific area depending on its frequency of use. The fig shows the design.

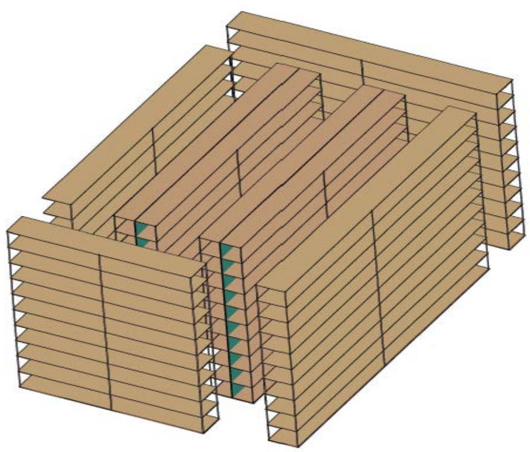


Figure 3: Suggested design of store

Data base developing

The structure of the database is critical to the success of project. It must be well thought out and properly designed so it is reliable and saleable. A poorly designed database can cause your data to become corrupt and not allow you to make additions for future needs. A database management system is a computer software application that interacts with the user, other applications, and the database itself to capture and analyse data. A general-purpose DBMS is designed to allow the definition, creation, querying, update, and administration of databases. All the required data is saved and recorded in computer for controlling the store. The screen shot show the database of store.

This is called ERD diagram. All the required data is saved and recorded in computer for controlling the store.

Entity relationship diagram

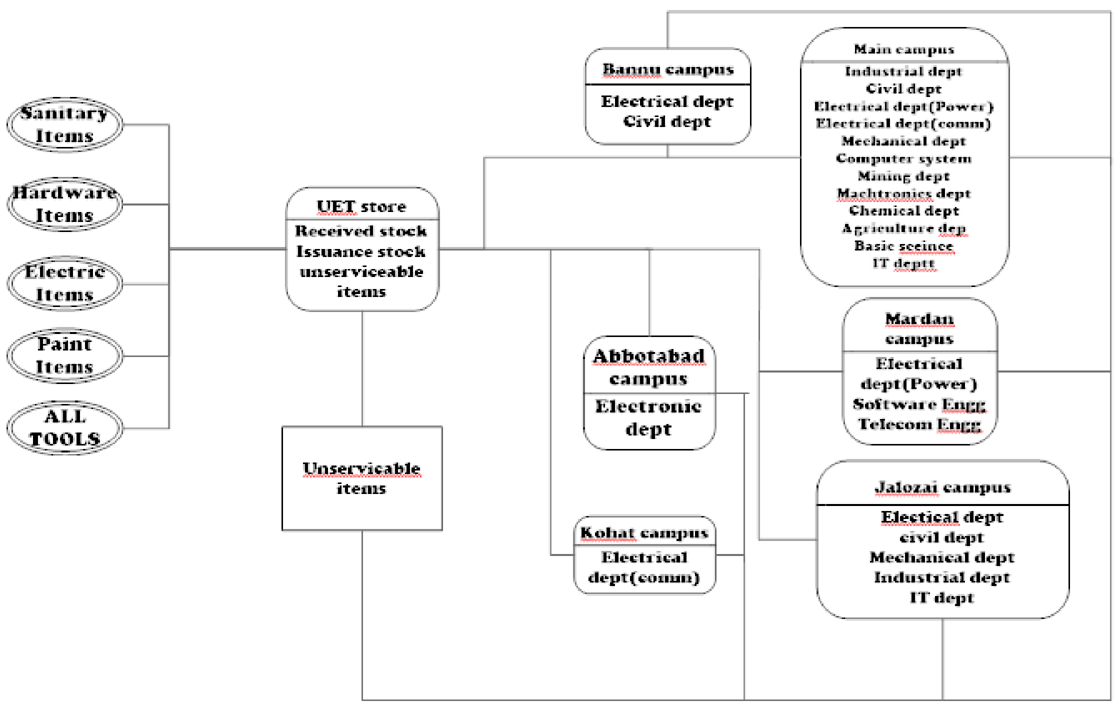


Figure 4: ERD diagram

Description of ERD diagram:

In ERD an entity relationship diagram (ERD) shows the relationships of entity sets stored in a database. An entity in this context is a component of data. In other words, ER diagrams illustrate the logical structure of database.

The ERD shows that all the items that is kept in the store are Electrical items, Paint, Sanitary, Hardware and all tools. The function of the store is to receive these items or issued it. These items are issued to specific department on demand. The connected campuses to store are main campus, Mardan, Abbottabad, Bannu, Kohat and Jalozai.

These campuses have different departments. When these have need of some they place an order to store personnel, after that they act on the order looking to stock an intensity of demand. All of this process have a data base that is developed using different software.

Developing online system for general access

These systems have quick response time. It is easy to use just form filling and get processed automatically by web and database servers. The system makes it easy to assign instruction for store. The system makes it easy to assign instruction for store. With only a few clicks, the viewer can view the stock and can place the order after seeing the current inventory level. Alternatively, each of the department have full access to see the items in the store what they are going to demand. Each of HOD can see and view the stock in the store. For this purpose, it creates a specific user name and password that will be given to HOD.

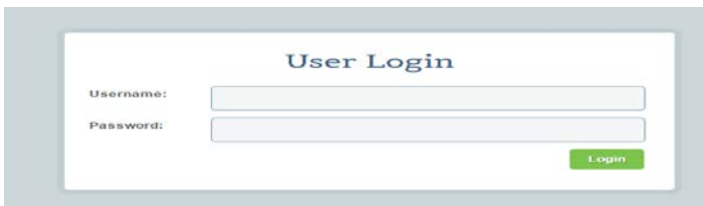


Figure 5: Login to view stock

Designing receiving and issuance form

For any issuing and inventory system to be effective, there must be controls in place to monitor the removal and addition of items to storage. The receiving form is an online form of receiving of items or adding inventory to stock, here some necessary information is entered and the inventory of specified class is added to that class. Similarly, if there is a demand comes from a department then an issuance form is filled by the operator and this is removing of inventory from the store. Each of the form has specific details that is given in the figures.

Figure 6: Receiving form

Figure 7: Issuance form

Generating reports for inventory system

A good inventory report should always be clear, simple, and exhaustive. There are regular base reports of inventory whether it is added or removed from the store. When there is addition to specific class or category of items then at the end of the day, the reports must be generated that is necessary to track each class of items. Moreover, if the level of a category is reduced to its safety level then report must be generated to order that class of items for fulfilling the demand.

ABC- ANALYSIS OF ITEMS:

Overabundance and scarcity of inventory in all levels can affect the availability of items to any organization. Monitoring system can be employed to check inventory imbalances to minimize demand dynamics. Also, it is easier to monitor and control vast system through the concept of importance of relative value. For simplification of monitoring system, classification of items are necessary.

There are so many types of items classification and categorizations available for inventory optimization. ABC analysis can be used for different purposes. ABC classification has an important assumption which is 80-20 rule. Another assumption is the planning horizon. There are no industry standards that define the Period of Analysis and this are randomly decided based on convenience.

ABC analysis also referred to as the Pareto analysis is a method of classifying items, events, or activities according to their relative importance. It is a well-established technique based on Pareto Principle for determining which items should get priority in the management of an organization’s inventory. Inventory are categorized into three classes; A, B and C. Most management efforts are expended in managing ‘A’ items. ‘C’ items get the least attention and ‘B’ items are in between.

Conventionally, ABC analysis has been based on the criterion of rupee’s volume and on the principle, that there are a relatively small number of items - category A, that account for the bulk of the rupee’s volume. At the other extreme, a large number of items - category C, account for a small share of the rupee’s volume. Category B items are between categories ‘A’ and ‘C’, both in number and rupee's volume. By this criterion, 'A' items are those of both high-value and high-demand and C items are low-value and low-demand.

Analysis says 20% of the items contribute to 80% of revenue. It implies that a small portion of items in Inventory contribute to maximum sales. As the classification is done according to the importance of their relative value, this approach is also known as Proportional Value Analysis (PVA). Therefore, it is a general trend in the industry to focus more on 'A' class items (approx. 20%) which results in maximum revenue (80%).

Data from University store is considered for this Study. This organization has over 700 different items and their data is analyzed. The analysis has a large impact on ABC analysis. The table below (Table1) shows stationary category items. Annual demand of each item and their respective unit cost which is taken in rupees is analyzed. Then annual usage rate for these items is determined by the product of annual demand with its unit price. From this, rank of each item is calculated i.e. items with their highest annual usage is considered as top of rank and next comes below these ranks. So for, as rank is completed category is assigned to each item.

S.No	Items	Average Usage	Unit Cost (Rupess)	Annual Usage (Rupees)	Rank
1	File Try Plastic.	25	90	2,500	9
2	Basket Plastic.	25	90	2,250	10
3	Calculator Citizen CT-714-D	25	435	10,875	3
4	Envelops 4x7 letter size (Khaki)	10000	0.6	6,000	6
5	Envelops 4x9 letter size (Khaki)	5000	0.7	3,500	8
6	Envelops File Size (Khaki)	5000	2	10,000	4
7	Envelops A/4 size (Khaki)	5000	1.75	8,750	5
8	Erasers Pelican.	300	6	5,400	7
9	Gum Stick (UHU) large size.	400	70	28,000	1
10	High Lighter Red/ Yellow/ green.	60	285	17100	2

Table 2: Stationary items

In the below table, items are classified into their ABC classification that is the classification in terms of cost.

Items	Annual Usage (Rupees)	Commulative Annual Usage (Rupees)	Annual Usage (%)	Category Assigned
9	28,000	28,000	30	A
10	17100	45,100	45	A
3	10,875	55,975	60	B
6	10,000	65,975	68	B
7	8,750	74,725	79	B
4	6,000	80,725	86	C
8	5,400	86,125	91	C
5	3,500	89,625	94	C
1	2,500	92,125	98	C
2	2,250	94,375	1	C

Table 3: Stationary items

Categor y	Items	Items Qty	% of Items	% of Items in inventory	Rupess in Category	% Rupess in
A	9,10	460	10	20	45,100	50
B	3,6,7	10025	30	30	29,625	30
C	4,8,5,1,2	15350	60	50	19,650	20
Total	**10**	**25835**	**100**	**100**	**94,375**	**100**

Table 4: Stationary items

From Table 3, it is concluded that ‘A’ Class of items consist of only a small percentage about 10% of total number of units handled by the stores but require heavy investment about 50% of total inventory usage value because of their high prices or heavy requirement or both.

B Class items are relatively less important; they may be 30% of total number of units managed by the stores. The percentage of investment contributed is about 30% of the total investment in inventory. In case of B class items as the sum involved is moderate, the same degree of control as applied in ‘A’ class items is not warranted.

Remaining ‘C’ Class items do not require much investment. It may be around 20% of the total inventory usage value but they are nearly 60% of the total number of units handled by the stores. For ‘C’ Class items, there is no need of exercising constant control. Orders for ‘C’ Class items can be placed after a relatively larger period of time with large quantities after ascertaining the consumption requirements.

REORDER POINT:

The basic formula for the reorder point is to multiply the average daily usage rate for an inventory item by the lead time in days to replenish it.

Reorder Point= [Daily usage*Lead time (in days)] +safety stock----------------------- Equation-1

This formula alteration means that replenishment stock will be ordered sooner, which greatly reduces the risk that there will be a stock out condition. However, it also means that a company will have a larger investment in its on-hand inventory, so there is a trade-off between always having available inventory and funding a larger inventory asset.

Some of items of Electric category with their annual demands and generated reorder points are given below.

S.No	Items Discription	Annual Demand	Re-Order Point
1	Call Push Batton open Nazz/Hero	24	**6**
2	Capacitor for C/Fans 2.5 (Fuji)	200	**50**
3	Capacitor for C/Fans 3.5 (Fuji)	200	**50**
4	Chowke 40 watt (Philips)	200	**50**
5	Chowke 20 watt (Philips)	100	**25**
6	Circuit Bracker 10 AMP (Hager)	100	**25**
7	Circuit Bracker 20 AMP (Hager)	100	**25**
8	Dimmer for Ceiling Fans (Pak)	400	**100**
9	Bend PVC 1 Inch (Gadoon)	10	**3**
10	Elbow PVC ½ (Gadoon)	20	**5**

Table 5: Login to view stock

So once stock reaches that re-order limits, store personal will need to place a new order. For example, in case of Call Push Batton, at 6 units, they will have enough to last them as they wait for new stock.

RESULTS:

While developing the system a conscious effort has been made to develop computerized inventory management system, making use of available techniques and resources.
Storage personnel faced a lot of problems as there is no proper design for store. For this new computerized inventory management system developed which could help in fast and easy access to items. Results achieved from this system are as follows:

Items present in the store were given standard nomenclature which is standard all over the world and everyone can easily avail and understand. Also, these items were classified into major categories because they were placed randomly in the store causing problems in its identification and tracking.

Moreover, unorganized arrangement of items results in wastage of time and money. In order to solve this issue, proper rack system is introduced in the store where different categories of items are properly managed with their designed capacities in a compact location.

Database management system is developed for store to keep proper record of items and enable its user to access database and monitor data. By developing this system it's easier to maintain the accuracy of information and handle data. A primitive access is given to all campuses of university which can only see the inventory status before placing an order.

Receiving form will be generated for incoming items from different vendors that were received by store personnel. Also issuance form will be generated for such items which are issued from the store.

Finally, general time oriented report is designed about store status which can helpful for its user to know the current level of store. However, this information can be re-examined for later use.

CONCLUSION:

Most of the organization have a lot of investment condensed in their inventories which is not feasible for the good wealth of organization. They even do not know how much is required to keep inventories to its best level. So it is necessary for every organization to keep inventory as low as possible which will obviously reduce the cost associated with inventory.
ABC analysis is the effective approach of classifying the inventory to different classes to reduce it holding cost and there will be easy access to each type of item without wasting time.

Currently here the store personnel mainly deal with placing and receiving the order of items. So to keep the inventory to its best level and also fulfil the demand on time, ABC classification of inventory is necessary to categorize the inventory on the basis of cost.

For knowing the reorder point to replenish the inventory again to its required level, an Inventory model is used known as EOQ model which is the most popular model and a best technique for finding the optimal lot sizes.

The results for us are marvellous and interesting too because the concerned persons even didn't know about the level of inventory and also they are really much inspired by the cost saving and inventory management system.

REFERENCES:

[1] Study of Storage System Performance and Storage Location Strategies, chapter 8 'storage systems' Automation, Production Systems by Mikel P Grover, pg. 331

[2] Wallace J. Hopp and Mark L. Spearman, 2001, Factory Physics, Irwin/McGraw-Hill.

[3] Jay Heizer and Barry render, 2007, Operation Management, Prentice Hall.

[4] FEARE, T., "GM Runs in Top gear with AS/RS Sequencing," Modem Materials Handling, August1998', pg. 50-52.

[5] Waters, c., *Inventory Control and Management*, Wiley, New York, 1992.

[6] Tersine, R., Principles of Inventory and Materials Management, 3rd ed., North Holland, New York, 1988.

[7] Bishop, J. "Experience with a Successful System for Forecasting and Inventory Control," Operations Research, Vol. 22, No.6, pp. 1224-1231, 1974.

[8] Zipken, P., Foundations of Inventory Management, McGraw-Hill, Boston, 2000.

[9] Hadley, G., and T. Whitin, Analysis of Inventory Systems, Prentice Hall, Upper Saddle River, NJ, 1963.

[10] Silver, E., D. Pyke, and R. Peterson: Inventory Management and Production Planning and Scheduling, 3d ed., Wiley, New York, 1998.

[11] S.P. Desselle, and D.P. Zgarrick, Purchasing and Inventory Management, Pharmacy Management: Essentials for All Practice Settings 2nd ed., New York: McGraw-Hill Co., Inc, 2009, p. 383.

[12] Tony Wild, Best Practice in Inventory Management, 2nd ed., Elsevier Science & Technology Books, p. 40.

[13] International Journal of Emerging Research in Management &Technology Available: http://www.ermt.net/docs/papers/Volume_3/3_March2014/V3N3-185.pdf.

[14] http://scm.ncsu.edu/scm-articles/article/safety-stock-analysis-inventory-management-models-a-tutorial

[15] http://www.inventoryops.com/safety_stock.htm

[16] http://www.lokad.com/calculate-safety-stocks-with-sales-forecasting.ashx

PICK AND PLACE MULTI-AXIS ARM FOR OBJECT SORTING BASED ON COLOR SENSOR

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Abstract: This paper presents design and implementation of a pick and place robotic arm with an application to color-based object sorting. The purpose is to develop a prototype for industrial applications where the objects on the conveyer belt are to be sorted. Color sensing is used for identification of the objects. The robotic arm includes low cost implementation of feed forward and feedback algorithms. This is suitable for the applications where size of the object and the position of the conveyor belt are fixed. Also, the position of the containers where different objects are to be placed should remain fixed. The hardware used in the robotic arm and for color sensing is described. Algorithm used for color detection is also presented along with the implementation details.
Keywords—robotic arm; color sorting; pick and place; conveyor belt

1. INTRODUCTION

With the advances in the area of robotics and automation, many simple and complex everyday tasks are being performed using robots. This has brought comfort, economic savings, and dependability in industry and in personal life. Sensing [13] plays an important role in automation and in robotics [15]. With correct type and amount of sensing, robots are able to perform complex tasks with high precision. A robotic arm (or humanoid robotic arm) is a common type of commercially and domestically used robots. Many applications have been developed in the past for robotic arms [3]. Pick and place of objects is one of the common applications. Planning of collision free motion for pick and place applications is presented in [2]. Pick and place application for components of CNC-Lathe machine has been discussed in [8]. Brain controlled pick and place application has been discussed in [7]. Work done in [4] describes a case packing application for robotic pick and place mechanism. Robotic vehicles have also been used in the pick and place applications [5]. Finally, the color based object sorting using pick and place has been discussed in [12].Work done in this paper is different from that in [12] in various ways (as discussed in Section IV).

The original contributions of the current work include: 1) Design of low cost robotic arm hardware, 2) Use of a combination of sonar and color sensors for object detection instead of visual sensor, 3) Development of model-less closed loop and open loop control algorithms, 4) Comparison of the current work with existing approaches.

The paper is organized as follows. Section II presents hardware details and overall flow of the application. Section III includes control algorithms, color sensing algorithm, and implementation details. Section IV discusses the comparison of the current work with some existing approaches. Section V concludes the paper.

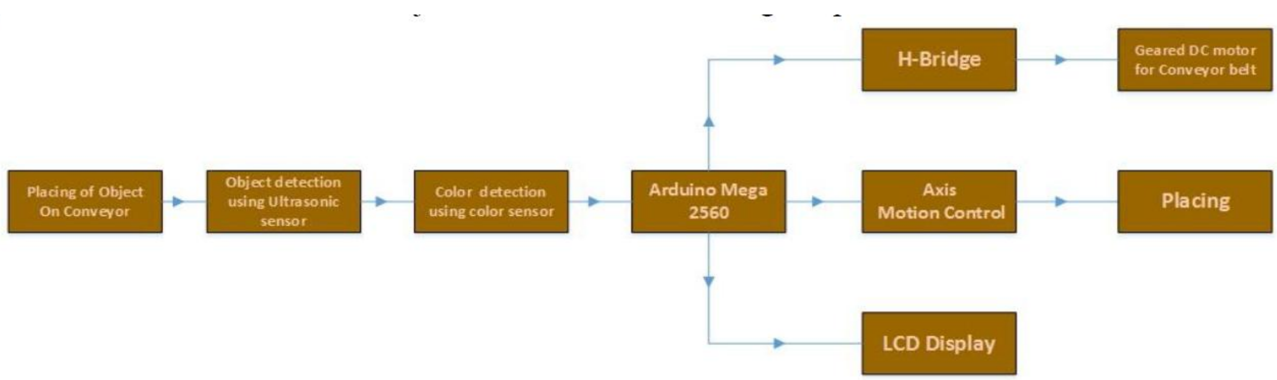

Figure 1. Block diagram of proposed system

2. RELATED WORK

Implementation of the pick and place of the objects from the conveyor belt is not a new idea. The way however that this task is implemented in the current work is new. Furthermore, sorting of colored objects has also been explored in the past but mostly with visual sensors (i.e. camera). In this section, we compare our work to the three existing solutions and discuss the pros and cons.

2.1 Lynxmotion AL5A based Application [12]

Work done in [12] is a colored object sorting application based on a visual sensor. Commercial robotic arm (Lynxmotion AL5A) is used for the sorting. The idea is to apply a blob filter to the images acquired by the camera. The filtered image is checked against pre-defined limits and the color decision is made. The arm acts accordingly and sorts the objects of different colors in their respective containers.

Compare to our work, the implementation and application of the colored object sorting idea are quite different. In terms of the implementation, the use of color sensing technology is completely different. Also, there is no need of any sonar sensors in the previous approach. In terms of application, the major difference is the conveyor belt. The robotic arm in [12] is not trained to handle the objects on a conveyor belt. Although it could be argued that the camera images can be used for both color sensing and position detection. But this may require faster processor and complex image processing algorithms. On the other hand, the algorithms used in the current work are quite simple and effective in the domain where no external changes occur in the environment.

2.2 CONSIGHT-I System[6]

CONSIGHT-I is also a vision based system to transport parts from the conveyor belt. This system is commercial level and the issue of cost is not a concern. Basic advantage is that the object is not required to be of a specific shape or be placed in specific orientation.The system is reprogrammable and is efficient in the presence of visual noise in the environment. In terms of functionality, CONSIGHT-I has two modes: a setup mode and an operational mode. In setup mode, the system is programmed to transport specific part. In operational mode, the parts are placed on the belt by the operator. The camera system detects the position and orientation of the part and transfers information to the robotic arm. The arm picks up the part from the belt and places it at a pre-specified location.

The current work differs from CONSIGHT-I in two areas. First, the detection of the object is through color and sonar sensors instead of a vision based system. In case of sonar sensor, the tracking is discontinuous. But on the other hand, sonar sensor is independent of the visual noise. Second, the CONSIGHT-I system is not designed for sorting of objects. It is for transportation of one type of objects at a time whereas the current work is applicable to sorting applications as well as single object transportation. However, CONSIGHT-I has the advantage of being able to adapt to different orientations of the object which is important when objects are disturbed or carelessly placed on the conveyor belt.

2.3 Automated System for Locating and Transferring Objects on a Conveyor Belt[11]

This work suggests a series of robotic manipulators along with a series of vision based detection systems for transportation of the objects on a conveyor belt. Here again, major difference is the detection technique. In this sense, our work is unique because we use no vision sensor. Another difference is that there is no control loop on the conveyor belt. The belt just keeps on moving. By having a control loop on the belt, it could be made sure that one arm picks up all the objects without missing any. On the other hand, a constantly moving belt may enable faster processing. Another difference of [11] is that it allows multiple objects placed in an overlapping fashion on the belt. In our work, overlapping is not taken care of.

3. DESCRIPTION OF THE SYSTEM

Hardware used in this work is shown in Figure 2. Major components include the robotic arm, color sensor, conveyor belt, and sonar sensor. Note that none of the sensors is mounted on the robotic arm itself.

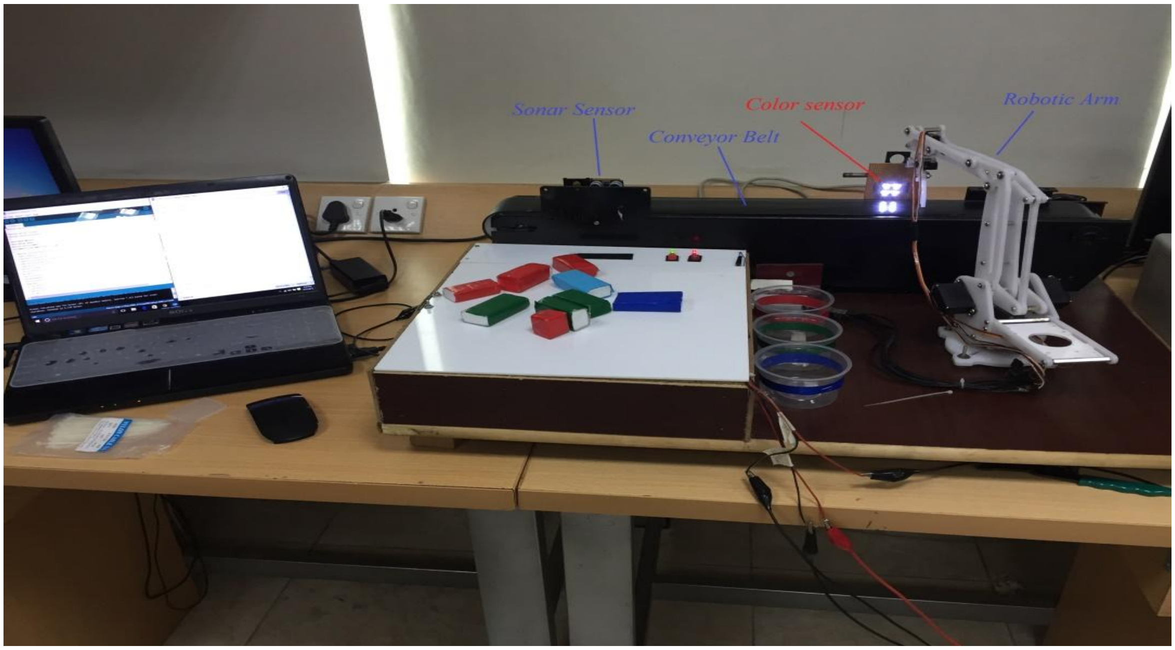

Figure 2. Picture of the overall System

The microcontroller used for processing and control is Arduino Mega 2560. It is a low cost easily available processing unit and is sufficient for the current application. Servo motors used in the joints of the robotic arm is a standard HITEC HS-311. Given the acrylic sheet structure of the arm and the weight of the objects, the torque required is calculated using the following equations.

$$\tau_M = (\tau_W + \tau_f)FOS \tag{1}$$

Where τ_M is the torque required from the motor, τW is the torque required to lift the weight of the arm, τ_f is the torque required to overcome the friction, and FOS stands for the factor of safety. In our case, the mass of the acrylic sheets is roughly 100 grams and the moment arm for each joint is 18 cm. Using the center of gravity value g = 9.81 m/sec2, and ignoring the torque due to friction, the factor of safety in our case is 1.25.Note that the base joint is supported by two motors. Total four servo motors have been used in the robotic arm.Color Sensor TCS3200 has an array of photo detectors, each with either a red, green, or blue filter, or no filter (clear) [14]. The filters of each color are distributed evenly throughout the array to eliminate location bias among the colors. Internal to the device is an oscillator which produces a square-wave output whose frequency is proportional to the intensity of the chosen color. HC-SR04 (ultrasonic ranging module) provides 2cm- 400cm measurement function; the ranging accuracy can reach to 3mm. Ultrasonic transmitters, receiver and control circuit are included in the module.

To achieve the requirement of fully automated system, the objects of different colors should move automatically towards the gripper of the robotic arm. To accomplish this desired task a conveyor belt is being used. The length of the conveyor belt is 2 feet with the width being 4.5 inches and depth is 5 inches.We used DC Gear to drive the conveyor belt. It is 12V and 300RPM Dc motor with readymade gearing system. The current drawn by the moto exclusively depend upon the load being driven.

4. OPERATION AND ALGORITHMS

4.1 Control Loops and Algorithm

The flowchart for the operation of the whole system is shown in Figure 3. The whole operation is a combination of open loop and closed loop control. There are two control system loops in the process. One control loop is that of the conveyor belt system. The second control loop is that of the robotic arm. The operation of the system starts with the placement of the colored object on the belt. The object detection by the sonar sensor is taking place in a feedback loop shown in Figure 4.

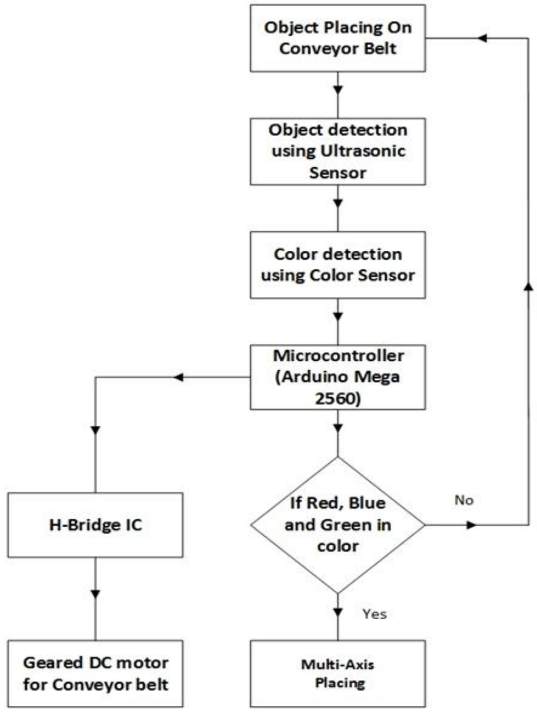

Figure 3. Flowchart of the Operation

The control law is a discontinuous decision based on the sonar sensor reading. As long as the object is not detected, the belt keeps on moving at a constant velocity. Once the object is detected, a countdown timer is started and at the end of the counting, the belt is stopped. The countdown is set in such a way that the object is stopped right in front of the color sensor. The event of the stop is also of limited time after which the belt starts moving again.

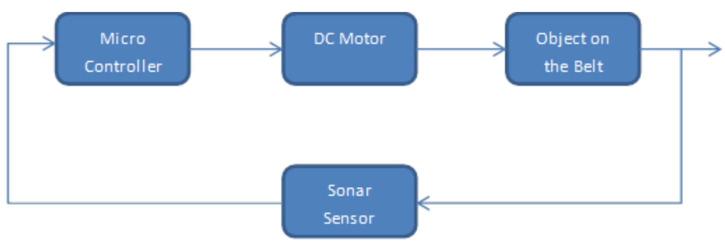

Figure 4. Feedback Control in Conveyor Belt

During the stopping time of the object in front of the color sensor, the color of the object is detected. If the color is found to be blue, green, or red, the arm is commanded by the controller to perform a pre-set routine i.e. to pick the object from the pre-known location at the belt and place it at the pre-known location of the container corresponding to the color of the object. This control loop is shown in Figure 4. Although Figures 4 and 5 suggest closed loop operations, certain parts of the process are still happening in open loop. For example, the exact stopping of the object in front of the color sensor is neither robust nor is resilient against the disturbances. There is no way of verifying whether the object has stopped exactly in front of the color sensor. Another open loop operation is the exact placement of the object in the correct container. It cannot be verified whether the arm has successfully placed the object in the container.

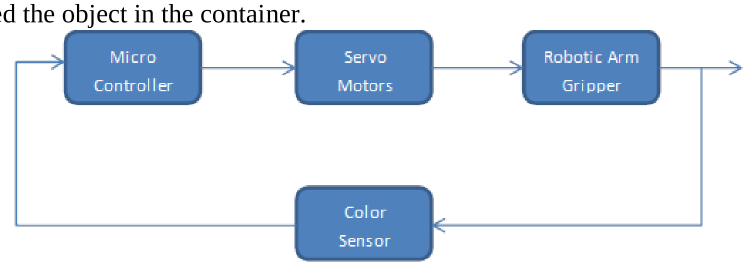

Figure 5. Robotic Arm Control Loop

Therefore, the pick and place solution proposed in the paper is less robust as compared to that in [12]. But it has the advantage of being low cost and less computationally extensive. Furthermore, by the addition of two or three extra sonar sensors, the robustness can be increased while keeping the cost and the computations in check.For example, placing a sonar sensor at the location of the color sensor and another near the necks of the object containers can provide feedback about the presence of the object at its pick up and drop down locations.

4.2 Color Sorting Algorithm

A major task in this work is to find ranges for red, blue and green from the intensities of red, blue and green light.The challenge is that these ranges must not overlap. Another challenge is that due to the change in the environment the readings change significantly e.g. because of change in lighting condition. Note that the readings of all the colors change simultaneously.Therefore it is difficult to implement the sorting algorithm directly from the readings. It has been found out that the difference among the readings almost stands in the specific range and that do not overlap. Following methodology has been used for the detection of red, blue and green colored objects.

We take the difference of two readings which are very close and then we have the range for each color without even overlapping. We take the difference of red and white (red-white) and blue and red colored intensities (blue-red). After the complete calculation of each and every reading we are left with the ranges through which we implement color sorting algorithm.

Table 1. Pseudo-code of Color sensing

```
Let,
Dwr = (red-white);
Dbr = (blue-red);
The range and condition for red object is
Dwr 1 to16
Dbr 18 to 37
The range and condition for blue object is
Dbr< 0
Because the difference of blue and red yields to negative values so it is very easy to sort blue color
The range and condition for green object is
Dwr 22 to32
Dbr 0 to 9
```

After implementing this algorithm on the software we tried many times, it always detects the write color. But there are some limitations. These readings and ranges are calculated in bright white light the results may be different in the different environment. But we can calculate any range in any environment by the above procedure.

4.3 Programming and Operation

The programming for the application has been done in C language. Sensors interfacing with Arduino board are very easy to understand. We have used a 5-axis robotic arm structure for pick and place application. Our structure consists of 5 servo motors connected to PWM (Pulse Width Modulated) pins of Arduino. Conveyer belt is used to transport the object.Object is sensed by sensors on the belt and picked up by arm for placement in respective box. Boxes of three different colors are used to sort the objects coming on conveyer (red, green and blue) irrespective of the order in which the objects are placed on the belt. DC motor is used to run the conveyer in forward direction. To have control of conveyer belt we have used a relay circuit with motor.

When a fixed distance line of sight i.e. 8cm in our case (detected by sonar sensor) is cut by the object placed on conveyer, a pulse is generated from the controller which is supplied to the BJT transistor. BJT is used for relay switching action.After receiving the pulse from the controller, BJT switches ON and in turn it switches ON the relay.As relay is turned on it changes the state of valve from normally close to normally open and DC motor is switched OFF for 2 seconds. Again pulse generated by controller becomes low and BJT turns OFF, so do relay for 1.2 seconds and object reaches in front of color sensor. Now color sensor senses the color of the object by the algorithm fed into the controller that is fixed range is defined for each color.

- Now if the difference between the blue and red values is greater from 0 but less than 9 it will pick green and place it in green box located on pre-defined location.

- If the difference between the blue and red values is greater than 18 but less than 37 it will pick red and place in its respective box.

- If the difference between the blue and red values is less than 0 it will pick blue and place it in blue box.
- If an object other than three primary colors is placed controller will not consider it and stops.

The delay of 1.2 seconds is calculated by hit and trial method as it is feed-forward process. After 1.2 seconds motor is again turned OFF so that next object is placed in starting of conveyer.

Each time the object is placed, detected by sonar and color sensor, picked and placed by arm it will be displayed on LCD. As the buckets are places at a fixed distance so we calculated by hit and trial because it is feed forward system. This can also be made automatic by putting another sensor on the arm to detect the color of the bucket too but in many industrial cases the placing position is already know and we also do not need this in object sorting.

5. CONCLUSIONS

A color sensor based pick and place robotic arm application has been reported. The system is based on environment where objects travel on a conveyor belt. The working of the systems and related hardware has been described. Applications of the proposed system include industrial manufacturing environment (e.g. assembly lines). For that indeed a more ruggedized hardware is required. Another application of the presented system is in education. Domestic applications may also be explored where a conveyor belt from kitchen to the dining table may be used and the arm may pick and place various dishes based on colored labels on the pots. A fundamental limitation of the presented implementation is that it detects only three colors. For future design and implementation, a more complex algorithm may be developed that is able to detect more than three colors.

6. REFERENCES

[1] Alessandro Golfarelli, Rossano Codeluppi and Marco Tartagni, “A Self-Learning Multi-Sensing Selection Process: Measuring Objects One by One”, ARCES-LYRAS LAB University of Bologna, Campus of Forlì,©2007 IEEE, *IEEE SENSORS 2007 Conference*.

[2] Brooks, Rodney A. "Planning collision-free motions for pick-and-place operations." *The International Journal of Robotics Research* 2.4 (1983): 19-44.

[3] Engelberger, Joseph F. Robotics in practice: management and applications of industrial robots. Springer Science & Business Media, 2012.

[4] Fallas, David M. "Case packing system having robotic pick and place mechanism and dual dump bins." U.S. Patent No. 8,997,438. 7 Apr. 2015.

[5] Hau, Low Kok, Gowrishankar Kasilingam, and K. Nithiyananthan. "Development of Prototype model for Wireless based Controlled Pick and Place Robotic Vehicle." *TELKOMNIKA Indonesian Journal of Electrical Engineering* 14.1 (2015).

[6] Holland, Steven W., Lothar Rossol, and Mitchell R. Ward. *Consight-I: A vision-controlled robot system for transferring parts from belt conveyors*. Springer US, 1979.

[7] Hortal, Enrique, et al. "Combining a Brain–Machine Interface and an Electrooculography Interface to perform pick and place tasks with a robotic arm." *Robotics and Autonomous Systems* 72 (2015): 181-188.

[8] Modi, Hardik A., and Dixit M. Patel. "Automated System Design For Pick & Place of M/C Components of CNC-Lathe–A Review Paper." International Journal for Innovative Research in Science and Technology 1.12 (2015): 259-261.

[9] Nonaka, Seri, et al. "Evaluation of human sense of security for coexisting robots using virtual reality. 1st report: evaluation of pick and place motion of humanoid robots." Robotics and Automation, 2004. Proceedings. ICRA'04. 2004 IEEE International Conference on. Vol. 3. IEEE,2004.

[10] Rohner, Ernst and Stoger, “Color quality assurance with instrumental color measurement”, Industrial & production engineering (1989), vol. 13, pp. 80-81.

[11] Sager, James L., and Michael R. Schmehl. "Automated system for locating and transferring objects on a conveyor belt." *U.S. Patent* No. 5,040,056. 13 Aug. 1991.

[12] Szabo, Roland, and Ioan Lie. "Automated colored object sorting application for robotic arms." Electronics and Telecommunications (ISETC), 2012 10th International Symposium on. IEEE, 2012.

[13] Webster, John G., and Halit Eren, eds. Measurement, Instrumentation, and Sensors Handbook: Spatial, Mechanical, Thermal, and Radiation Measurement. Vol. 1. CRC press, 2014.

[14] Y. Jiang and Y. Deng, “Design of Multipoint Color Measuring Device Based on TCS3200”, Instrumentation Technology, vol. 03, (2011), pp. 54-57.

[15] Yousef, Hanna, Mehdi Boukallel, and Kaspar Althoefer. "Tactile sensing for dexterous in-hand manipulation in robotics—A review." Sensors and Actuators A: physical 167.2 (2011): 171-187.

The Implementation of Six Sigma to improve the processes by Reducing the Defect Rate in Apparel Manufacturing Industry

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Abstract: In the recent era for the business excellence, reduction in process variation is directly related to customer satisfaction. So to meet the customer's satisfaction, the companies have to improve their manufacturing processes by reducing nonconformities. Now a day's Six Sigma is a famous tool for the improvement of processes and making the operations more effective. This paper deals with the implementation of Six Sigma by using the approach of DMAIC (Define, Measure, Analysis, Improve, and Control). The main focus was the reduction of defects occurring in the sewing process of garment manufacturing. Before applying this DMAIC methodology, the defect rate of identified major defect categories which contribute to overall 71.7% of total defects rate. After the successful implementation of Lean Six Sigma by using the approach of DMAIC, the processes improve by reducing the defect rate up to 25 % of total defect rate.

Key Words: Six Sigma, DMAIC, Defect Rate, Manufacturing Industry

1. INTRODUCTION

Quality is the distinctive aspect to measure the performance of manufacturing competition. Two important factors have an effect on the quality of product. First one is product design and the other factor is the degree of conformance of the manufactured products to the design specifications (7). So to contend in the competitive market the manufacturing organization should operate their production setup at optimum level by using their resources efficiently and effectively to deliver quality product at low cost. A number of strategies and tools are proposed by researchers for the organization improvements. Such proposals consist of Total Quality Management, Quality Awards, Total Preventive Maintenance (TPM), Lean and Six Sigma (8). Six Sigma is a disciplined, data-driven approach and methodology for eliminating defects and main purpose is to make the product as per customer specifications. (1). Six sigma applications will give successful result by the involvement of top management with commitment and keeping the cultural change in mind (13). Six Sigma define as "an organized and systematic method for strategic process improvement and new product and service development that relies on statistical methods and the scientific method to make dramatic reductions in customer defined defect rates'' (5). Six sigma procedures, frame work and dimensions have valuable contribution to improve the quality system. This Six Sigma procedure is in general recognized under the short form DMAIC (Define, Measure, Analyze, Improve and Control) (3).Six Sigma has vital role to improve the quality by removing the cause of defects and variability in textile processes. Successful implementation of Six Sigma DMAIC methodology has been done in different type of organizations such as automotive industry, small scale enterprises, manufacturing operations and services (2). As the project is about the garments manufacturing firm which is facing problem of high defect rate. To improve the process, product quality and reduce the defect rate company adopted Six Sigma DMAIC methodology.

2. LITERATURE REVIEW

Before the discussion on the application of Six Sigma in Garments manufacturing industry, we have to review the literature on successful implementation of Six Sigma in different manufacturing industries.

Md. Mazedul Islam et al., in 2013 worked in garment manufacturing industry. They implement the Six Sigma to reduce the top surface rework, printed label rework, sewing fault rework, pinhole rework, fabric rework Improper fly shape, and other reworks. After applying Six Sigma it was found that sewingpercent defective reduced to approximately 40%. In finishing, stitching D.H.U. (Defects per Hundred Unit) came down to approximately 8% from 16% as earlier, uncut thread D.H.U. came down to approximately 10% from 22% as earlier (6).

Uddin S.M. and Rahman C.M.L. in 2014 study the garments manufacturing industry. This study follows the DMAIC methodology of Six Sigma in order to find out the major defects, their root causes and then suggests logical solutions in order to minimize those defects. After the execution of the solutions, the result found is very considerable. The defect percentage has been reduced to 7.7from 12.61 (11).

Jitender Kumar et al., in 2014 choose the thread manufacturing textile firmto study the Six Sigma for the reduction of defects. In this study they use DMAIC approach, as DMAIC increase the profit margin, improve financial condition through minimizing the defects rate of product. With the help of DMAIC approach the defects has been reduced from 13012 to 513 (4).

Syed MisbahUddin., RashidulHasan., Md. Saddam Hosen., (2014) how to minimize the defects rate by introducing and implementing the DMAIC Methodology of Six Sigma into a sewing section of a selected garment factory. This research found that the selected garment industry was operating at a defect percentage of 11.229. The rate was very high at this present business context. The result found after implementation of the methodology was very significant. The defect percentage was reduced from 11.229 to 7.604 (10).

3. APPLICATION OF SIX SIGMA DMAIC METHODOLOGY

Six Sigma is emerging approach to quality management system and adoptive set of methodologies with focus on continuous quality improvements. In this research we have implement the DMAIC methodology for the purpose improvement. DMAIC is comprises of Define, Measure, Analyze, Improve and Control. All of the DMAIC technique steps are compulsory and always carry on in the given order.

3.1 Define Phase

Define is the first phase of the DMAIC methodology of Six Sigma. The purpose of this phase is to define the problem, goal of the project and the process that needs to be improved to get higher sigma level.

PROJECT TITLE:	Managing and Enhancing the Operational Effectiveness by Reducing Defect Rate.				
BUSINESS CASE:	From (Dec to 1st Week of March) due to high defect rate company faces loss of revenue, customer satisfaction and reputation. High defect rate resulted into an average loss of Rs 1 million(Total number of defects*Total time of repaire*Piece rate). By lowering the defect rate upto 25% we can save upto Rs 1 million Per month.				
PROBLEM STATEMENT:	Managing and Enhancing the operational effectiveness by reducing the defect rate of identified major defect catogories which contribute to overall 71.7% of total defect rate.				
OBJECTIVE:	Reducing defect rate upto 25% of total defect rate.				
METRICS:	Primary Metric= Defect Rate= Total defects/ total inspected*100 Secondary Metric= Productivity				
PROJECT SCOPE:	Sewing Operations				
PROJECT TEAM:	**Sibtain Abbas, Munir Ahmad, Amar Abbas, Gohar Ali,**				
MILESTONE LIST:	Define Phase	Measure Phase	Analyze Phase	Improve Phase	Control Phase
	3rd june 2015	17th July 2015	20th Aug 2015	21st Sept 2015	15th Oct 2015

Table 1. Project Charter

3.2 Measure Phase

The measure phase cover the numerical studies and data analysis, addition to this it focus on measurement system validation and gathering root causes

3.2.1 Attribute Agreement Analysis

To assess the consistency and correctness of the appraisers' ratings, four appraisers's rated Sewing quality on 25 samples of Garments twice. Garment samples were randomly presented. After collecting Data operator's performance was checked by using Attribute Agreement Analysis in minitab-16. The results of the Analysis are given below.Ordinal Scale was used (Poor/Fair/Good).

Assessment Agreement (within Appraisers)					Each Appraiser vs Standard				
					Assessment Agreement				
Appraiser	# Inspected	# Matched	Percent	95% CI	Appraiser	# Inspected	# Matched	Percent	95% CI
Adnan	25	25	100.00	(88.71, 100.00)	Adnan	25	18	72.00	(50.61, 87.93)
Muzamil	25	22	88.00	(68.78, 97.45)	Muzamil	25	14	56.00	(34.93, 75.60)
Sohail	25	23	92.00	(73.97, 99.02)	Sohail	25	12	48.00	(27.80, 68.69)
Younus	25	23	92.00	(73.97, 99.02)	Younus	25	13	52.00	(31.31, 72.20)
# Matched: Appraiser agrees with him/herself across trials.									

Table 2.Attribute Agreement Analysis

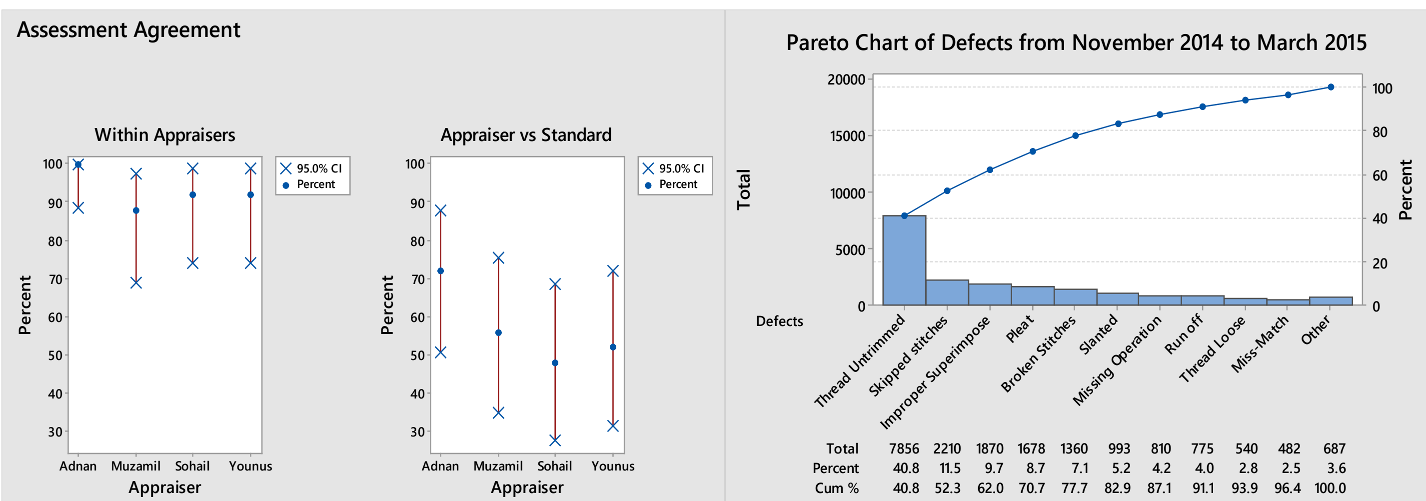

Figure 1. Attribute Agreement Analysis

3.2.2 Poissions Process Capability

To verify the current stability and whether or not our defect rate meets the specified limits of our sewing operations standard or not a poissions process capability analysis was conducted using Mini-Tab 17. The graphs show a highly un-controlled process with special cause variation depicted in red color.

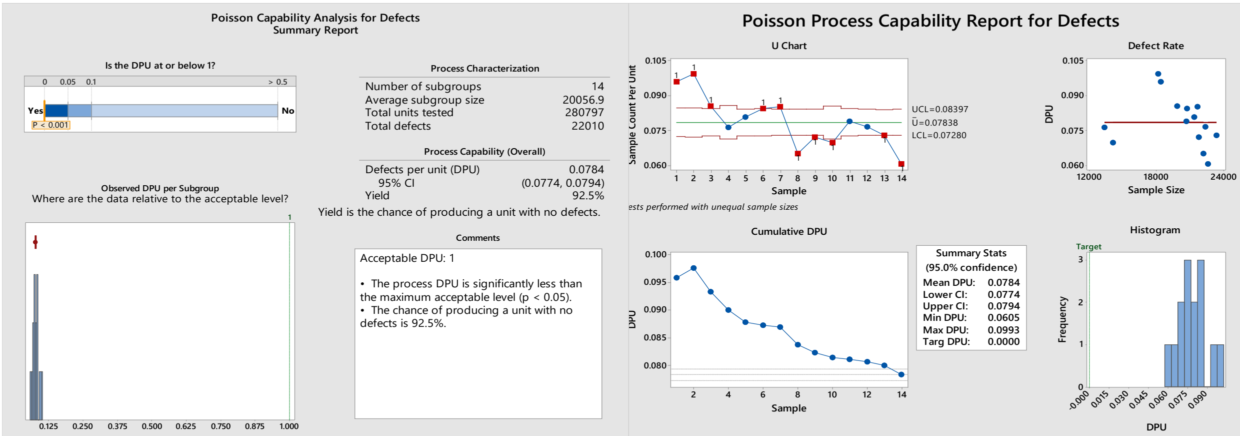

Figure 2.Poissions Process Capability

3.2.3 Ishikawa Diagram

Potential causes of sewing defects were organised through Ishikawa digram. Sessions of brain-storming were conducted to enlist all the possible causess of sewing defects. Ishikawa diagram helped to visulalize the Potential causes and their effects.

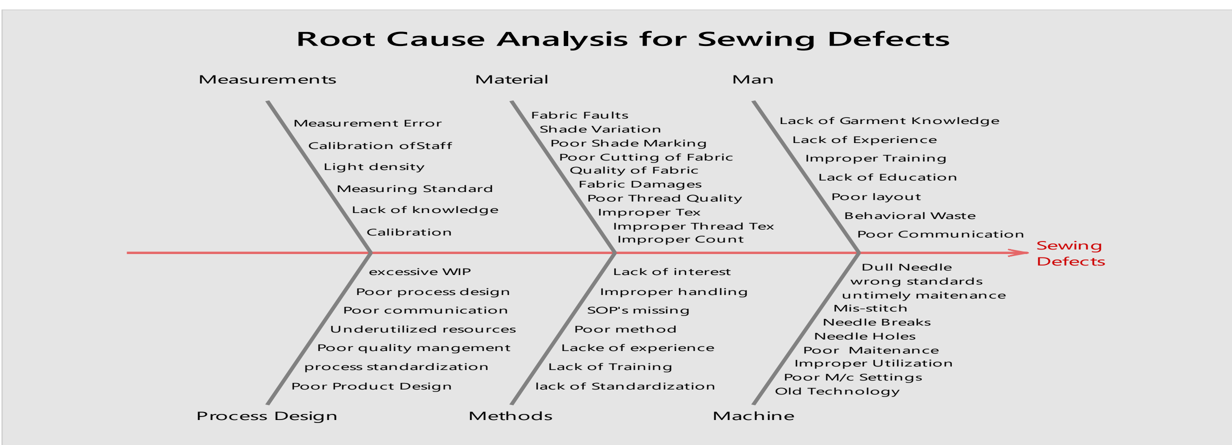

Figure 3. Ishikawa Diagram

3.2.4 Sigma Level CalculationLast 13 Week Data

Total Defects = 30099, Total Inspected = 290797, Opportunity per Unit= 1, Total opportunity= 290797
DPU (Defects/Units) = Total Defects/ Total Produced =30099 /290797 =0.10
DPO (Defects per Opportunity) = Total defects/ (Total Produced*1) =0.10
Yield = 1-DPO = 0.90
DPMO= DPO*1000000 =900000 Sigma Level = 2

3.3 Analyze Phase

Key performance indicators were found by anonymously interview the team members to select the KPIV's from the factors enlisted in Cause and Effect diagram. Out of all the factors enlisted in Ishikawa diagram Experience of worker, Qualification of Worker, Method, Layout, Poor Quality management, machine type used got highest weightage in Delphi method analysis. Factors were analyzed then.

Null hypothesis	**Alternative hypothesis**		**Factor Information**			**Analysis of Variance**				
all means are equal	At least one mean is different		Factor	Levels	Values	Source	DF	Adj SS	Adj MS	F-Value
	Significance level	α = 0.05	Experience	4	Intermediate, Metric, Middl	Experience	3	1.082	0.3608	1.05
	Equal variances were assumed for the analysis					Error	18	6.1900	0.3439	**P-Value**
						Total	21	7.273		**0.395**

Table 3.One-way ANOVA: Defects versus Qualification

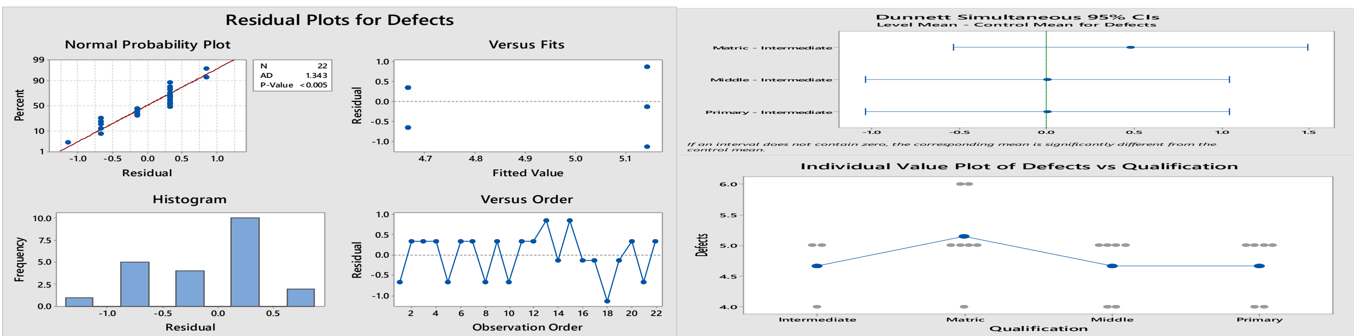

Figure 4. One-way ANOVA: Defects versus Qualification

Null hypothesis	**Alternative hypothesis**		**Factor Information**			**Analysis of Variance**				
all means are equal	At least one mean is different		Factor	Levels	Values	Source	DF	Adj SS	Adj MS	F-Value
	Significance level	α = 0.05	Experience	5	1, 2, 5, 8, 10	Experience	4	3.051	0.7628	0.95
	Equal variances were assumed for the analysis					Error	21	16.833	0.8016	**P-Value**
						Total	25	19.855		**0.454**

Table 4.One-way ANOVA: Defects versus Machine Type

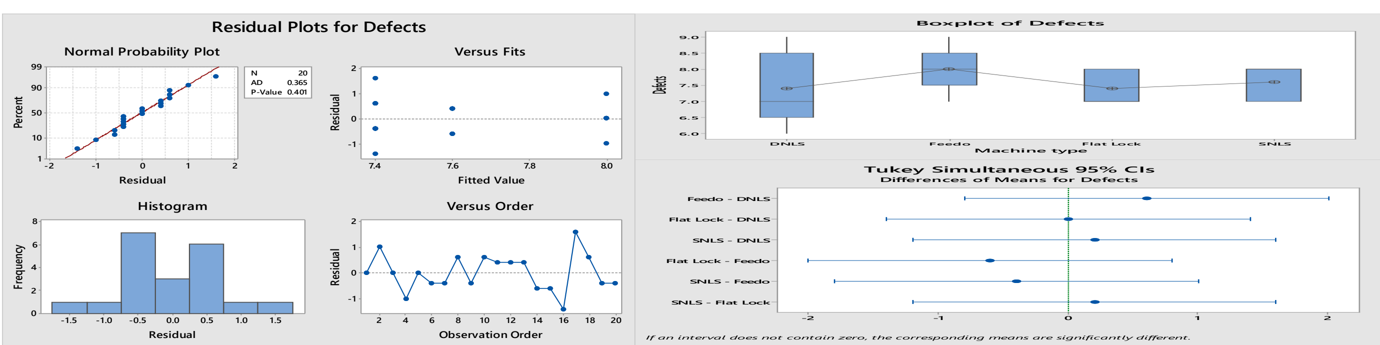

Figure 5. One-way ANOVA: Defects versus Machine Type

Null hypothesis	**Alternative hypothesis**	**Factor Information**			**Analysis of Variance**				
all means are equal	At least one mean is different	Factor	Levels	Values	Source	DF	Adj SS	Adj MS	F-Value

	Significance level	α = 0.05	Experience	5	1, 2, 5, 8, 10	Experience	4	3.051	0.7628	0.95
	Equal variances were assumed for the analysis					Error	21	16.833	0.8016	**P-Value**
						Total	25	19.855		**0.454**

Table 4.One-way ANOVA: Defects versus Experience

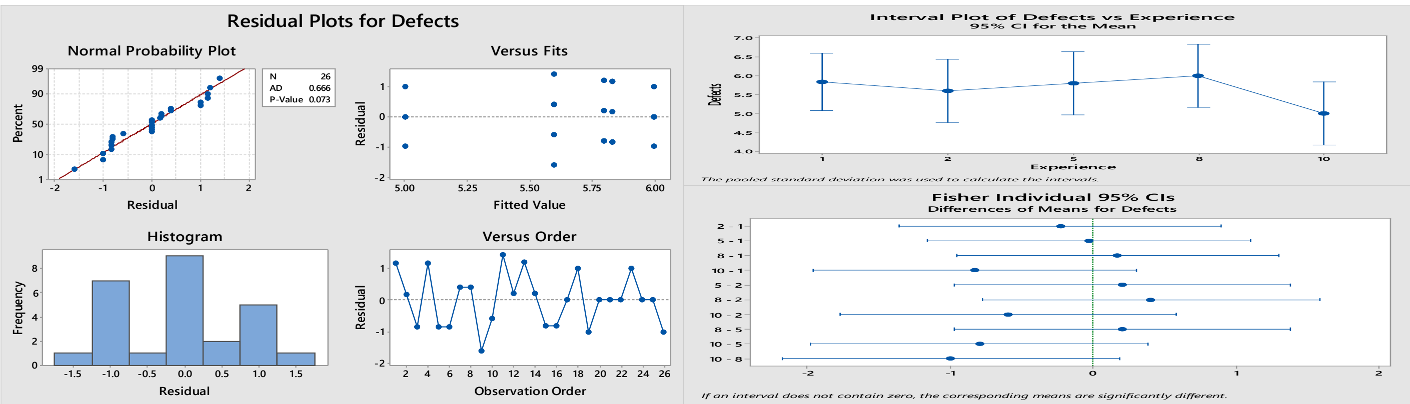

Figure 6. One-way ANOVA: Defects versus Experience

Null hypothesis	**Alternative hypothesis**		**Factor Information**			**Analysis of Variance**				
all means are equal	At least one mean is different		Factor	Levels	Values	Source	DF	Adj SS	Adj MS	F-Value
	Significance level	α = 0.05	Experience	2	1, 2	Experience	1	60.00	60.002	0.95
	Equal variances were assumed for the analysis					Error	20	33.82	1.691	**P-Value**
						Total	21	93.82		**0.000**

Table 5.One-way ANOVA: Defects versus Method

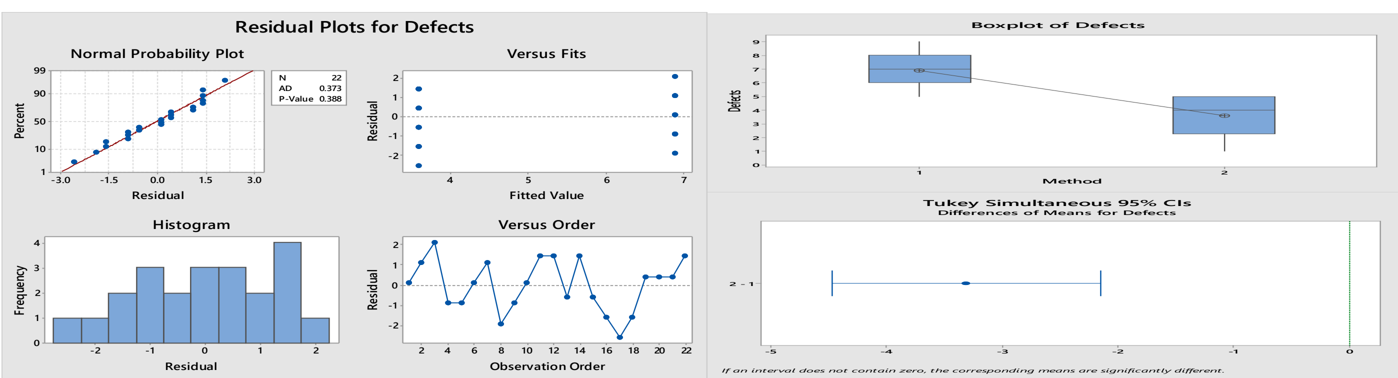

Figure 7. One-way ANOVA: Defects versus Method

3.4 Improve Phase

Denim manufacturing is quite different from the discrete manufacturing organizations. In denim manufacturing the major and very critical resource is the Human Resource. Human Resource skill and awareness to quality standards is very vital in achieving better quality.

By analyzing the key performance indicators in analyze phase we observed that only method was significant factor in having p value<0.05. Poor quality management, poor layout, lack of standardization, lack of visual control was the attribute variables that were hindrance in order to achieve process excellence.

In order to achieve operational effectiveness a system name 7/0 (Seven -Zero) was developed keep in view of all the above said input variables.

3.4.1 What is 7/0 Quality System?

A Systematic Approach consist of strong quality culture and a structured approach towards achieving minimum Defect rate through 5s implementation, layout designing, Kaizen Culture, Poka Yoke (fool Proofing), Work Flow Improvement, Standardization of Work, SPC, 7-QC Tools. Most of the Defects are created due to lack of standardization, Poor Working Methods, Poor Design of Stitching Floor. Development of a system was necessary in order to overcome the defects. The system which created robust results was 7/O system. Methods were defined. Layout of entire stitching Floor was redesigned.

3.5 Control Phase

In order to achieve long run benefits of the improvements. Various controls were defined. Failure Mode and Effect Analysis and Statistical Process Control were the main tools applied in this section.

3.5.1 C-Chart of defects

20 samples containing a total of 1424 garments were inspected and chart of their defects were drawn after improvements. Chart shows that our sewing process is stable now.

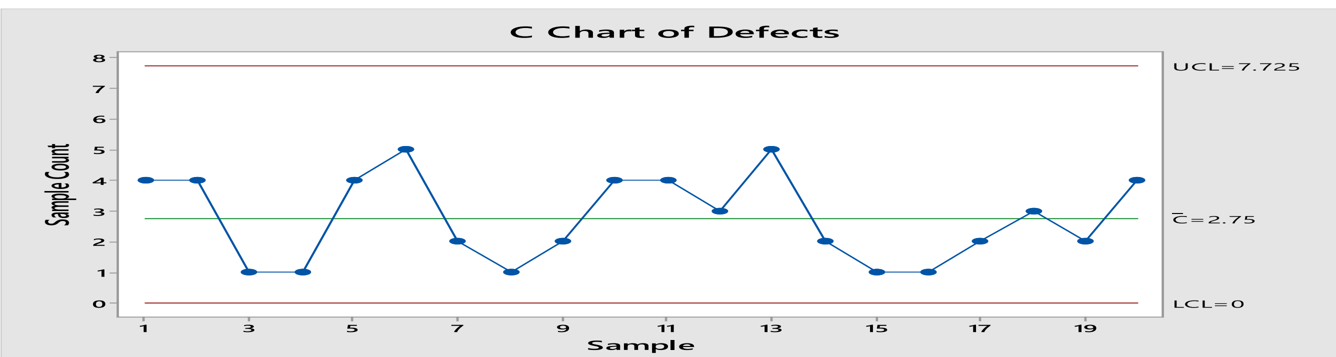

Figure 9.Control Chart

3.5.2 Failure Mode and Effects Analysis

A detailed failure mode and effect analysis of each and every sewing process was defined and controlled.

Process/Function	Potential Failure Mode	Potential Effect of Failure	S	Potential Causes of Failure	O	Current Process Control	D	RPN	Recommended Action	Responsibility
Feeding of Cutting Parts into Lines	Wrong Cutting Lot Feeding	Sewing Defects,	7	Wrong Cutting Report	4	Verification through Cutting Report	5	140	Strictly Follow the Cutting Report for Verification Without any carelessness,	Deputy Manager Production
Bk Pocket Hemming	Improper Stitching	Skipped Stitches	5	Wrong Trim card issuance	3	Quality & production	3	45	Verification of Trim card by production	Deputy Manager

				Bobbin might be wrongly threaded	3	Verifies the Trim card information	3	45	supervisor,	Production, Production In charge
Feeding of Accessori es	Wrong Feeding of Accessorie s	Shade variation, Defective Garment	5	Wrong Understanding of Trim card, Wrong Trim Card	2	Quality verifies before issuance of Accessories	5	50	Verification of Trim card From PD By Production In charge, Verification By Quality In charge, 7/0 Audit system,	In charge WIP/ In charge Sewing Production
Attach Care Label	Wrong Care Label Attachmen t	Garment Defect	3	Lack of training	5	Quality verifies before issuance of Accessories	4	60	Method Follow-up, 7/0 Audit	QC Inspector, Supervisor Front section
				Lack of knowledge of worker	3		4	36		
Cover Stitch	Wrong Stitching	Puckerin g	5	not following the notches on front rise	7	No current Control	5	175	Method Follow-up, 7/0 Audit	QC Inspector, Supervisor Front section
Mock Stitch	Improper Mock Stitch	Uneven Stitches	5	Needle Breakdown	3	No current Control	5	75	Periodic Maintenance of Machine	Mechanical Engineering Deptt, I.E Deptt
				Lack of Operator training	5		4	100		
Attach Left Fly with Zip	Wrong Attachmen t of Fly,	Defects in Garment,	4	Wrong Zip, Wrong Shade Marking,	2		5	40	Follow-up 7/0 Audit System	Supervisor Front Section, QC Inspector
Hem Watch and Back pocket	Wrong hemming	Skipped Stitches	6	Method	3	No Process Control Available	2	36	Maintenance of Machine on time, Operator Training on using machine.	Small Parts Supervisor, Maintenance Department,
				Improper threading.	7		6	252		
Close Pocket Bag	Sewing Defects	Puckerin g or Pleat	6	Wrong type of needle for the material.	3	No Process Control Available	3	54	Method Follow-up, Handling Should be made better, Notches on Panels must be followed, 7/0 Audit	Supervisor Front Section, QC Inspector
				Needle size and thread weight are mismatched.	4		5	120		
Pocket Bag Attach	Defective Back Pocket	Run-off stitch, Pleat at Pocket Bag	6	Speed of Machine, Wrong Method,	7	Work Instructions	7	294	Improved method must be followed, Notches must be followed, worker should be made conscious of his work	Supervisor Back section, QC Inspector
				Improper stretching of fabric plies	3		3	54		
Yoke Attach	Improper yoke attach	Run-off stitch, Broken Stitches on Yoke	6	Speed of machine	3	Standardized work.	3	54	,Change the needles at regular intervals on operations	Supervisor Back section, QC Inspector
Back Pocket Attach	Wrong Attachmen t of Back Pocket	Dog Ear, Wrong Edge Margin,	5	Speed of machine,	2	No current control	3	36	Worker Must follow the machine guides, 7/0 Audit system,	Supervisor Back Section,
				Improper training of worker.	5		6	180		
Close Inseam	Plus or minus Panel Length	Measure ment Defects, Run-off,	6	Wrong information about needle gauge	7	No current control	7	294	7/0 Audit system, Method enforcement, Better cutting Procedures	, Supervisor Assembly-1, QC Inspector

				Lack of training	7		4	168		
Close Out-seam	Plus or minus Panel Length	, Run-off, Twisted Leg	7	Wrong Shade marking	3		5	105	Alignment of notches	Instructor Industrial Engineering,
				Wrong Folding	2		4	56		
Waist belt Attach	Wrong waist belt attachment	Pleat at waist belt, run-off	7	Wrong type of needle for the material.	3	No current control	2	42	Use the ideal foot, feed and plate that help to minimize flagging, 7/0 Audit system	Supervisor Assembly 1, QC Inspector
				Needle size and thread weight are mismatched.	2		3	42		
Hem Bottom	Improper Hemming	Ropy Hem, Pleat,	5	Worker might hold back during sewing	7	No current control	5	175	Start using folder correctly, Instruct the sewing operator.	Supervisor Assembly 2, QC Inspector
Close Band end	Needle breakage	broken stitches, Skipped Stitches	5	Improper Method	7	No current Control	7	245	Good quality needles should be used, Maintenance should be periodic and on time	Supervisor Assembly 2, QC Inspector
Loop Attach	Wrong Loops Attached	Loops Misalign ment, Loop Untrimm ed	4	Needle clamp screw is loose	3	No Current control	4	48	Worker Training, 7/0 Audit system	Supervisor Assembly 2, QC Inspector
Leather Patch Attach	Wrong Leather patch Attachmen t	Garment Defect	4	Material pulled and/or moved excessively during sewing	2	No current Control	7	56	Verification of trim card during Its issuance by Quality Inspector, 7/0 Audit System	Quality In charge Line # 1, QC Inspector
Trimming	Wrong Trimming	Untrimm ed Threads	7	Improper Trimming	7	No current Control	6	294	Follow-up of Sop, 7/0 Audit System	Quality In charge Line # 1, , QC Inspector
				Not following the SOP	7		6	294		

Table 6. FMEA

5.3 After Improvement Six Sigma Calculations

Total Defects = 4256, Total Inspected = 93224

Opportunity per Unit= 1, Total opportunity=93224

DPU (Defects/Units) = Total Defects/ Total Produced = 4256/ 93224 = 0.045

DPO (Defects per Opportunity) = Total defects/ (Total Produced*1)=0.045

Yield = 1-DPO= 0.9543

DPMO= DPO*1000000=0.045*1000000= 45000 Sigma Level = 3

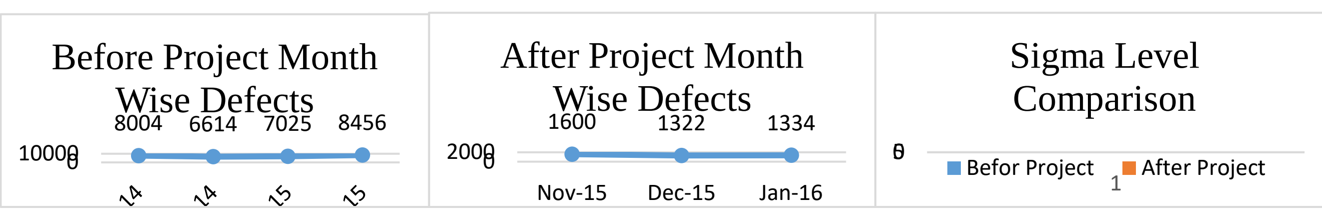

Figure 11. charts

4. CONCLUSION

DMAIC is a business process excellence methodology. It improves the existing processes enormously resulting in improved quality, productivity, reduced lead times and delighters customers. While DMADV is used in new process designing.

This paper presents the step by step application of DMAIC phases from problem statement to improve and control of problems. At the start of project defect rate was 71 % but after the successful application of Six Sigma DMAIC approach Defect rate reduce up to 25 % and the sigma level improved from 2 to 3 Sigma.

5. REFERENCE

1. C.Manohar, A.Balakrishna, (2015), Defect Analysis on Cast Wheel By Six Sigma Methodology to Reduce Defects and improve the Productivity in Wheel Production Plant. International Research Journal of Engineering and Technology (IRJET). Page 1659-1663

2. Dr. AnupamaPrashar, (2013). Right-First-Time dyeing in Textile using Six Sigma methods. International Journal of Scientific & Engineering Research, Volume 4, Issue 8, August-2013. Page 1517-1525

3. Jeroen de Mast., JoranLokkerbol., (2012). An analysis of the Six Sigma DMAIC method from the perspective of problem solving. Int. J. Production Economics 139 (2012) 604–614

4. Jitender Kumar., MukeshVerma., K.S. Dhillon., (2014). Reduction in defects rate using DMAIC approach-A Case Study. International Journal of Enhanced Research in Science Technology & Engineering, Vol. 3 Issue 12, December-2014, pp: (146-152)

5. Linderman, K., Schroeder, R.G., Zaheer, S., Choo, A.S., (2003). Six Sigma: a goal-theoretic perspective. Journal of Operations Management 21, 193–203.

6. Md. Mazedul Islam, Adnan Maroof Khan, Md.MashiurRahmanKhan., (2013). MINIMIZATION OF REWORKS IN QUALITY AND PRODUCTIVITY IMPROVEMENT IN THE APPAREL INDUSTRY. International Journal of Engineering and Applied Sciences. January 2013. Vol. 1, No.4

7. MOHAMMED T. HAYAJNEH, OMAR BATAINEH, RAMI AL-TAWIL, (2013). Applying Six Sigma Methodology Based On "DMAIC" Tools to Reduce Production Defects in Textile Manufacturing,

8. Neha Gupta, 2013, An Application of DMAIC Methodology for Increasing the Yarn Quality in Textile Industry, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684 Volume 6, Issue 1 (Mar. - Apr. 2013), PP 50-65

9. Syed MisbahUddin., RashidulHasan., Md. Saddam Hosen., (2014). Defects Minimization through DMAIC Methodology of Six Sigma. International Conference on Mechanical, Industrial and Energy Engineering, 26-27 December, 2014, Khulna, BANGLADESH

10. Uddin S.M. and Rahman C.M.L., (2014). Minimization of Defects in the Sewing Section of a Garment Factory through DMAIC Methodology of Six Sigma. Research Journal of Engineering Sciences Vol. 3(9),

11. Young HoonKwak, Frank T. Anbari (2006). Benefits, obstacles, and future of six sigma approach. Technovation 26(2006)708s

TO OPTIMIZE THE MAINTENANCE SYSTEM OF A GARMENTS MANUFACTURING INDUSTRY THROUGH MODELING

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Abstract: This research was conducted to optimize the maintenance system of a Garments Manufacturing Industry through computer simulation. The aim of this research was to present an approach for the optimal maintenance and repair strategies to ensure maximum system availability at minimum cost. The desired simulation models were developed through AweSim 2.0. The downtime due to corrective as well as preventive maintenance in stitching lines had been calculated by determining per day failure rate. The maintenance, repairing inventory system had also been observed by analyzing the daily consumption of items. The experimental controls of developed simulation models were defined before running. The results from the models were verified and validated. The analysis process included simulation results, cost and downtime analysis. Proposed models were developed to rectify the existing maintenance system. The optimum levels were identified when the total cost of maintenance inventory and downtime is at its minimum level. But system availability time has to be increased.

Keywords: Maintenance system, Computer simulation, Corrective maintenance, Preventive maintenance, Inventory system.

1. INTRODUCTION

The importance of an effective maintenance program in Garments industry cannot be ignored because it plays such an important role, as in personal health care insurance, maintenance may be considered the heath care of our manufacturing machines and equipment. It is required to effectively reduce waste and run an efficient, continuous manufacturing operation, business, or service operation. The cost of regular maintenance is very small when it is compared to the cost of a major breakdown at which time there is no production. A good maintenance program requires company-wide participation and support by everyone ranging from the top executive to the shop floor personnel. Intelligent maintenance systems (IMS) predict and forecast equipment performance so “near-zero breakdown" status is possible. Near-zero downtime focuses on machine performance techniques to minimize failures. By looking at data (current and historical), it can predict future performance. Today, in industry, the cost of downtime has a big impact on profitability. If equipment starts to wear, it is possible to start producing parts with unacceptable quality and not know it for a long time. Eventually, machine wear will seriously affect not only productivity but also product quality.

1.1. Research Problem:

The aim of this research is to present an approach for the optimization of maintenance and repair system of Garments Manufacturing Industry to ensure increased system availability at minimum cost.

1.2. Research Objectives:

The research objectives are as follows:

1. To optimize the maintenance system of a Garments manufacturing industry through modeling
2. To reduce the down time of stitching machines by determining failure rate of machines this includes (queue time + service time)
3. To optimize the maintenance system inventory which includes spare parts required for repair and maintenance
4. To reduce the inventory cost invested in maintenance spare parts by analysis of daily consumption of items

1.3. Scope of the Research:

The research work is limited to find out the downtime due to corrective as well as preventive maintenance and inventory available in store for repair with the support of cost analysis. All the data has been gathered from a Textile Mills Ltd. It covers major issues such as Failure Rate or Breakdowns arrival in the system, pattern of daily consumption etc.

2. MATERIALS AND METHODS

This study is practical and carried out in local textile industry. The research has been conducted as per operations research methodology, which essentially involves the following steps:

1. System study
2. Formulate the problem
3. Specify model
4. Build model
    a. Collect data
    b. Develop simulation model
    c. Define experimental control
5. Simulate model
    a. Run model
    b. Verify model
    c. Validate model
6. Draw inferences by interpretation of model output
7. Support decision making
8. Conclusion

2.1 Minitab

Minitab is the primary statistical software for quality improvement worldwide. It is used for the following purposes:

1. Effortless Data Analysis: Minitab is used for data analysis and helps us to interpret our results with confidence
2. Basic Statistics: Access a comprehensive set of statistical tools, including Hypothesis Tests, Descriptive Statistics, Normality Tests and Confidence Intervals.
3. Presentation Quality: Minitab is used to present the data successfully and confidently using remarkable, practiced graphs.
4. Instinctive Design: Focus on analyzing the data. Minitab has user-friendly menus, state-of-the art graphs, and more.

2.2 AweSim with Visual Slam:

AweSim is the system that supports the modeling and simulation process described in this research work. It provides integrating capabilities to store, retrieve, browse and communicate with extremely written software applications. The most openness and interconnectivity to databases, spread-sheets, and word processing programs such as Microsoft Office. Since AweSim is built in Visual Basic and C/C++, programs written in these languages are easily incorporated into its architecture. The use of standard programs built in C/C++ or VB are easily added as components of AweSim. Model of Visual Slam based on two parts.

2.2.1 Network:

In this part modeller make a model with the help of different AweSim nodes. Each node in AweSim has its own functionality. Nodes use in this research work has been used.

2.2.2 Control:

When the network is complete one make a control for the network. Without control model cannot be simulated. While making the control for the network no. of various types of control statements are used. The control statements that are used by me in this developed simulation model.

2.3 Textile Garments Division:

Textile is one of the foremost and leading textile manufacturers, based in Lahore, Pakistan, engaged in the export of quality products like: Yarns, Garments and Fabrics. In their quest to vertically integrate, they have installed a garments facility capable of producing twill and denim pants, trousers, etc…, thereby offering their customers the flexibility of not only buying grey or dyed fabric but garments as well.

 ISBN: 978-969-7710-01-0

2.4 Stitching machines in Garments Division:

In Garments Division, there are 860 Stitching Machines; these machines are of different types having different quantity ratios.

2.5 Maintenance system in Garments Division:

As the goal of this research is to present an approach to the optimal maintenance and repair strategies of Textile industry Garments division, by increasing system availability and reducing cost. In this industry, maintenance department is going through two kinds of maintenance:

2.5.1 Corrective Maintenance in Garments Division:

"Run to failure" or Failure Based Maintenance (FBM) is a common maintenance philosophy. Where equipment is maintained after break down, this maintenance is often most expensive because worn equipment can damage other parts and cause multiple damages. Machines are gone through corrective maintenance when breakdown occurs. The time between machines arrival for corrective maintenance are also determined which is given as follows:

Table 2.5.1 Descriptive Statistics for Corrective Maintenance

Sr. #	Variable	Count	Mean	StDev	Minimum	Median	Maximum	P-Value	Normal/ Non-Normal	Distribution
01	Av.# of Break-Down		8.500	1.567	4.833	8.750	10.417	> 0.05	Normal	Exponential
02	Av.# of Down-time	10	159.7	35.7	87.4	161.3	217.3	> 0.05	Normal	Normal
01	Average Time between Breakdown Arrival in a Line = 480/8.50 = 56.47 minutes									
02	Average Repair (Service) Time in a Line for a Breakdown = 159.68/8.50 =18.79 minutes									

2.5.2 Preventive Maintenance in Garments Division:

Preventative maintenance is a policy that assigns replacement or repair of system parts at assigned units of time and/or cycles regardless of the condition. Where equipment is maintained before break down occurs. All machines are gone through preventive maintenance after 3 months to reduce the failures as maximum as possible. The time between machines arrival for preventive maintenance are also determined.

2.5.3 Needles Break or Replace in Garments Division:

Needles' setting is also the responsibility of maintenance department when it is broken or it has to be replaced due to damages. Needles are attached to stitching machines when it is broken or it has to be replaced due to damages. The time between Needle's Breakage and Needle's Replace arrival in a line are also determined which is given as follows:

Table 2.5.3 Descriptive Statistics for Needle's Breakage and Needle's Replace

Sr. #	Variable	Count	Mean	StDev	Minimum	Median	Maximum	P-Value	Normal/ Non-Normal	Distribution
01	Av. Needles Breakage	58	1.854	0.707	1.000	1.708	4.000	< 0.05	Non-Normal	Exponential
02	Av. Needles Replace	58	9.682	2.424	5.333	9.250	16.000	> 0.05	Normal	Exponential
01	Average Time between Needle's Breakage Arrival in a Line = 480/1.9 = 252.6 minutes									
02	Average Time between Needle's Replace Arrival in a Line = 480/9.7 = 49.5									

2.6 Spare parts inventories Consumption in Garments Division:

It is also the responsibility of maintenance department to manage the spare parts inventories. There are approximately two thousand 2000 different items used for machinery repair and maintenance.

1. Monthly inventory is reviewed and demand is generated.
2. Lead time for order is 3 to 5 days.

2.6.1 Inventory Items Selected for Simulation:

Through ABC Analysis, I have selected needles and shuttles to be simulated for optimization:

2.6.2 Consumption or Demand Rate:

Above mentioned inventory items consumptions statistics are given below.

Table 2.6.2 Inventory items consumptions statistics (Needles)

Sr. #	Variable	Count	Mean	StDev	Minimum	Median	Maximum	P-Value	Normal/ Non-Normal	Distribution
01	DPX17	58	6.914	4.586	0.000	6.000	21.000	< 0.05	Non-Normal	Lognormal
02	DCX27	58	48.48	14.48	22.00	46.00	80.00	> 0.05	Normal	Normal
03	DPX5	58	46.02	12.13	21.00	45.00	69.00	> 0.05	Normal	Normal
04	DVX 57	58	12.95	7.71	0.00	12.00	34.00	< 0.05	Non-Normal	Lognormal
05	TVX5	58	11.69	5.338	2.00	11.00	30.00	> 0.05	Normal	Normal
06	DOX558	58	0.034	0.262	0.00	0.00	2.00	< 0.05	Non-Normal	Exponential

Table 2.6.2(a) Inventory items consumptions statistics (Shuttles)

Sr. #	Variable	Count	Mean	StDev	Minimum	Median	Maximum	P-Value	Normal/ Non-Normal	Distribution
01	SN		11.71	7.148	3.00	11.00	26.00	< 0.05	Non-Normal	Exponential
02	DN		6.323	4.080	0.00	5.000	18.00	< 0.05	Non-Normal	Lognormal
03	Bartack		7.629	3.872	2.00	7.000	23.00	< 0.05	Non-Normal	Lognormal
04	St Eyelet		0.419	0.666	0.000	0.000	3.000	< 0.05	Non-Normal	Exponential
05	ZigZag		0.274	0.771	0.000	0.000	4.000	< 0.05	Non-Normal	Exponential
06	Mock		0.193	0.437	0.000	0.000	2.000	< 0.05	Non-Normal	Exponential
07	PktWelt		0.177	0.528	0.000	0.000	2.000	< 0.05	Non-Normal	Exponential

2.7 Developing Simulation Models:

According to problem study, the following simulation models have been developed;

1. PM (Preventive Maintenance Model)
2. CM (Corrective Maintenance Model)
3. Inventory Models of selected items

2.7.1 PM (Preventive Maintenance Model):

Two Technicians are responsible for preventive maintenance of all the machines of stitching unit. Preventive maintenance model is given as follows:

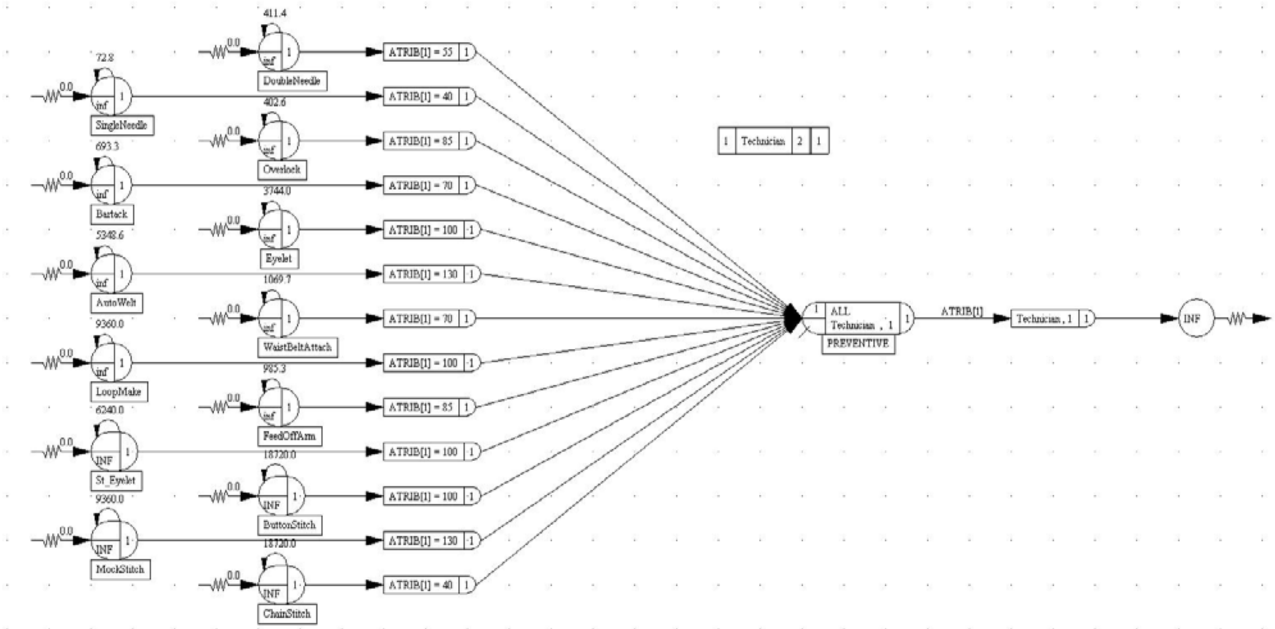

Figure 1. PM (Preventive Maintenance Model)

2.7.2 CM (Corrective Maintenance Model):

One Technician is responsible for corrective maintenance of 1 specific line. Corrective maintenance model is applicable for other lines are given as follows:

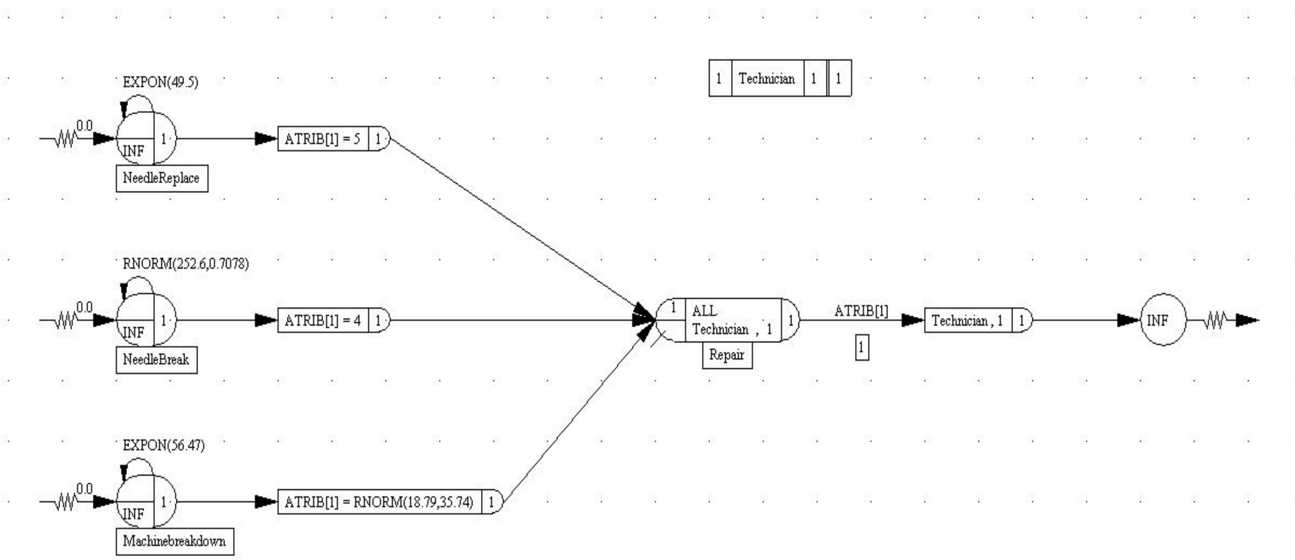

Figure 2. CM (Corrective Maintenance Model)

2.7.3 Inventory Models:

Inventory models are developed as per demand rate of each item discussed earlier and minimum stock levels are also listed. An exemplary inventory model of Needle DCX27 is given below. All inventory models are same as given below but only data variables are changed as per consumption and stock level. Inventory model of Needle DCX27 is as follows:

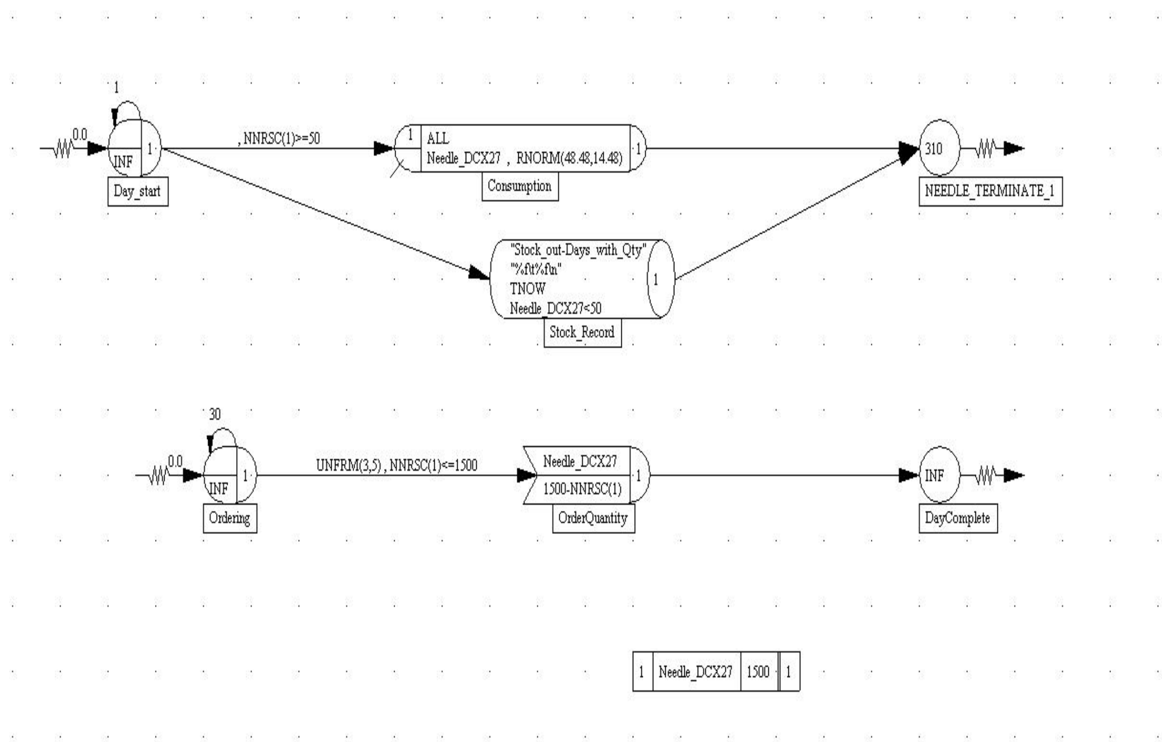

Figure 3. Inventory Model of Needle DCX27

3. SIMULATION RESULTS & DISCUSSIONS

According to Simulation Models, the following results have been observed;

3.1. Preventive Maintenance Results:

Preventive maintenance AweSim report shows the following results:

1. Average Waiting Time in preventive maintenance file # 1 is 14.199 minutes which shows that Average Queue Time for a machine to be serviced is 14.199 minutes.
2. Average Queue Length in preventive maintenance file # 1 is 0.326.
3. 1.246 Resources are being utilized out of 2 in preventive maintenance. 0.754 Resource is being under-utilized.
4. 0.754 Resource is not being utilized which is available to us.
5. In Preventive maintenance our resource utilization is 62.3% and 37.6% resources are not being utilized.

3.2. Corrective Maintenance Results:

Corrective Maintenance AweSim report shows the following results:

1. Queue Length in corrective maintenance file # 1 is 1.209 which predicts that 1.209 machines averagely wait in queue to be serviced.
2. Average Waiting Time in corrective maintenance file # 1 is 28.857 minutes which show that Average Queue Time for a machine to be serviced is 28.857 minutes.
3. 0.431 Resource is not being utilized which is available to us.
4. 0.569 Resource is being utilized out of 1 in each area of corrective maintenance. 0.431 Resource is being under-utilized.
5. In Corrective maintenance our resource utilization is 56.9% and 43.0% resources are not being utilized.

3.3. Maintenance Inventory Results:

Maintenance inventories AweSim reports shows the following results:

Table 3.3.1 Maintenance Inventory Results (Needles)

Sr. #	Variable	Average Waiting Time	Stock-out	Range (Min---Max)	Inventory Utilization (%)	Inventory Availability (%)	Average Inventory	Remarks
01	DPX17	0.00	No	450-700	62.5	37.4	607.247	Surplus inventory is available
02	DCX27	0.00	No	0-1500	90.2	9.7	799.157	Stock level is optimum
03	DPX5	0.00	No	479-2000	84.1	15.8	1335.737	Surplus inventory is available
04	DVX57	0.00	No	7-400	89.6	10.3	220.751	Stock level is optimum
05	TVX5	0.00	No	82-500	82.8	17.1	341.423	Surplus inventory is available
06	DOX558	0.00	No	199-200	2.8	97.1	199.685	Surplus inventory is available

Table 3.3.2 Maintenance Inventory Results (Shuttles)

Sr. #	Variable	Average Waiting Time	Stock-out	Range (Min---Max)	Inventory Utilization (%)	Inventory Availability (%)	Average Inventory	Remarks
01	SN	0.00	No	16-25	59.8	40.1	22.478	Surplus inventory is available
02	DN	0.00	No	0-10	85.8	14.1	6.149	Stock level is optimum
03	Bartack	0.00	No	0-15	81.9	18.0	10.712	Stock level is optimum
04	St Eyelet	0.00	No	0-1	80.8	19.1	0.712	Stock level is optimum
05	ZigZag	0.00	No	0-1	74.0	25.9	0.756	Stock level is optimum
Sr. #	Variable	Average Waiting Time	Stock-out	Range (Min---Max)	Inventory Utilization (%)	Inventory Availability (%)	Average Inventory	Remarks
06	Mock	0.00	No	0-1	65.2	34.7	0.905	Stock level is optimum
07	PktWelt	0.00	No	0-1	63.0	36.9	0.926	Stock level is optimum

4. PROPOSED MODELS

Some Proposed Models are being suggested to optimize the maintenance system.

4.1 1st Option for Corrective Maintenance:

In Proposed Option 1: Making a Team/Pool of Two Technicians in which Two Technicians are equally responsible for Corrective Maintenance of Two specific lines. AweSim report of 1st Option predicts the following results:

1. Average Queue Length of Corrective Maintenance in 1st Proposed Model File # 1 is 1.109 but it is 1.209 Minutes in Existing Model. So, by applying this option Queue Length will be reduced.
2. Average Waiting Time of Corrective Maintenance in 1st Proposed Model File # 1 is 12.922 Minutes but it is 28.857 Minutes in Existing Model. So, by applying this option Waiting Time will be reduced.
3. In 1st Proposed Model of Corrective Maintenance1.196 Resources are being utilized out of 2 in each area of Corrective Maintenance. 0.804 Resource is being under-utilized.
4. In 1st Proposed Model of Corrective Maintenance 0.804 Resource out of 2 is not being utilized which is available to us.
5. In 1st Proposed Model of Corrective Maintenance our Resource Utilization is 59.8% but it is 56.9% in Existing Model and 43.0% Resources are not being utilized in 1st Proposed Model.

4.2 2nd Option for Corrective Maintenance:

In Proposed Option 2: Making a Team/Pool of Three Technicians in which Three Technicians are equally responsible for Corrective Maintenance of Three specific lines. AweSim report of 2nd Option predicts the following results:

1. Average Queue Length of Corrective Maintenance in 2nd Proposed Model File # 1 is 0.700 but it is 1.209 Minutes in Existing Model. So, by applying this option Queue Length will be reduced.
2. Average Waiting Time of Corrective Maintenance in 2ndProposed Model File # 1 is 5.528 Minutes but it is 28.857 Minutes in Existing Model. So, by applying this option Waiting Time will be reduced.
3. In 2nd Proposed Model of Corrective Maintenance1.729 Resources are being utilized out of 3 in each area of Corrective Maintenance. 1.271 Resources are being under-utilized.
4. In 2nd Proposed Model of Corrective Maintenance 1.271 Resources out of 3 are not being utilized which is available to us.
5. In 2nd Proposed Model of Corrective Maintenance our Resource Utilization is 57.6% but it is 56.9% in Existing Model and 42.3% Resources are not being utilized in 2nd Proposed Model.

4.3 3rd Option for combined (Preventive + Corrective) Maintenance:

In Proposed Option 3: One Technician is responsible for combine Preventive and Corrective Maintenance of one specific line. AweSim report of 3rd Option predicts the following results:

1. Average Queue Length for Combined (Preventive + Corrective) Maintenance in 3rd Proposed Model File # 1 is 4.883 but it is 0.326+1.209 Minutes in Existing Model.
2. Average Waiting Time for Combined (Preventive + Corrective) Maintenance in 3rd Proposed Model File # 1 is 106.656 Minutes but it is 14.199+28.857 Minutes in Existing Model.
3. In 3rd Proposed Model for Combined (Preventive + Corrective) Maintenance 0.713 Resource is being utilized out of 1 in each area of Maintenance. 0.287 Resource is being under-utilized.
4. In 3rd Proposed Model for Combined (Preventive + Corrective) Maintenance 0.287 Resource out of 1 is not being utilized which is available to us.
5. In 3rd Proposed Model for Combined (Preventive + Corrective) Maintenance our Resource Utilization is 71.2% but it is 62.3%+56.9% in Existing Models and 28.7% Resources are not being utilized in 3rdProposed Model.

4.4 4th Option for Combined (Preventive + Corrective) Maintenance:

In Proposed Option 4: Making a Team/Pool of Two Technicians in which Two Technicians are equally responsible for combined Preventive and Corrective Maintenance of Two specific lines. AweSim report of 4th Option predicts the following results:

1. Average Queue Length for Combined (Preventive + Corrective) Maintenance in 4th Proposed Model File # 1 is 3.113 but it is 0.326+1.209 Minutes in Existing Model.
2. Average Waiting Time for Combined (Preventive + Corrective) Maintenance in 4th Proposed Model File # 1 is 34.645 Minutes but it is 14.199+28.857 Minutes in Existing Model.
3. In 4th Proposed Model for Combined (Preventive + Corrective) Maintenance 1.417 Resources are being utilized out of 2 in each area of Maintenance. 0.583 Resource is being under-utilized.
4. In 4th Proposed Model for Combined (Preventive + Corrective) Maintenance 0.583 Resource out of 2 is not being utilized which is available to us.
5. In 4th Proposed Model for Combined (Preventive + Corrective) Maintenance our Resource Utilization is 70.8% but it is 62.3%+56.9% in Existing Models and 29.1% Resources are not being utilized in 4th Proposed Model.

4.5 5th Option for Combined (Preventive + Corrective) Maintenance:

In Proposed Option 5: Making a Team/Pool of Three Technicians in which Three Technicians are equally responsible for combined Preventive and Corrective Maintenance of Three specific lines. AweSim report of 5th predicts the following results:

1. Average Queue Length for Combined (Preventive + Corrective Maintenance) in 5th Proposed Model File # 1 is 2.163 but it is 0.326+1.209 Minutes in Existing Model.
2. Average Waiting Time for Combined (Preventive + Corrective) Maintenance in 5th Proposed Model File # 1 is 16.325 Minutes but it is 14.199+28.857 Minutes in Existing Model.

3. In 5th Proposed Model for Combined (Preventive + Corrective) Maintenance 2.051 Resources are being utilized out of 3 in each area of Maintenance. 0.949 Resource is being under-utilized.
4. In 5th Proposed Model for Combined (Preventive + Corrective) Maintenance 0.949 Resource out of 3 is not being `utilized which is available to us.
5. In 5th Proposed Model for Combined (Preventive + Corrective) Maintenance our Resource Utilization is 68.3% but it is 62.3%+56.9% in Existing Models and 31.6% Resources are not being utilized in 5th Proposed Model.

4.6 Inventory Optimization

Excessive amount is invested in inventory with wrong predictions of Minimum Stock Levels and Consumptions. The inventory levels must be as per consumption. Following table determines the optimized state of inventory items:

Table 4.6 Inventory Optimization (Needles & Shuttle)

Sr. #	Variable	Average Waiting Time	Stock-out	Range (Min---Max)	Inventory Utilization (%)	Inventory Availability (%)	Average Inventory	Remarks
Option # 06	DPX17	0.00	No	5-250	86.4	13.5	158.437	Proposed Stock level is optimum
Option # 07	DPX5	0.00	No	23-1500	89.3	10.6	841.347	Proposed Stock level is optimum
Option # 08	TVX5	0.00	No	2-420	86.3	13.6	261.423	Proposed Stock level is optimum
Option # 09	DOX55 8	0.00	No	2-3	68.5	31.4	2.685	Proposed Stock level is optimum
Option # 10	Shuttle SN	0.00	No	1-10	81.7	18.2	7.478	Proposed Stock level is optimum

5. CONCLUSION

It is concluded that Waiting Time and Queue Length can be reduced if we go to the concept of team or pooling.

A Comparison of Existing Corrective Maintenance System and Proposed System are given in the following tables.

Table 5. Corrective Maintenance (Existing vs. Proposed)

Model	Average Waiting Time	Average Length	Resource Utilization	Resource Availability	Technician/ Specific Line	Remarks
Existing	28.857	1.209	56.9%	43.1%	1/1	
Proposed Option 1	12.922	1.109	59.8%	40.1%	2/2	Waiting Time and Queue Length is reduced
Proposed Option 2	5.528	0.700	57.6%	42.3%	3/3	Minimum Waiting Time and Queue Length

Table 5(a). Combined Preventive and Corrective Maintenance (Existing vs. proposed)

Model	Average Waiting Time	Average Length	Resource Utilization (%)	Resource Availability (%)	No. of Resources Used	Technician/ Specific Line	Remarks
Existing	14.199+28.857	0.326+1.209	62.3+56.9	37.7+43.1	2+12	CM*= 1/1 PM*= 2/All	
Proposed Option 3	106.656	4.883	71.3	28.7	12	Combined CM +PM 1/1	Waiting Time increased but No. of Resources reduced
Proposed Option 4	34.645	3.113	70.8	29.1	12	Combined CM +PM 2/2	Waiting Time and Queue Length is reduced
Proposed Option 5	16.325	2.163	68.3	31.6	12	Combined CM +PM	Minimum Waiting Time with Less No. of

						3/3	Resources

CM*= Corrective Maintenance PM*= Preventive Maintenance

Proposed Option 5 should be implemented as Waiting Time is less and minimum no. of Resources is used. Monthly salary of RS.40000 is also saved as Two (2) Technicians are lessened.

5.1. Inventory Optimization:

It is concluded that excessive amount is invested in inventory with wrong predictions of minimum stock levels and consumptions. There are approximately 2000 items being used for repair and maintenance of machinery in stitching unit. Optimized inventory levels with cost of the observed items are given below:

Table 5.1 Proposed Inventory Optimization Options (Needles & Shuttle)

Sr. #	Variable	Existing Inventory	Proposed Inventory	Rate/- (PKR)	Amount Saved (Rs.) Invested in Inventory
Option # 06	DPX17	700	250	12	5400
Option # 07	DPX5	2000	1500	7.75	3875
Option # 08	TVX5	500	420	16.7	1336
Option # 09	DOX558	200	3	20	3940
Option # 10	Shuttle SN	25	10	800	12000
				Total Cost Saving	**26551**

6. RECOMMENDATIONS

It is recommended that there are approximately 2000 Items being used for Repair and Maintenance of Machinery in Stitching Unit of Textile industry. I have observed only 13 items among them but all the items must be check for inventory optimization.

It is also recommended that management should implement Proposed Option 5 for Corrective and Preventive Maintenance with minimum Waiting Time and Minimum No. of Technicians. The 2 Technician’s salary is also saved which is approximately RS. 40000 per month.

Instead of AweSim simulation software, modern software of simulation can be used for better results.

7. REFERENCES

1) Duffuaa, S.O. Ben-Daya, M. Al-Sultan K.S. and Andijani A.A. (2001), “A generic Conceptual simulation model for maintenance systems”, Journal of Quality in Maintenance Engineering, Vol 7, pp. 207-219.

2) Marseguerra, M. Zio, E. (2000), "Optimizing maintenance and repair policies via a combination of genetic algorithms and Monte Carlo simulation", Reliability Engineering and System Safety, 68, pp. 69-83.

3) Duane Steward. (2007), "The Role of Simulation and Modeling in Disaster Management", Journal of Medical Systems.

4) Clark. G.M. (1991), "Principles of modeling", Winter Simulation Conference Proceedings.

5) Zolfaghari, S. Lopez Roa Erika, V. (2006), “Cellular manufacturing versus a hybrid system”, Journal of Manufacturing Technology Management, Volume 17, Issue 7.

6) Takayuki Kataoka. (2007), "Integrating Activity Based Costing and Process Simulation for Strategic Human Planning", IFIP — The International Federation for Information Processing.

7) KUMAR, A. SHIM, S.J. PHE, A. (2008), “Simulating Staffing Needs for Consultation in Hospital Clinics”,Journal of Operations and Logistics Volume 2, Issue 2.

8) Reilly, J.O. (2002), “Introduction to AWESIM”, Proceedings of the 2002 Winter Simulation Conference.

9) Reilly, J.O. Lilegdon, W.R. (1999), “Introduction to AWESIM”, Proceedings of the 1999 Winter Simulation Conference.

10) Virtual Development and Training Centre in Magdeburg. (2007), “Topology-Based Methods in Visualization”, the Conference SimVis 2007.

11) Kima, T. Fishwickb, P. (2002), “An XML-based 3D model visualization and simulation framework for dynamic models”, Computer and Information Science and Engineering Department, University of Florida, Gainesville, FL 32611.

12) Xin, H., and W. Jianan. (2012), "Up-Regulation of Endogenous Leptin improvesHuman Mesenchymal StemCellsurvival abilityin Vitro andthis Cells protect Fatal Cardial Myocytesfrom Apoptosis", Heart Cardiovascular disease clinical research.

13) Albino, V., Carella, G. and Okogbaa, O. (1992), ``Maintenance policies in just-in-time manufacturing lines", International Journal of Production Research,Vol. 3, pp. 369-82.

14) Al-Zubaidi, H. and Christer, A.H. (1997), ``Maintenance manpower modeling for a hospital building complex", European Journal of Operations Research, Vol. 99, pp. 603-18.

15) Mukhopadhyay, S.K. and Bhattacharyyaa, A. (1973), ``Optimizing the size of inspection crew: a case study", IE Journal ME, Vol. 59, pp. 1151-4.

16) Ntuen, C.A. and Park, E.U. (1999), ``Simulation of crew size requirement in a maintained reliability system", Computers and Industrial Engineering, Vol. 37, pp. 219-22.

17) Alan B. Pritsker, Claude Dennis Pegden, 1986 “Introduction to Simulation and Slam II” A Halsted Press Book, John Wiley & Sons, Systems Publishing Corporation, West Lafayette, Indiana.

18) Duffuaa, S.O., Campbell, J.D. and Raouf, A. (1999), Planning and Control of Maintenance Systems: Modeling and Analysis, John Wiley and Sons, New York, NY.

19) Emerald Group Publishing Limited 1967, Bradford, United Kingdom viewed 18 May 2013, <http://www.emerald-library.com/ft>.

20) Emerald Group Publishing Limited 1967, Bradford, United Kingdom viewed 18 May 2013, <http://www.emeraldinsight.com/journals.htm?articleid=843283&show=abstract>.

21) Elsevier B.V., January 2012, 525 B Street, Suite 1800, San Diego, CA 92101 viewed 15 May 2013, <http://www.sciencedirect.com/science/article/pii/S0951832002000431>.

22) ProQuest Publishing company, 2007,Ann Arbor, MI, United States of America viewed 10 May 2013<http://www.csa.com/partners/viewrecord.php?requester=gs&collection=TRD&recid=20070661414038MT>.

Reckoning of criticality for preventive and corrective maintenance of amine solution pumps

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Abstract—**Today, demand for effective manufacturing is increasing in every kind of industry. Every industry demands the suitable maintenance of their system and all other production facilities. Now a day asset holders are using highly technical and advanced machines to increase their productivity, but maintenance of these machines became also difficult and time-consuming. In this regard, this paper majorly focuses on the assessment of most critical equipment among the industries, where preventive maintenance and corrective maintenance being carried out. Finding critical equipment is a time and money saving technique because when asset holders already know which equipment are critical then it will be easy to keep a close eye on that equipment and also help to schedule their maintenance routine. To decide the critical equipment, in this paper scoring/ ranges system has been used for some parameters. After that, cumulative percentage of that score will calculated and finally an always better control (ABC) analysis is carried out to identify critical equipment. In the end, excel based template is also proposed in this paper with a case study of ten amine solution pumps. The results of this case study will identify the most critical pumps among all ten pumps, which could help the industry to minimize the failure and unnecessary stoppages and help to schedule their maintenance by keeping eye on critical equipment.**

Keywords—ABC analysis, preventive, corrective, critical equipment

I. INTRODUCTION

It is a known fact that maintenance resources are quite scarce. To have its optimal use, one need to prioritize equipment based upon their importance. Importance can assessed only by knowing how critical an equipment is. Equipment criticality definition varies from organization to organization. The assumptions used to assess what equipment is critical or not technically based. As a result, when different individuals are ask to identify critical equipment, they will likely select different pieces of equipment. Often it is told, “All equipment are critical!” The potential for equipment failure having significant safety, environmental or economic consequences may be overlooked. A consistent definition for equipment criticality needs to adopt. The definition used in the context is “critical equipment is that equipment whose failure has the highest potential impact on business goals of the company [1]”. In this paper, an attempt has been made to better qualify the criticality of ten amine solution pumps used in a refinery. This will help in effective planning and implementation of preventative maintenance programs and corrective maintenance actions in a plant.

According to SS-EN 13306:2010 maintenance is defined as “combination of actions intended to retain an item in or restore it to, a state in which it can perform the function that is required for the item to provide a given service. Retention” and “restoration” are denominations for action types that are then converted into “preventive” and “corrective” maintenance types in the maintenance vocabulary. Following this criterion, the European standard for maintenance terminology [2] presents the different types of maintenance classified according to Figure 1.

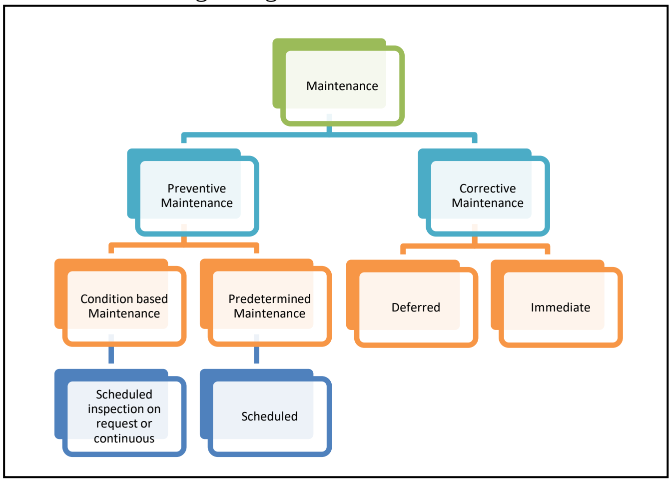

Fig 1: Maintenance types according to EN 13306:2001 [3]

II. PREVENTIVE MAINTENANCE

Preventive maintenance (PM) is a caring, serving the facilities and equipment. It actually saves any industry from the loss. PM maintain the equipment in their satisfactory and working condition. PM can include cleaning, checking minor repairs, refueling, inspection or changing of machine parts. It increases the productivity of the equipment. PM makes assets like new because they are maintained properly. PM decreases operating costs because stakeholders can avoid and save big cost by fixing small problems by PM. PM is divided into two subcategories, namely condition- based maintenance (CBM) and predetermined maintenance (PDM). Currently, condition monitoring or machine analysis programs have gained a lot of value. Two of them are predictive maintenance program and condition based maintenance programs, which come under the umbrella of preventive maintenance. These programs done by using some very latest equipment like vibration monitoring devices, wear particles analyzers and by using some other diagnostic techniques. This can be done while machines are in running condition in order to help plan maintenance [4]. A bad side of these programs is that these programs need large budgets and intensive data. That is why their implementation is limited.

III. CORRECTIVE MAINTENANCE

Corrective maintenance (CM) defines as “A form of maintenance whereby no routine maintenance tasks are performed. The only planned maintenance on the asset is restored after a problem necessitates some action”. CM is the wait-for-failure strategy and does not entail any prediction of when an item will fail. Depending on the failed items impact on the functioning of the system, it is in maintenance could either be performed immediately or be scheduled at a later point in time as illustrated in Figure 1. CM commonly referred to as repair. If the organization allocates very limited resources to maintenance, it is able to carry out only corrective maintenance because money and maintenance capacity for preventive maintenance will not be available. Under this condition, the organization can produce and show a profit but it will be limited due to different occurring failures and consequent losses [5].

As mentioned above the purpose of this paper to identify the most critical pumps among all ten pumps by using ABC analysis. This method will useful for any industry to find out the most critical equipment, which helps the asset holders to look over their preventive maintenance and corrective maintenance actions after finding the critical equipment.

IV. METHODOLOGY OF ABC ANALYSIS

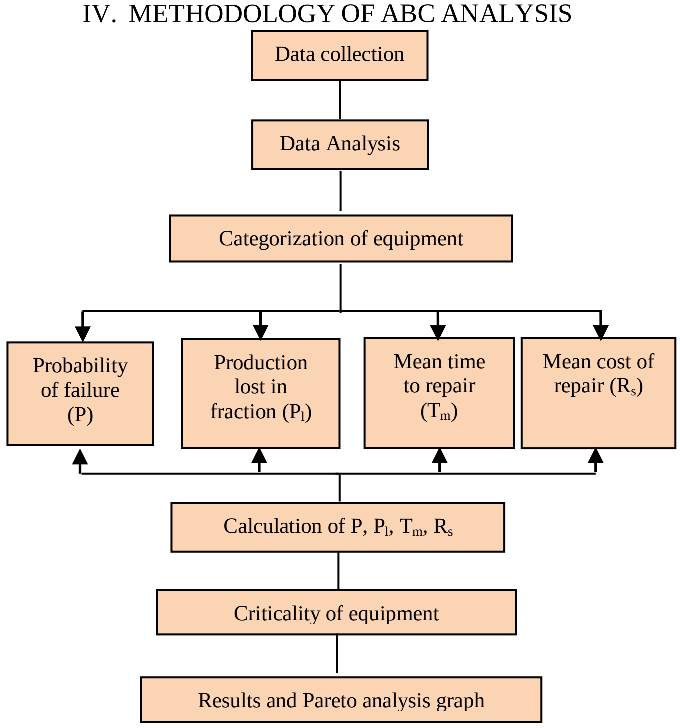

Fig 2: ABC Analysis methodology

Planning for preventive and corrective maintenance for production requirement is very much necessary. It always creates problems that which machine should be chosen to do maintenance. Experience shows that when preventive maintenance is applied on every machine it produces more complications in the system rather than improvement of results [6]. So it is necessary to identify the most critical equipment first before taking any initiative for preventive maintenance. This not only results in improvement but also affects the profit of company in a positive manner.

A. Data collection

Data Collection is most important in every kind of research activity and collection of data is also very important for any industry to assist stakeholders in taking the decision about the programs or policies. Choosing data is also an important factor, it is impossible to use the data of an entire industry for some research purpose. Data collection before analysig criticality specially is very important. For ABC analysis quantitative breakdown data is needed, which contains the information about the breakdown, a reason of breakdown, equipment downtime and information about loss.

B. Categoriation of equipment

Maintenance always should be carried out on the critical equipment to save the money and time. There are several opinions on determining the criticality. One research suggests a five level priority rating on the basis of efficient operation of the equipment important to the production process [7]. One other research proposed three levels of priority which are an emergency, machine running and not applicable [8].

While taking preventive maintenance and corrective maintenance into account there are several variables that affects the likelihood of machine failures. A different kind of production systems require different type of process and equipment. The following four critical factors represent that these factors will affect the breakdown of the plant mostly [9].

1. Probability of equipment failure (P)
2. Production loss per hour(Pl)
3. Mean time to repair (Tm)
4. Mean cost of repairs (Rs)

For above four factor scores to be applied in a judicious way for every pump. Further, the multiplication of every pump score provides total score, which is used to find out the most critical pump(s). For the purpose of scoring system/ range system, the most important thing is data related to above four factors. From above four factors mean time to repair is easy to find, but for other three factors, it is necessary to set the ranges. There are two ways to set the ranges, first one is to create a program in Matlab or any other coding software which creates automatic ranges according to data but that must need 30 to 50 years old data. Another method is that every industry sets their standards according to their data every year which is quite easy. In this study, the ranges have been set by myself to just show that how this ABC analysis works and how this template of excel work with it. It is very important that the ranges must be between 0.1 to 1.

1. *Probability of equipment failure (P)*

It is well known that criticality of an equipment is directly proportional to the number of failures per unit time. Mathematically:

$$\boldsymbol{Criticality} \propto \frac{\mathbf{1}}{\boldsymbol{MTTF}} \propto \frac{\boldsymbol{Number\ of\ failures}}{\boldsymbol{Unit\ time}}$$

To decide the score of criticality, a range of a number of failures must defined. Suppose, the range should be always small when the number of failures is small and same as range must be high if the number of failures are high [6]. The range limits and criticality scores identified are shown in table 1.

TABLE I. Range limits and criticality score.

Lower range limit # of failure	Upper range limits #of failure	Range type	Score
0	3	Very Low (VL)	0
3	6	Low (L)	0.25
6	12	Medium (M)	0.75
12	24	High (H)	1

2. *Production loss per hour (Pl)*

Production loss is a very important aspect to find out the criticality of an equipment. It entails, how much an equipment failure affects the production. Critical equipment always loses too much production. In this study, all ten pumps are of same nature, so the score of production loss is given same to all pumps.

3. *Mean time to repair (Tm)*

Mean time to repair is also an important factor to analyses the critical equipment. It determines the downtime loss. Which means if the equipment is down for many hours that equipment is that much critical. Formula to calculate mean time to repair is

Total downtime per unit time / Total number of failures per unit time

4. *Mean cost of repair (Rs)*

The more the equipment fails and causing industry too much loss in terms of maintenance cost that equipment needs more attention. In this paper, this factor also is given a score as to actual expenses incurred on an average for repair in monetary terms.

V. Criticality of Equipment

All these factors have been now giving some scores in a way that highest number shows the most critical equipment. As these factors multiply with each other, also show the highest numerical value. Now, ABC analysis will be carried out in order to decide the most critical, semi- critical and non-critical equipment.

VI. Results

In this paper, a case study of ten amine solution pumps has been given to find out the most critical pump among all ten pumps. Four years' failure data has been used in this case study. Table II will show the failure data for the past four years. In this table, PPM shows preventive maintenance actions and REM Corrective maintenance actions.

TABLE II. Data obtained from breakdown history Unit time: 4 Years

Pump	PPM	REM	Total no of failure	Total downtime in hours
P5-0201A	55	8	63	60288
P5-0201B	26	6	32	26760
P5-0201C	20	4	24	25224
P5-0201D	9	10	19	24264
P5-0201E	19	10	29	27264
P6-0201A	11	18	29	16296
P6-0201B	12	11	23	22104
P6-0201C	21	8	29	29232
P6-0201D	9	16	25	20928
P6-0201E	13	3	16	15744
Total	195	94	289	

Now table III shows the categorization of the total score of equipment. The scores in this table, namely the production loss and mean cost of repairs of each piece of equipment have been calculated and it is found that the score of production loss of all the equipment is same because all pumps are of same nature. These pumps also given the score for mean cost of repairs as 1 to 0.1 respectively.

TABLE III. Categorization of total score of the equipment

S.no	Pump	Prob. Of failure	Score	Production loss	Mean time to repair	Mean cost of repair	Total score (h)
1	P5-0201A	High	0.75	1	956.95	1	717.71
2	P5-	High	0.75	1	836.25	0.7	439.0

	0201B						3
3	P5-0201C	High	0.75	1	1051.00	1	788.25
4	P5-0201D	High	0.75	1	1277.05	0.8	766.23
5	P5-0201E	High	0.75	1	940.14	0.8	564.08
6	P6-0201A	High	0.75	1	561.93	1	421.45
7	P6-0201B	High	0.75	1	961.04	1	720.78
8	P6-0201C	High	0.75	1	1008.00	1	756.00
9	P6-0201D	High	0.75	1	837.12	0.67	420.65
10	P6-0201E	High	0.75	1	984.00	0.2	147.60

Next, table IV shows the cumulative score of every pump. It can be observed in table IV and figure 3 pump P5- 0201C, P5-2010D, P6-0201C are most critical pumps among all ten pumps. Their score is the highest among all ten. A new preventive maintenance schedule could help to reduce the criticality of these pumps and decrease the downtime.

TABLE IV. Cumulative score of ABC analysis

S. No	Pump	h	H	Cum Score %	Criticality
1	P5-0201C	788.25	788.25	13.73%	Critical
2	P5-0201D	766.23	1554.48	27.07%	Critical
3	P6-0201C	756.00	2310.48	40.24%	Critical
4	P6-0201B	720.78	3031.26	52.79%	Semi critical
5	P5-0201A	717.71	3748.98	65.29%	Semi critical
6	P5-0201E	564.08	4313.06	75.12%	Low critical
7	P5-0201B	439.03	4752.09	82.76%	Low critical
8	P6-0201A	421.45	5173.54	90.10%	Low critical
9	P6-0201D	420.65	5594.19	97.43%	Low critical
10	P6-0201E	147.60	5741.79	100.00%	Non Critical

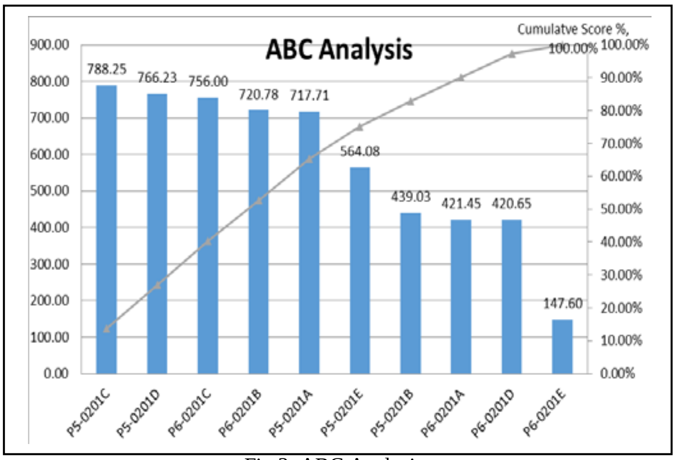

Fig 3: ABC Analysis

VII. Excel Based Template for ABC Analysis

An excel based template is also proposed in this paper for the ease of maintenance personnel so that they can quickly input data in required cells and calculate the results. Table V will show the area where the required data to be input. In this table, yellow shaded boxes represent the cells in which maintenance personnel should input the required breakdown data. Table VI is the most important part of this template where data are compiled from all the provided breakdown data. Table VI is directly connected with the provided data in table V. As maintenance personnel enter the data in table V, table VI will be updated by using some excel formulas and conditions. In table VI, probability of the failure column consists conditional formatting, there are four columns in the probability of failure column, which represent very low, low, medium and high respectively including different color for every condition. In table VI yellow boxes also represents to input the data manually. After that table VII, which is directly connected with table VI, represents the categorization of equipment, it calculates the total score. Table VIII sort out the most critical equipment at the top and calculate the total score (h) cumulative scores (H) of equipment and helps to create Pareto analysis chart.

TABLE V. Categorization of total score of the equipment

Type	Start date	end date	Total Time to failure (TTF) in days	Total Time to failure (TTF) in Hours	Total Time to failure (TTF) in Minutes	Description	Equipment	ActTotSum
PPM	1-Jan-11	20-Feb-12	415	9960	597600	Visual Insp. Amine Pump Pkg	P5-0201A	227,881.39
PPM	1-Feb-11	31-Mar-11	58	1392	83520	Visual Insp. Amine Pump Pkg	P5-0201A	110,447.58
REM	1-Mar-11	20-Jul-11	141	3384	203040	Visual Insp. Amine Pump Pkg	P5-0201A	411,248.95
REM	1-Apr-11	15-Jun-11	75	1800	108000	Visual Insp. Amine Pump Pkg	P5-0201A	149,379.88

TABLE VI. Calculation using breakdown data

Equip	PPM	REM	Total no of failure	Total downtime in hours	Mean Cost of repair	Probability of Failure Score (Ps)	Probability of Failure				Mean cost of repair score (R_s)	Production loss in hour (P_l)	Mean time to Repair (T_m)
Total													

TABLE VII. Categorization of equipment

Categorization of equipment			
S.No	Pump	Prob: of Failure	Total Score ($S \times R_s \times P_l \times T_m$)

TABLE VIII. Cumulative score section

S. No	Pump	h	H	Cumulative Score %	Criticality

VIII. CONCLUSION

Preventive and corrective maintenance help to reduce the cost of production, with that if a simple method to identify the critical equipment is used that also affect the production process. This exercise also suggests to the management up to what percentage of criticality; the preventive maintenance program should be extended through a cumulative score. In this study, pump P5- 0201C, P5-2010D, P6-0201C are found out to be most critical. These pumps need more attention among all other pumps. Finally, an excel based template is also proposed which is very handy and easy to use. This method will help in any process industry to find out the most critical equipment, which helps them to schedule their maintenance program accordingly and help to avoid sudden failure and decrease corrective maintenance programs.

IX. FUTURE RECOMMENDATIONS

In this paper, a simple method to find the critical equipment among all equipment has been proposed. The only bottleneck is in this process is to set the ranges for the probability of failure, production loss and mean cost of repair. So, as a recommendation that could be possible by two ways, i.e. either every industry makes some standard ranges for all these three parameters and that changes every year, according to data. Another way to create some software using Matlab that creates ranges itself on just providing the data but that also need almost 40 to 50 years old data of equipment.

References

[1] R. Smith and R. K. Mobley, *Rules of thumb for maintenance and reliability engineers*: Butterworth-Heinemann, 2011.

[2] A. Parida and U. Kumar, "Maintenance performance measurement (MPM): issues and challenges," *Journal of Quality in Maintenance Engineering*, vol. 12, pp. 239-251, 2006.

[3] A. C. Márquez, *The maintenance management framework: models and methods for complex systems maintenance*: Springer Science & Business Media, 2007.

[4] W. Bartelmus and R. Zimroz, "Vibration Condition Monitoring of two stage gearboxes," in *4th International Conference. Acoustical and Vibratory Surveillance Methods and Diagnostics Techniques. Compiegne France*, 2001, pp. 645-656.

[5] V. LEGÁT, F. MOŠNA, V. ČERVENKA, and V. JURČA, "Optimization of preventive maintenance and information system," *W SKRÓCIE*, p. 24, 2002.

[6] V. N. Namboothiri and P. Joshy, "An approach for identification of critical equipment for preventive maintenance of a plant," 2011.

[7] R. H. Clifton and R. H. Clifton, *Principles of planned maintenance*: Arnold, 1974.

[8] A. S. Corder, *Maintenance management techniques*: McGraw-Hill, 1976.

[9] A. A. Aremu, A. O. Aremu, and O. A. Adeaga, "Assessment of Critical Equipment for Preventative Maintenance of Plastic Plant," in *ASME 2015 Power Conference collocated with the ASME 2015 9th International Conference on Energy Sustainability, the ASME 2015 13th International Conference on Fuel Cell Science, Engineering and Technology, and the ASME 2015 Nuclear Forum*, 2015, pp. V001T06A003-V001T06A003.

THE STUDY TO EVALUATE THE FACTORS THAT INFLUENCE ON AVIATION ACCIDENTS IN USA

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Abstract: In today world, people became more time conscious and luxury loving, which resulted in the diversion of people's attention from ancient means of transportation to the modern ways i.e. aviation. The transition not only facilitated people but increased the air traffic and the number of aviation accidents as well.
The purpose of this study is to find out the major causes of the aviation accidents in different segments of aviation operation in United States
We obtained the data for a period of 24 years from Jan 1992 to Dec 2015, from two different data bases; a NASA maintained database "Aviation safety reporting system" (ASRS) [1] and National transportation safety board (NTSB) maintained database "Aviation accident and incident data system"(AIDS) [2]. The data for each segment of the operation were separately organized to use the correlation among the accidents and further descriptive statistical tools were used to show and evaluate the relationship between the factors affecting the accidents. To see the accidents more closely, we grouped the accidents into three segments of aviation operations: General Aviation (GA), CFR 14 Part 135 and CFR 14 Part 121.
We found that the size of the flight, terrain, and seasonal effects have significant influence on the number of aviation accidents in United States. The General Aviation, which is the smallest segment of aviation operation dominates over other segments' accident (CFR 14 Parts 121 and 135). It caused for 97.5 % of all aviation accidents. The data also shows the significance of seasonal trend that 44% of all aviation accidents took place between the months of May and August.
At the end of the study we present recommendations for policy makers and a mathematical model that forecast the upcoming unfavorable events in the aviation and to give timely remedies to reduce the accidents in aviation industry to a certain level.

1. INTRODUCTION

In this fast growing, scientifically facilitated and abundantly mechanized world accidents are inevitable in every walk of life. People suffer huge losses and many of them even lose their lives. Steps have been taken for the retardation but still lot need to be done in this field.
Taking all types of accidents is beyond the scope of the paper, therefore we are taking the aviation accidents into consideration so that, if not all the factor, some of them are exposed and remedies should be suggested to avoid them. There are many factors which are responsible and need to be considered in the aviation industry to ensure the safety of the crew members as well as the passengers.
An aviation accident is defined under 49 Code of Federal Regulations (CFR) 830.2 as an occurrence when the operation of an aircraft, with the intent of flight, results in substantial damage to the aircraft, death or serious injury to any person.
The purpose of this paper is to diagnose the causes and factors, which are responsible for the accidents in General aviation, CFR 14 Part 121 and CFR 14 Part 135. Technological as well as environmental conditions are responsible in some way or the other.
The paper mainly focuses on these factors of the accident i.e.: size factor, seasonal factor and regional factor. To go into the depth of the above factors, data of 24 years have been collected from NASA maintained database "Aviation safety reporting system" (ASRS) [1] and National transportation safety board (NTSB) maintained data based "Aviation accident and incident data system"(AIDS) [2] for Jan 1992 to Dec 2015

After reviewing the literature of the impact of aviation accidents (i.e.:, seasonal and segmental categories) we came at the conclusion that the number of accidents may be retarded by diagnosing and forecasting weather phenomena well ahead of its occurrence and passing information to the air traffic control (ATC). We suggest that the affected air space (where accidents occur frequently) may refrained. Ineffective use of air space produces huge costs that could be reduced by in-time identification of hazardous weather phenomena.
In this paper, we discussed various factors effecting the aviation accidents and their causes. Related data is obtained mainly from two sources as given in the references [1, 2]. Analytical results and the findings are compiled in a way to facilitate the reader, which progress systematically and in an interlinked fashion.

The study has been organized in separate sections to recognize and highlight the factors of aviation accidents. We started with the introduction of problems with a thorough literature review. This is followed by describing the data and the tools used for data analysis. Then we provided the results and discussed in detail with possible reasons and solution in the recommendation section. In the last section, we concluded our study after putting recommendations for the aviation industry, regulatory authorities, Governments, and researchers etc.

2. LITERATURE REVIEW

Many factors play their role in the aviation accidents i.e.: Aircraft Design, Environment, Human Factor, Management, Manufacturing, Seasonal Factors, Size of Flight, Maintenance, etc. Dealing with all the above stated factors is beyond the scope of the paper, to discuss these factors each requires separate attention and paper. Majority of the authors have made the Human Factor responsible contributing 45% of the accident while the contribution of the Environmental Factor is 3-5% remaining other factors are responsible for the rest of the 50% (Johnson, Holloway) [3]. The given data shows that the contribution of Environmental factor in the aviation accident is indirectly proportional to the rate of accidents.
"To error is to men" human by its nature cannot avoid mistakes and its implications are drastic in many occupational accidents, the involvement of civil and military aviation accidents is 70% to 80% (Wiegmann, Shappell 2001) [4]. Minor detail related to human factor should be collected with the assistance of well trained staff and appropriate instruments in order to minimize the effect.
Another factor that poses dangers to the aviation is the bird, of all species, strike which also varies from region to region. The strike rate is higher in those areas which are near to the greenery and water. The factor has direct relation with rate of accidents and the type of damage caused depends upon the mean body mass (Dolbeer, Wright, Cleary) [5].
The analysis shows that the major portion of the accident is caused while landing. Due to the miss understanding between the control room and the crew members, and due to the unfavorable weather condition (i.e.: Thunderstorms, Air Turbulence, Ceiling and Visibility, In-flight Icing). Birds (red-tail hawk, Gull, Scoter, Cormorant) collision is the factor, ranked as third major cause of the accidents below 3000 ft. altitude (Wang, Herricks) [6].
There are various factors which are responsible for the high risks rate with small planes. Firstly, they are driven by non-professional people. The rules are relaxed for amateur pilots, who don't have to log as many flight hours to be certified. Another reason is mini planes, which land at small airports that may not even have paved and well equipped runways (Sullivan 2014) [7].
The influence of geographic factor on the aviation accidents varies from region to region and the rate is different for different regions. It is found that United States is the major victim, suffering 788 accidents and 10,625 fatalities. Through proper training and sound knowledge of the locality to the pilot accidents of this nature can easily be minimized (Calderone and Gould 2015) [8].

3. RESEARCH METHODOLOGY

3.1 Method of Data collection

Data used for this study is obtained from two data bases; NASA maintained database "Aviation safety reporting system" (ASRS) [1] and National transportation safety board (NTSB) maintained data based "Aviation accident and incident data system"(AIDS) [2] for a period of Jan 1992 to Dec 2015. The data consist of Aviation accidents happened to CFR 14 Part 135, CFR 14 Part 121 and General Aviation (GA). Most of the General Aviation (GA) flights are used for personal and recreational purposes. However some flights are conducted for revenue generating purposes too. CFR 14 Part 135 is commuter airlines (Part 135 scheduled) and air taxis (part 135 unscheduled) and CFR 14 Part 121 are generally referred to major airlines and cargo carriers. Before March 1997, Scheduled aircraft with 30 seats fell under CFR 14 Part 121, while those with less than 30 seats were considered CFR 14 Part 135. Because of regulatory changes, CFR 14 Part 121 now includes all aircraft with 10 or more than 10 seats; thus some commuters once regarded as CFR 14 Part 135 are now considered CFR 14 Part 121.

Accidents are categorized into sub groups (i.e.: Destroyed (damage due to impact that cannot be economically repairable), Substantial (damage which adversely affects the structural strength and performance, and requires major repairs and replacements), Minor (damage that neither destroys the air craft nor causes substantial damage and can be renderd airwothy by simple repairs and replacements) and None (the aircraft sustained any damage in the occurrence but there must be a serious injury or fatality of one or more passengers or crewmembers in the accident).) while injuries are categorized according to the severity of the injuries into Fatal (any injury which results in death within 30 days of the accident) and Serious (any injury which require hospitalization for more than 48 hours i.e.: resulting in fracture of any bone, severe damage to tissues and internal organs and second or third degree burns affecting more than 5 percent of the body) injuries. [9]

NASA Aviation safety reporting system (ASRS) receives, processes, and analyze reports of unsafe and hazardous situation that are voluntarily submitted by pilots, air traffic controllers, dispatchers, flight attendants, and maintenance technicians. They submit their reports on a specific designed report format, which describe both unsafe occurrences and hazardous situation. The filled out form can be submitted either by posting on ASRS address or electronically by using Report Submission Form (RSF) procedure.

The national transportation safety board (NTSB) and aviation accident and incident data system (AIDS) contains information collected during NTSB investigation of an accident or incident involving aircraft within the United States, its territories and possessions and international water.

Aviation accident and incident data system (AIDS) is mainly composed of accidents. It contains many fields for each accident record, including the information regarding the aircraft, environment, location of the accident, flight phase, injury level and the date at which the accident recorded

3.2 Data Analysis

Our analysis is mainly based on descriptive statistic and correlation studies. The purpose of these analysis is to show the relationship amongst the accidents occurred in different segments of aviation operation and the factors affecting these accidents and its distribution. Correlation study is used to find out the relation between numbers of accidents and the factors such as flying hours. Descriptive statistics tells more about the distribution of accidents. Minitab statistical package is used for the statistical analysis of data to determine the variance, range and deviation of the accidents with respect to the months and years.

4. RESULT AND DISCUSSION

The accidents have been grouped into three segments of aviation operations as we discussed in the introduction section i.e. General Aviation (GA), CFR 14 Part 135, and CFR 14 Part 121. The analysis of the accidents data show that General Aviation accidents dominate over other segments' accidents (CFR 14 Parts 121 and 135) [See Figure 01]. General Aviation accidents are responsible for 97.5% of all aviation accidents while CFR 14 Part 121 for 2.03% and CFR 14 Part 135 for only 0.47% of all aviation accidents. In General Aviation segment, fixed-wing airplanes are responsible for 86% of total GA accidents, helicopters accounting for only 9% of total GA accidents, whereas all other aircrafts accounting for less than 5% of total GA accidents.

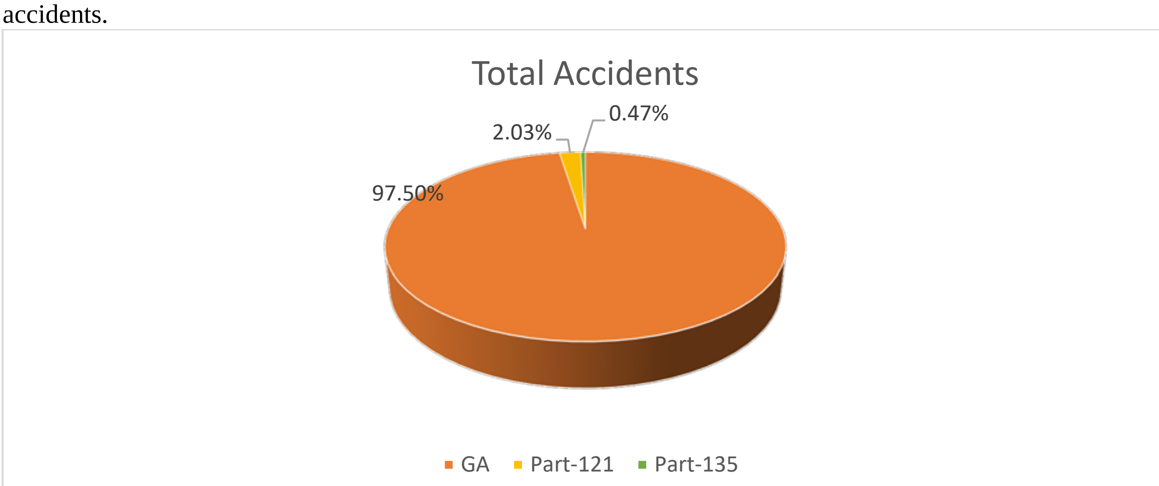

Figure 01. Aviation Accidents' ratio of three segments of Aviation operations for 1992 to 2015

However, the rate of General Aviation (GA) accidents have significantly decreased from 8.5 to 6.5 accidents per 100,000 flight Hours, during the period of 1992 to 2012 and 5.8 in 2015. The number of GA aviation accidents has dropped from 1908 to 1209 during the last two decades i.e.: from the year 1992 to 2015. As Figure 02 shows that there is a consistent downward trend over the time span in General Aviation (GA) accidents. The data show that there is 36.6% decrease happened in the number of General Aviation accidents in the last two decades i.e. from 1992 to 2015 in US aviation Accidents.
The statistics of the Aviation accidents data for the period of 2009 to 2012 show that substantial event dominate over other events. The aviation accidents are caused for 3% destroyed event, 95% substantial, and 1% for each Minor and None events. However the distributions of these events are different for different segments of aviation operations (Table 01). It is also evident from the Table 01 that all accidents events are dominated by General aviation accidents except None which is by Part 121.

Table 01. Event wise grouped data of GA, Parts 121 and 135 for the period of 2009 to 2012

	General Aviation (GA)		Part 121		Part 135	
	No: of events	%age	No: of events	%age	No: of events	%age
Destroyed	143	2	3	3	2	1
Substantial	5618	96	45	43	160	97
Minor	48	1	11	10	1	1
None	36	1	46	44	2	1

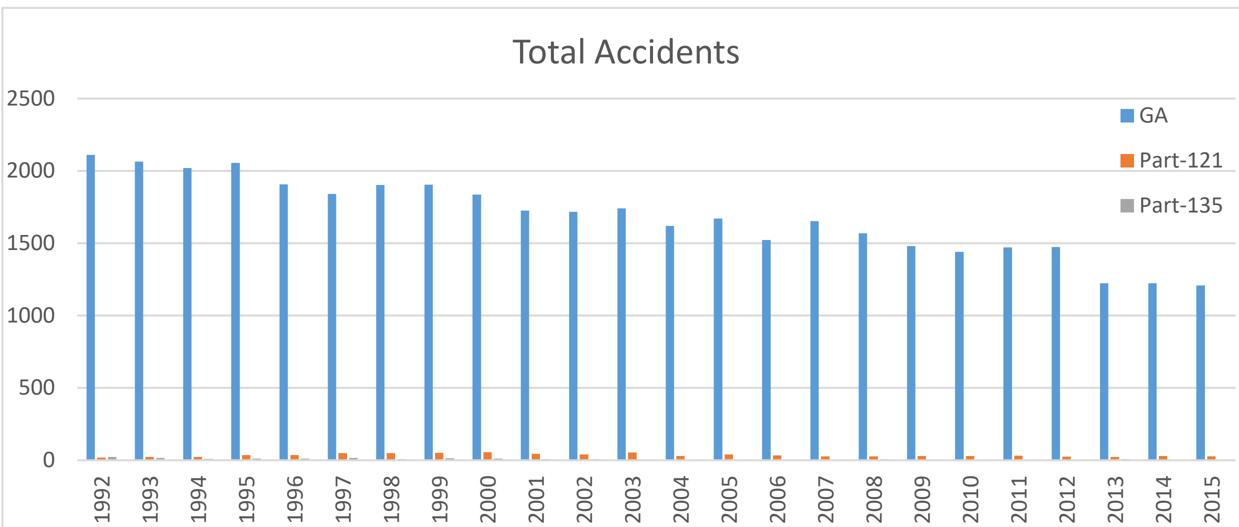

Figure 02. Annual Aviation Accidents of three segments of Aviation Operations for 1992 to 2015

Although in the rate of CFR 14 Part 121 accidents, no significant changes have been observed during the period, which have changed from 0.146 to 0.157 accidents per 100,000 flight hours in the last two decades.
Though there is a consistent decrease happened in the rate of General aviation accidents but it is still much higher than rate of accidents in CFR 14 Parts 121 and 135. [See Figure 02].
The rate of accident from 2001 to 2015 is almost flat. The flatness of the rate of accident curve across the decade suggests that the modestly decreasing trend in annual accidents number was primarily due to reduction in General Aviation (GA) Operations (flight hours).
Figure 03 shows the behavior of General aviation, 14 CFR Part 121 and 14 CFR Part 135 accidents rate. The rate of accidents for 14 CFR Part 121 which remain stable in a range 0.129-0.309. Unusual fluctuation (in term of rapid increase) has been observed in accidents rate for 14 CFR Part 135 after 1997. The fluctuation in the rate of accidents is only due to 14 CFR Part 135 scheduled services. It became prominent due to the legislation according to which since March 20, 1997, aircraft with 10 or more seats used in scheduled passenger service have been operated under 14 CFR 121. The increase in rate of accidents in scheduled 14 CFR Part 135 is because of shifting a safer operation group to 14 CFR Part 121. When scheduled flights were categorized by the number of passengers seat, it become evident that begining in 1994, three years before the change in

regulation, crash rates of flight with 10-30 seats were even more lower than the crash rate of flights with more than 30 passenger seats (Baker et al. 2009) [10]. This 10-30 passengers seats commuters was the safest operation group among all.

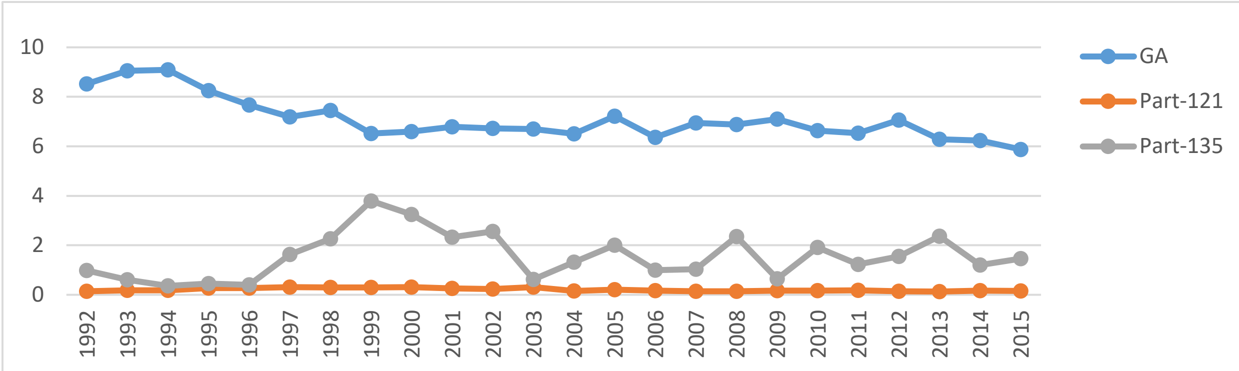

Figure 03. Annual Aviation Accidents per 100,000 flight hours of three segments of Aviation operations for 1992 to 2015

Reasons for the improved safety of 10-30 seat scheduled commuters probably include the 1992 requirement i.e. turbine-powered aircraft with 10 or more seats must be equipped with approved ground proximity warning system to prevent their all-too prevalent controlled-flight-into-terrain crashed (Thomas, Benzyl, Mainwaring, Conway) [11].
The crash rate of scheduled commuter with less than 10 seats was much higher than the scheuled commuter having 10-30 passenger seats (Baker et al. 2009) [10].
After year 2000, the accident rate of Scheduled 14 CFR Part 135 operations declined dramatically [See Figure 04]. The decline was happend as a result of the efforts made to reduce crashes in Alaska where 91% of the scheduled 14 CFR Part 135 commuter crashes were occured. Among such efforts by the FAA is the Alaska Capstone project, which provides information to the pilot about weather, terrain, and air traffic and permits trained pilots to fly safely at lower altitudes using GPS [12].

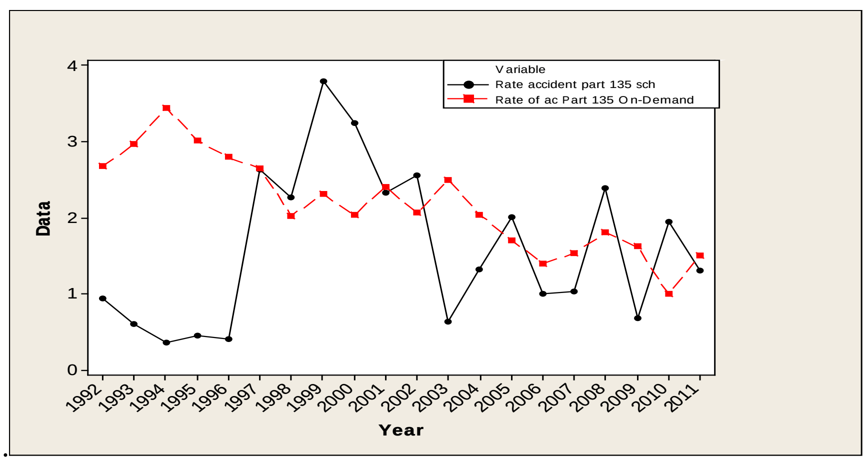

Figure 04. Rate of accidents 14 CFR Part 135 Scheduled and On-Demand services

Rate of accidents for 14 CFR Part 135 unscheduled services are steadily decreasing as shown in Figure 04. This decline in the annual part 135 unscheduled services could be the result of a number of factors, including the general decline in aviation activity after September 11, 2001; a fluctuation in overall U.S. aviation accidents; and other factor.

4.1 Regional Factor

The impact of terrain factor on the aviation accidents differs from place to place and the rate is different for different places but the United States has been the major victim of it. The air carriers operated under the regulation of 14 CFR Part 135 scheduled operations, 47 accidents occurred in Alaska out of total 56 accident by the period of 2001 to 2012. It shows 83% accidents in 14 CFR Part 135 Scheduled operations occurred in Alaska State. In 14 CFR Part 135 unscheduled services, 30% accidents in US occurred in Alaska State. Later on minor reduction in accident happened due to Alaska capstone project which gives information i.e.: weather, traffic and terrain that helps pilot fly safely.

4.2 Seasonal Distribution of Accidents

There is a stronger seasonal trend exists in the data, a regular repeating pattern of highs and lows related to quarter of the year as well as a downward trend as evident from the figure 04. There is more Aviation accidents happened in summer in the United States of America than other months [See Figure 05].
As the weather gets warmer in USA, more families start planning their getaways. During the summer, there are more occasions to have a great time in great weather, but with increase in aviation activity level, there is a potentially greater chance for more accidents to happen [101 critical days in summer].
The eleven years data (From 2002 to 2012) of United States accidents, show that the United States Aviation, on average, suffers 124 accidents per month during the first four months; average per month increase in accidents is 200 in summer and again decreases to 133 accidents per month in the last four months of the year. The data also shows that 44% of all aviation accidents took place between the months of May and August. While 27% aviation accidents took place in the first fourth months and 29% in the last four months of the year. The largest percentage of accidents took place in the months of June, July and August. It reaches its peak in the month of July [See Figure 06].
The monthly distribution is positive correlated with the aviation activities, as the aviation activity level increases; there are potentially greater chances of the accidents to happen. The exact relationship between activities and accidents may change over time, but the number of accidents or mishaps will always be dependant on the number of aviation activities (Current Procedure for Collecting and Reporting U.S General Avaition Accident and Activity Data 2005).

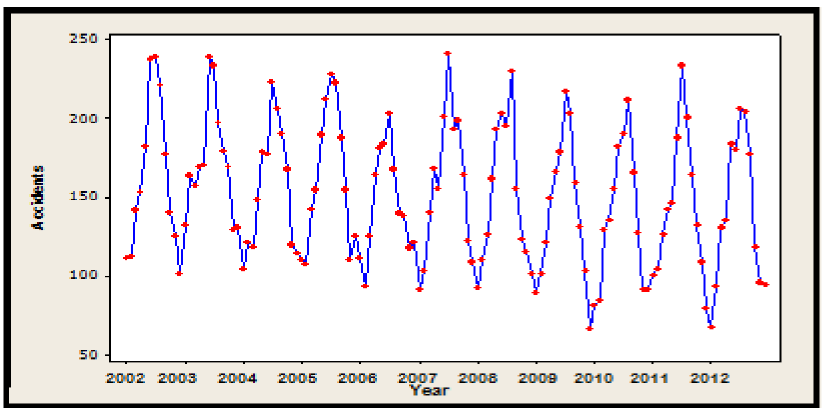

Figure 05. Monthly Aviation Accidents data for the period of 2002 to 2012 which show the seasonal and downward trend in the data.

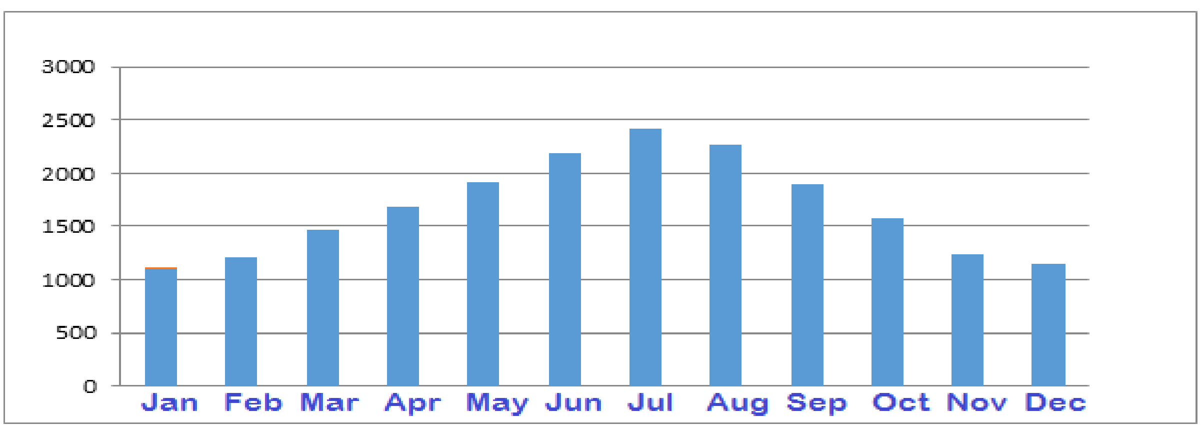

Figure 06. Average Monthly Aviation Accidents for the period 2002 to 2012

4.3 Time series

First the autocorrelation function of the time series was obtained to show the structure of the time series. The series appears to slowly wander up and down as shown in Figure 07. The figure show the autocorrelation function for monthly accidents data with 5% significant limits. The series shows a distinct seasonal pattern for autocorrelation. The ACF decreases from a positive value P=0.8 toward 0 as the lag increase, then from 0 toward negative reaching to its extremes P=-0.8 and again decaying toward 0 and so on. It has an alternating pattern of positive and negative lags. It is clear from the auto-correlation pattern that the accident data have strong similarities with each other. So the data is not independent, it is depended on one another in a specific pattern. Analysis of the data from the current study show seasonal plus downward trend along a random component. However, the analysis show that the random component is not so prominent in the data.

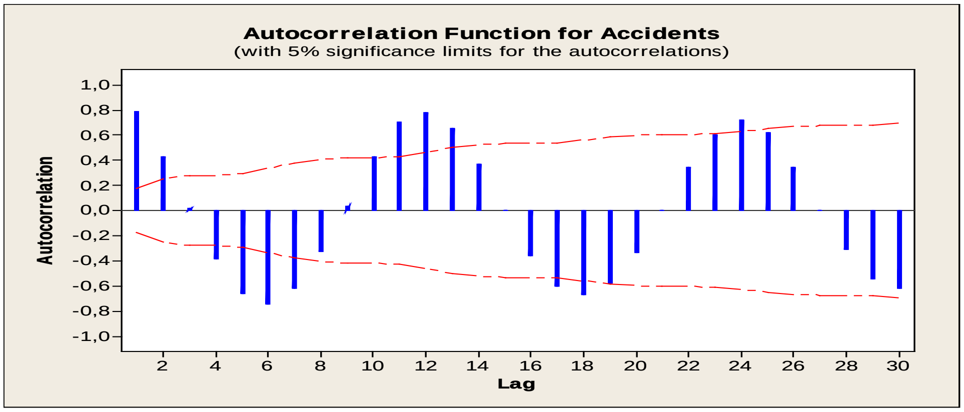

Figure 07: Autocorrelation Function of the monthly aviation accident data

As the aviation accidents data seems to exhibit both cyclic and random components, it is necessary to decompose the series (Wold 1958). Holt's method can be used to deal with the time series which contain both trend and seasonal variations. Holt-Winters seasonal method comprises the forecast equation and three smoothing equations — one for the level St, one for trend Gt, and one for the seasonal component denoted by Ct, with smoothing parameters α, β and Υ.

The Holt-Winters method has two versions, additive and multiplicative, the use of which depends on the characteristics of the particular time series. In this study, data fit better to Multiplicative version as the MSE value was smaller than for additive than Multiplicative version.

The general forecast function for the Multiplicative Holt-Winters method is

$Yt = (St + Gt)\, Ct + \varepsilon t$ .... (1)

Components of the Time series

For modeling the periodic components, time series was decomposed in Level, Trend, and seasonal components [Figure 08].

The Level:

$$St = \alpha * (Yt/Ct\text{-}n) + (1-\alpha) * (St\text{-}1 + Gt\text{-}1 \ldots\ldots\ldots (2)$$

The trend:

$$Gt = \beta *(St - St\text{-}1) + (1-\beta) * Gt\text{-}1 \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Seasonal component:

$$Ct = \gamma * (yt / St\text{-}1 - Gt\text{-}1) + (1-\Upsilon)*Ct\text{-}n \ldots\ldots\ldots (4)$$

After decomposition of the series, the random component can be found by using equation (6).

The distribution of the random component is identified as Logistic distribution (8.285, 0.981) [Figure 09].

$$Ft,\, t+\tau = (St + \tau Gt)C(t+\tau)\text{-}n \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where Ct-n was seasonal factor from the last cycle of the data.

$$\text{Random component } (\varepsilon t) = Yt - (St + Gt)\, Ct \ldots\ldots (6)$$

After derivation of all the values equation (1) may be the possible mathematical model to forecast the monthly accidents.

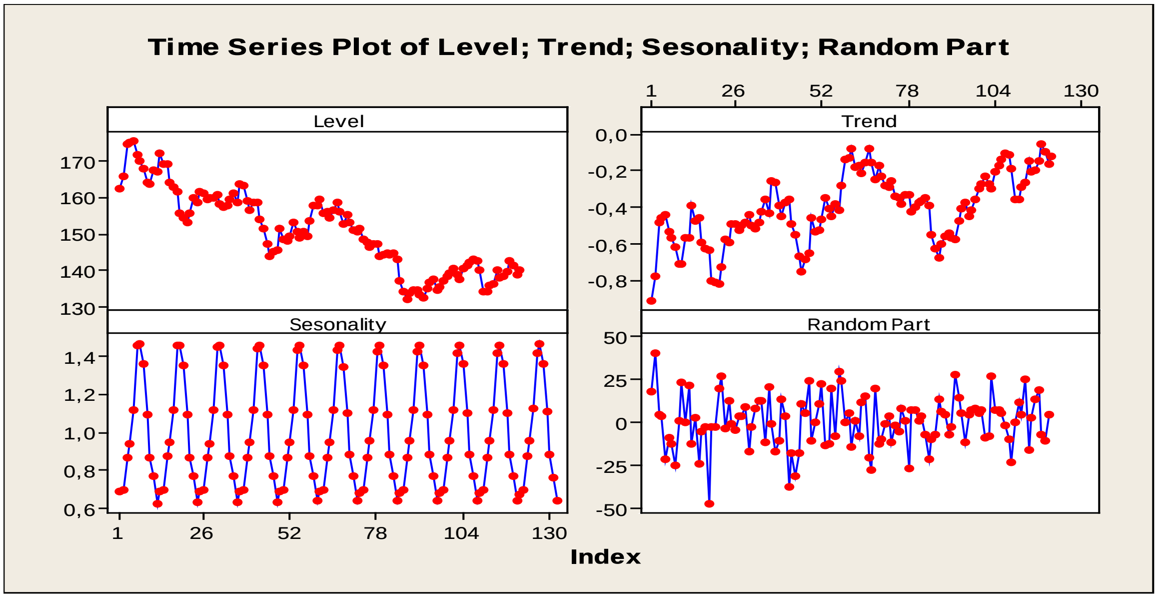

Figure 08: Estimated components for Holt-Winters method with Multiplicative seasonal components.

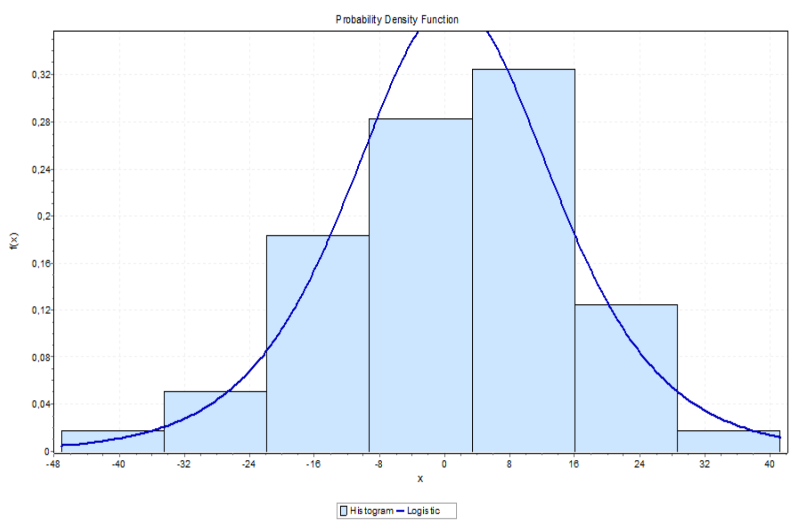

Figure 09: Probability distribution of the random component of the Time series.

5. CONCLUSION

The analysis of the data for the given period of 24 year exquisitely displayed the proportion of the accidents in different segments (GA, 14 CFR part 135 and 14 CFR part 121) of the aviation. The nature of the accidents and the causes were found varying from segment to segment. When compared, it is found that the GA dominates over the remaining two segments and its contribution is 97.5%. The three segments when compared for the calculation of rate of accidents from 1992 to 2015, it is seen that GA under goes a consistent decline while no prominent change is observed in the rest of the two types of segments.

A general decline in the accident of the 14 CFR part 135 unscheduled is found due to decrease in the aviation activity. While drastic downfall in the number of accidents in the 14 CFR Part 135 scheduled was due to the result of the improved safety measure in aviation activity.

Seasonal and regional factors varies depending upon the geographic and environmental conditions. These two factors affect all the three segments almost equally. But the segment with larger size become more victim of it.
Accidents cannot be completely eliminated but efforts can be made to reduce its effects or the number of accidents can be minimized using different corrective and preventive ways and means. In order to up-root the factors causing various types of accidents in all types of aviation the accident reporting system should be refined and made friendly enough so that all the

causes are brought in the knowledge of the safety board. It is found that crew members do not report the factor which cause a near miss in the aviation considering it minor and in this way it goes unattended. Complexity of the formal way of reporting the near-miss, forms, is one of the primary cause, forms should be made simple and crew members should be encouraged enough so that may not hesitate to report even minor causes.

Confusions and contact barriers created between the crew members and the control room due to the ill-functioning of the radar system and other technologies used in the aviation should also be considered and refined. Because of the above said two factors either the crew member obtain delayed information or do not get the appropriate information.

Whatever the type of accident is, our target is to minimize aviation accidents by using a primarily non-regulatory, proactive, and data-driven strategy to get effective results for that purpose. The aviation safety board need to revise its policies and frame them such that it should be easy to follow and comprehensive enough to cover all even minor details.

6. REFERENCES

1. NASA maintained database “Aviation safety reporting system” (ASRS) http://akama.arc.nasa.gov/ASRSDBOnline/QueryWizard_Filter.aspx

2. National Transportation Safety Board Aviation Accident and incident data system (NTSB): http://www.asias.faa.gov/pls/apex/f?p=100:24:0::NO:

3. C.W. Johnson, C.M. Holloway “On the Over-Emphasis of Human ‘Error’ As A Cause of Aviation Accidents: ‘Systemic Failures’ and ‘Human Error’ in US NTSB and Canadian TSB Aviation Reports” USA, NASA Langley Research Center, Hampton, VA 23681-2199, pp.1-34.

4. Douglas A. Wiegmann and Scott A. Shappell (2001) “Human Error Analysis of Commercial Aviation Accidents: Application of the Human Factors Analysis and Classification System (HFACS)”Aviation, Space, and Environmental Medicine, Vol. 72. pp. 1006-16.

5. Richard A Dolbeer, Sandra E Wright, Edward C Cleary “Ranking the Hazard of Wildlife Species to the aviation” Wildlife society, Vol.28, pp.372-378

6. Jinfeng Wang and Edwin E. Herricks “Bird-aircarft strike threat assessment using avian radar information” Center of Excellence for Air Technology, Department of Civil and Environmental Engineering, University of Illinois, Urbana, IL 61801

7. Gail Sullivan (2014) “The many reasons small planes crash” Morning Mix, Washington Post Online. [Accessed November 22, 2016] URL: https://www.washingtonpost.com/news/morning-mix/wp/2014/12/09/why-small-planes-crash-more-often/?utm_term=.185a3170f46d

8. Julia Calderone and Skye Gould (2015) “The 25 countries with the most airline accidents and fatalities” Tech News Online. [Accessed November 22, 2016] URL: http://www.businessinsider.com/airplane-accident-statistics-by-region-2015-11

9. International Civil Aviation Organization, Homepage Retrieved November 22, 2016 from http://www.icao.int

10. Baker et al. (2009) “Crash rates of scheduled commuter and air carrier flights before and after a regulatory change” Aviate Space Environ Med., Vol. 80(4): pp. 381-385.

11. Thomas TK, Benzyl DM, Mainwaring JC, Conway GA. (2000) “Controlled flights into terrain accidents among commuter and air taxi operators in Alaska” Aviate Space Environ Med., Vol. 71: pp. 1098-1103.

12. FAA. “Capstone comes to Southeast Alaska” 2003. Mar 31 [Accessed September 12, 2008]. From http://www.faa.gov/news/press_release/news_story.cfm?newsId=6375

DEVELOPMENT OF A FUZZY LOGIC-BASED QUANTITATIVE RISK ASSESSMENT MODEL SUBJECT TO HSE HAZARDS

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Abstract: Decision making in oil and gas industry regarding risk assessment has become a challenging task due to uncertainty and imprecision associated with the risk. Several approaches are followed for the risk assessment process like; qualitative, quantitative and semi-quantitative approaches. Typically, in oil and gas industry, the qualitative approach is applied for evaluating the risk assessment of hazards related to health, safety, and environment. The qualitative approach has high uncertainty in evaluating the risk due to the subjective opinions of experts. In order to overcome the ambiguities involved with a qualitative approach, this paper has developed a quantitative risk assessment model based on fuzzy logic theory, in which the numerical scaling values have been assigned to likelihood, consequence and related risk. Results generated by the developed fuzzy model were compared with an existing qualitative method of an oil and gas industry, which was showing quite satisfactory results between both approaches. A case study was carried out in order to validate the results. The developed fuzzy logic model will enable decision makers in evaluating the risk involved with oil and gas industry.

1. INTRODUCTION

Risk assessment has become a challenging task in today's competitive business environment due to uncertainty and imprecision associated with the risk in oil and gas industries. However, the unwanted accidents and failures are very expensive for industries. It can be caused by personal injuries of workers, environmental damages, degradation and damage of the assets, which have high effects on the reputation of the industry. Therefore, prediction and prevention of failures and harmful accidents are very important for industries. Oil and gas industries are trying to improve their performance to carry out more effective strategies in order to reduce risks associated with unwanted failures. Typically, in oil and gas industry, the qualitative approach is applied for evaluating the risk assessment of hazards related to health, safety, and environment (HSE). The existing process may increase the uncertainty in ranking and select the critical factors of HSE categories; people, environment, asset, and reputation. In order to overcome the ambiguities involved with a qualitative approach, this research has developed a quantitative risk assessment model based on fuzzy logic theory, in which the numerical scaling values have been assigned to calculate the risk level with likelihood and severity of consequence [1, 2].
Considering the above arguments, some objectives have been set to develop a fuzzy logic based quantitative risk assessment model and validation of that model with the industry data which has been taken from oil and gas industry. To fulfill the aims, this study incorporated the quantitative risk assessment approach with fuzzy logic to evaluate the risk and reduce the risk ranking ties involved with four categories of hazard (people, environment, asset, and reputation).

FUZZY LOGIC RISK ASSESSMENT

Fuzzy Logic (FL) was introduced in 1965, by Lotfi A. Zadeh [3]. Fuzzy Set Theory. It is based on the set of mathematical principals to represent knowledge based on degrees of membership and degrees of truth. It reflects towards the thinking and intellectual capabilities of people in giving models and different circumstances. The use of FL approach in risk assessment has been covered a range of application such as; assessing of earthquake risk, assessing of environmental risk, assessing of project risk, safety risk assessment, and supply chain risk assessment [4]. The advantages of fuzzy logic are to deal with the complex problem where linguistic variables are used to express the specific logic rules. In terms of risk assessment, FL has been the virtuous approach in dealing with operational risk, where the assessment is often based on the expert opinion [5, 6]. Moreover, input and output membership functions can be used to manage the variables. The fuzzy logic consists of following components.

FUZZY SET. A fuzzy set is defined as a set with a flexible linguistic boundary instead of crisp number boundary, in which each variable of fuzzy logic consists of a truth value that ranges in a degree between 0 and 1. Typically, the truth value is based on completely true and completely false. A fuzzy set X of the universe discourse U is defined by a membership function UA: U [0, 1].

FUZZY RULES AND FUZZY REASONING. The fuzzy Rules and reasoning are based on 'IF-THEN' and 'AND-OR' statement, which is formed of 'IF Likelihood are L AND the Consequence are C, THEN Risk is R.'. This statement describes the relationship between Likelihood, consequence, and Risk. The simple example of IF-THEN and AND-OR rules is: IF the severity of people is catastrophic AND the likelihood of people is Unlikely, THEN the risk will be high.

FUZZY INFERENCE SYSTEM. The Fuzzy Inference system or Fuzzy-rule-based-system mainly consist of three components; fuzzification, knowledge base or rule base, reasoning mechanism and defuzzification. Figure 1 represents the basic structure of Fuzzy Inference System.

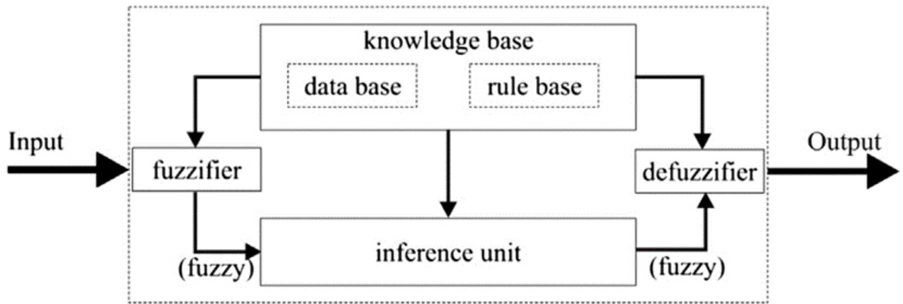

Figure 1. Fuzzy Inference System

FUZZIFICATION. In fuzzification process, the membership functions are defined as "the input variables which have been applied to their actual values". In this process, the truth-value for the foundation of each rule is computed, and it will apply to the concluding part of each rule. These sets of rules are generated from engineering knowledge with the collection of IF-THEN statement.

DEFUZZIFICATION. In the process of defuzzification, the values are estimated for weighting and averaging from the dependent variables which based on a single output fuzzy crisp number after applying the fuzzy inference rule. Also, in defuzzification process, the aggregated membership functions can simply represent the value of the overall risk as a fuzzy system [6, 7].

2. RESEARCH METHOD

The methodology used for developing of the fuzzy logic based risk assessment model is shown in Figure-2

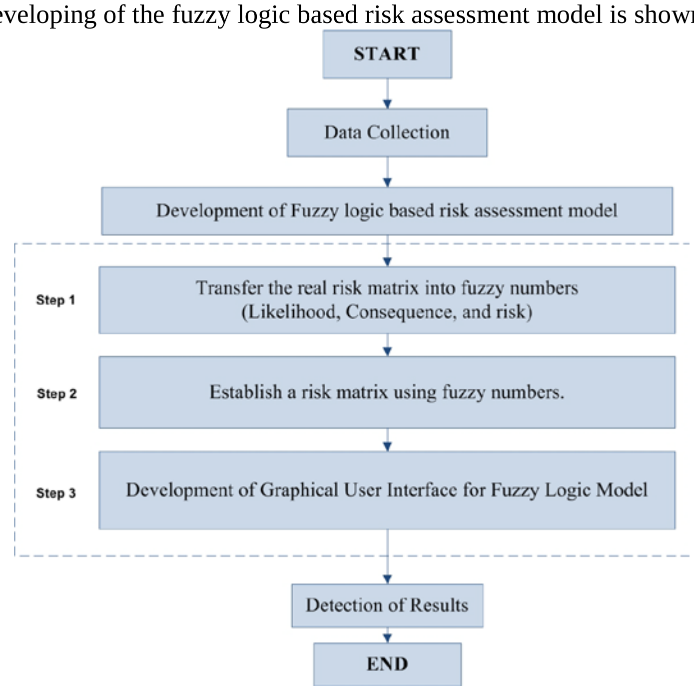

Figure-2 Research methodology

DATA COLLECTION

According to Burn and Grove, data collection is an accurate systematic gathering of information relevant to the specific objectives and questions of the study [8]. In this phase of the study, the created template was sent to responded in Oil and Gas industry to assess the risk of hazard or unwanted event through likelihood and consequence with their existing risk assessment method.

The received data is based on the qualitative approach, in which five assessors (expert/decision makers) assess the overall risk of four categories such as; people, environment, asset, and reputation. Moreover, the categories are divided into the severity of consequence and likelihood. Further, the severity of consequence and likelihood has been divided into five attributes.

DEVELOPMENT OF FUZZY LOGIC BASED RISK ASSESSMENT MODEL

The proposed model has been developed using Fuzzy Logic Toolbox in MATLAB software. The linguistic variables and membership functions have been used to construct the risk assessment model. The proposed model consists of two input variables with five attributes and one output variable with four attributes. The input variables are represented by; Likelihood and consequence. Where the output variable represented as the total risk as shown in Figure-3.

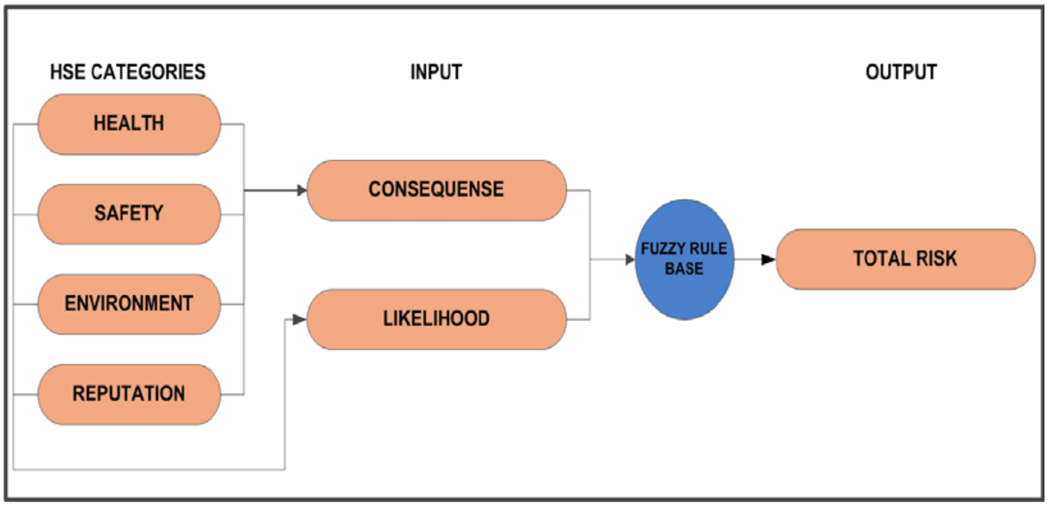

Figure-3. Fuzzy Logic based quantitative risk assessment model

The following steps have been followed for development of the fuzzy logic model.

STEP 1.

The obtained data were transferred into a fuzzy number to evaluate the overall risk. In this study, the triangular fuzzy numbers are used to evaluate the overall risk of failure. According to Xixiang Zhang 2014, a Triangular fuzzy number not only can be used to express the uncertainty of information, but it can be used to represent the fuzzy terms in information processing [9]. Besides integrating with decision making, the triangular fuzzy number has been applied in many fields such as; risk evaluation, performance evaluation, forecasting, matrix games and space representation. Table-1 represent the Triangular fuzzy numbers for consequence, likelihood, and risk level.

Table-1. Triangular fuzzy number for Consequence, Likelihood, and Risk

Consequence	Likelihood	Fuzzy numbers	Risk	Fuzzy numbers
Insignificant	Remote	(0, 1, 2)	Low	(1, 1, 25)
Minor	Unlikely	(2, 3, 4)	Medium	(1, 25, 50)
Moderate	Possible	(4, 5, 6)	High	(25, 50, 75)
Major	Likely	(6, 7, 8)	Very High	(50, 75, 100)
Catastrophic	Almost Certain	(8, 9, 10)		

STEP 2.

The HSE risk matrix is used to develop the rules for the fuzzy logic model. A set of twenty-five aggregation rules have been settled and determine that how the risk level changes under the different scenarios. The rules in the rule base are the combination of likelihood, consequences, and total risk. Through utilizing this rule base with Mamdani implication method, fuzzy results were generated which were defuzzified by using the centroid method in Matlab R2014a software.

STEP 3.

Calculation of risk level is done by interpreting the final output risk score. However, the fuzzy rules and risk rating can be modifiable according to company's own risk criteria.

3. RESULT AND DISCUSSIONS

In order to check the performance of the proposed model, a case study of HSE has been taken into account from oil and gas industry. This case study is based on the vessel property damaged due to improper lifting method. Failure occurs when the suspended load dropped during lifting. A loss of mooring could result in the vessel drifting into collision with nearby structures and it can be caused significant loss of life or environmental consequences. The risks associated with the vessel break-up would be well reviewed using by both traditional and proposed methods.

RISK ASSESSMENT

To carry out the risk assessment using the fuzzy logic model, likelihood and severity of consequences were required. For measuring the risk impact of failed vessel on people, environment, asset and reputation the simulation has been done by the proposed model. The individual risk has been evaluated by Fuzzy logic based model as shown in Figure-4. Collected data have been used to calculate the risk of four categories; people, environment, asset, and reputation.

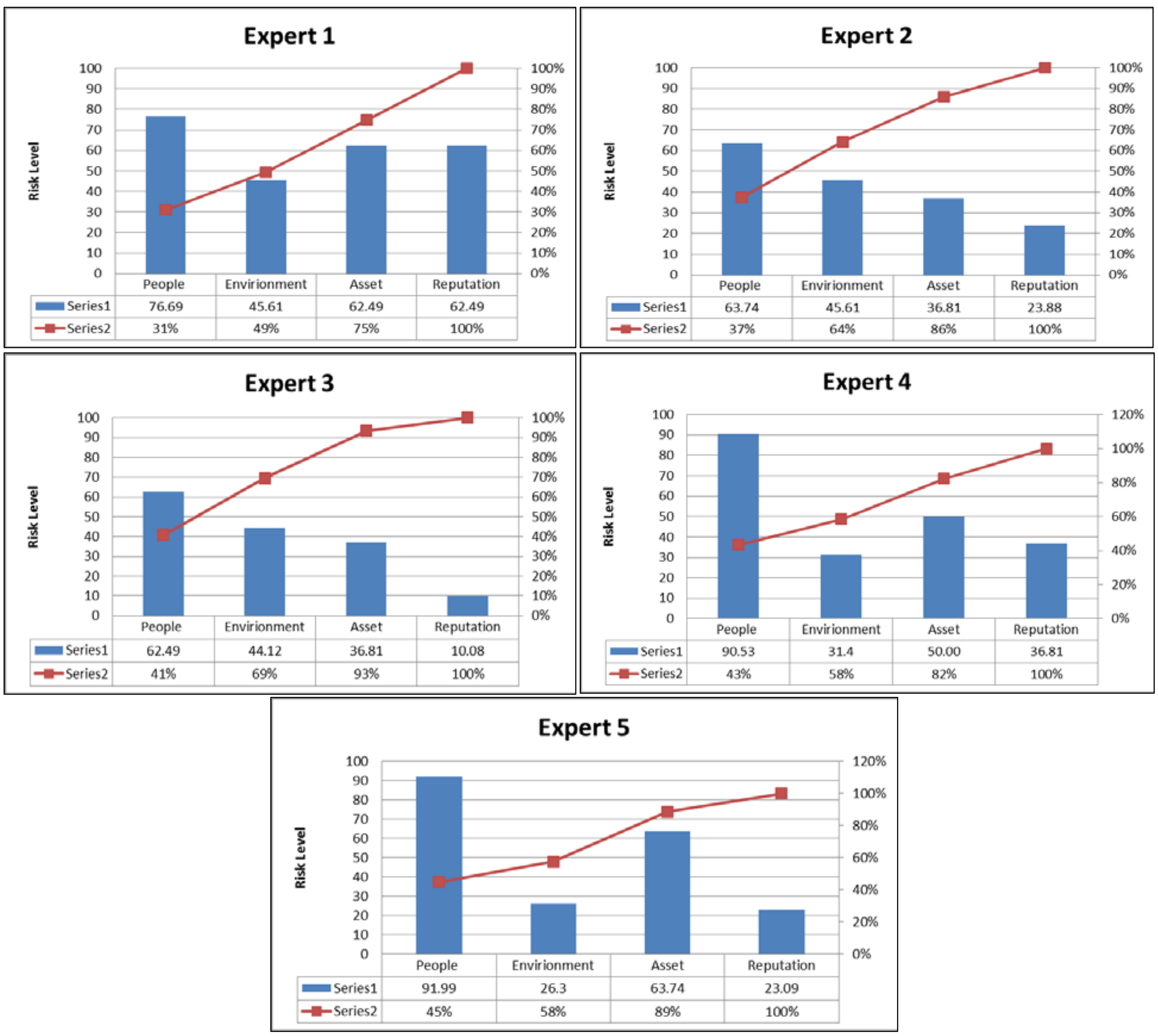

Figure-4. Individually measured risk score of four categories

Obtained results from the model have been compared with the existing method results as shown in Table-2. It is found that the risk result of both methods are similar, while the developed model results indicate the risk score of the categories from where the decision maker can easily take the decision of critical category. The overall working accuracy of the developed model is 90%.

Table-2 Results comparison of existing and developed model

Comparison of Results							
	Existing method results			Developed Model Results			
	Category	Experts	Risk Level	Category	Experts	Risk Score	Risk Level
1	People	Expert 1	Very high	People	Expert 1	76.7	Very High
2	People	Expert 2	High	People	Expert 2	63.7	High
3	People	Expert 3	High	People	Expert 3	55.9	High
4	People	Expert 4	Very high	People	Expert 4	90.5	Very High
5	People	Expert 5	Very high	People	Expert 5	92	Very High
6	Environment	Expert 1	Medium	Environment	Expert 1	45.6	Medium
7	Environment	Expert 2	Medium	Environment	Expert 2	45.6	Medium
8	Environment	Expert 3	Medium	Environment	Expert 3	44.1	Medium
9	Environment	Expert 4	Medium	Environment	Expert 4	31.4	Medium
10	Environment	Expert 5	Medium	Environment	Expert 5	26.3	Medium
11	Asset	Expert 1	High	Asset	Expert 1	55.9	High
12	Asset	Expert 2	Medium	Asset	Expert 2	36.8	Medium
13	Asset	Expert 3	Medium	Asset	Expert 3	36.8	Medium
14	Asset	Expert 4	Medium	Asset	Expert 4	42.7	Medium
15	Asset	Expert 5	Very high	Asset	Expert 5	63.7	High
16	Reputation	Expert 1	High	Reputation	Expert 1	55.9	High
17	Reputation	Expert 2	Low	Reputation	Expert 2	23.9	Low
18	Reputation	Expert 3	Low	Reputation	Expert 3	10.1	Low
19	Reputation	Expert 4	Low	Reputation	Expert 4	36.8	Medium
20	Reputation	Expert 5	Low	Reputation	Expert 5	23.1	Low

Finally to analyze the average obtained an experts' risk scores of four categories has been considered. Moreover, the priority has been settled according to the criticality of affected categories as shown in Table-3. It indicated the obtained risk score 77.09 of category people has high ranked among all categories. Further, the priority of remaining categories; environment, asset, and reputation will be entertained according to their risk ranking score.

Table-3. Calculated average score, risk ranking and priority of HSE categories

Category	Score	Ranking	Priority
People	77.09	Very High	1
Environment	36.6	Medium	3
Asset	49.97	Medium	2
Reputation	34.77	Medium	4

4. CONCLUSION

The fuzzy inference system can be implemented to lead more reliable risk assessment model. In this paper, a fuzzy logic based quantitative risk assessment model was developed to evaluate the health, safety, and environment categories; people, environment, asset and reputation. Obtained results from model also compared with the existing method results with and overall 90% of accuracy. The developed model has the ability to deal with uncertainty and also will assist the decision maker to rank or prioritize the critical HSE categories quantitatively.

REFERENCES

[1] M. Nikbakht, A. Sayyah, and N. Zulkifli, "Hazard identification and accident analysis on city gate station in natural gas industry," in *Environmental Engineering and Applications (ICEEA), 2010 International Conference on*, 2010, pp. 13-17.
[2] K. Shuaib, H. Hussin, and M. A. A. Majid, "FUZZY MULTI-CRITERIA DECISION MAKING MODEL FOR RISK ASSESSMENT," 2006.
[3] L. A. Zadeh, "Fuzzy sets," 1965.
[4] H. K. Chan and X. Wang, "Fuzzy Hierarchical Model for Risk Assessment," *London: Springer London. doi*, vol. 10, pp. 978-1, 2013.
[5] M. Hellmann, "Fuzzy logic introduction," *Université de Rennes,* vol. 1, 2001.
[6] A. S. Markowski and M. S. Mannan, "Fuzzy risk matrix," *Journal of hazardous materials,* vol. 159, pp. 152-157, 2008.
[7] O. Y. Abul-Haggag and W. Barakat, "Application of Fuzzy Logic for Risk Assessment using Risk Matrix," *International Journal of Emerging Technology and Advanced Engineering,* vol. 3, 2013.
[8] N. Burns and S. K. Grove, *Understanding nursing research: Building an evidence-based practice*: Elsevier Health Sciences, 2010.
[9] X. Zhang, W. Ma, and L. Chen, "New similarity of triangular fuzzy number and its application," *The Scientific World Journal*, vol. 2014, 2014.

LIFE CYCLE ASSESMENT MODEL FOR CO2 EMISSION OF STEAM ABSORPTION CHILLER

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Abstract: Abstract: Greenhouse gasses emission has been evolving as a major problem in today's era. And the main cause is the burning of fossil fuels (coal and natural gas etc.). Since this emission remains hidden throughout the whole life cycle of product/process and cannot be identified easily. Here in this scenario, a life cycle assessment model will be built to evaluate the amount of CO_2 equivalent release to the environment during the operational phase of a steam absorption chiller. The Life cycle assessment study will focus on the operational phase of Steam absorption chiller, for this purpose the data of gas district cooling plant of Universiti Teknologi Petronas will be used to validate the Life cycle assessment model.

Keywords: LCA,CO_2, Life cycle assessment, GDC, GHG

1. INTRODUCTION

Carbon dioxide (CO_2) is the primary greenhouse gas emitted through human activities. Human activities are altering the carbon cycle both by adding more CO_2 to the atmosphere. While CO_2 emissions come from a variety of natural sources. Based on the EDGAR database created by the European Commission and Netherlands Environmental Assessment Agency released in 2014. The following Table 1 lists the 2014 annual CO_2 emissions estimates (in thousands of CO_2 tons) along with a list of emissions per capita (in tons of CO_2 per year) from the same source.

Table 1. CO_2 Emission in Malaysia 2014 (Olivier, Peters et al. 2012)

Country Name	CO_2 Emission (kt) in 2014	Emission in capita (t) in 2014
Malaysia	227,000	7.5

Universiti Teknologi PETRONAS (UTP) produces its own electrical power and chilled water for air conditioning system, which is used by the campus. The plant is located in the UTP campus in Tronoh, Perak West Malaysia. The Gas District Cooling (GDC) generates the electricity and chilled water. Basically, GDC is a cogeneration plant system that produces chilled water and electrical power in which natural gas is used as the fuel for gas turbines, which generate electricity. The excess heat from the turbine output is used as the primary energy source in steam absorption chillers to produce chilled water for air-conditioning systems. Here, the heat is used to vaporize the cooling-liquid solution in the generator of steam absorption chillers. Such an integrated energy system utilizes the free energy (heat) from the turbine outlets, which would otherwise be released to the environment and wasted. At UTP the two steam absorption chillers installed produce the chilled water with a capacity of 1250 RT per chiller. Substantial energy loss being released to the environment in the operational phase of SAC, which contributes to CO_2 emission. Hence it is important to study the operational phase of SAC in order to know the amount of CO_2 emission to the environment.

The objective of this study is to develop an LCA model for the steam absorption chiller during the operational phase used and to assess the hidden CO2 emission during the operational phase of the Steam absorption chiller.

The operational phase of steam absorption chiller to be studied is located at the GDC. The absorption chiller is used for producing chilled water to fulfill the air conditioning demand of the campus.

An Excel-Based template will be developed to evaluate the CO_2 equivalent released during the operation phase of a steam absorption chiller.

2. LIETRATURE REVIEW

(Majid and Amin 2011) Universiti Teknologi PETRONAS (UTP) produces its own electrical power and chilled water for air conditioning system, which is used by the campus. The plant is located in the UTP campus in Tronoh, Perak West Malaysia. The Gas District Cooling (GDC) generates the electricity and chilled water. The excess heat from the turbine output is used as the primary energy source in steam absorption chillers to produce chilled water for air-conditioning systems. Here, the heat is used to vaporize the cooling-liquid solution in the generator of steam absorption chillers. Such an integrated energy system utilizes the free energy (heat) from the turbine outlets, which would otherwise be released to the environment and wasted.

(Williams 2010) Observed that An alarming amount of CO_2 is emitted by the absorption chillers used for producing chilled water for satisfying the air conditioning demands of buildings. Figure 1shows the pounds of CO_2 resulting from the production of 1 ton-hr of cooling by a two-stage steam absorption chiller. The basic parameters are the same as those of the single-stage steam absorption chiller, except high-pressure, 100-psig streams is utilized, increasing the chiller coefficient of performance from 0.71 to 1.35. Input energy includes natural gas as well as electricity for auxiliary equipment. CO_2 emissions are 29-percent higher.

(Beccali, Cellura et al. 2016) Used simplified LCA tool for comparing different solar heating and cooling system in two different locations.in order to calculate the energy and environmental impacts of energy systems. Furthermore to compare beccali developed a simple LCA comparison tool. Hence the comparison results are highlighted that the operational phase of different SHC systems is responsible for 60% to 90% impact during LCA of examined systems. Result also indicated that the operational phase varies with climatic conditions of installation sites. i-e in winter using solar thermal systems demands high heating on another hand a hot weather leads to a high contribution to the energy production from solar heated panels.(Xing, Xu et al. 2008) a life cycle energy consumption & environmental emission effects of two office building structures in china is compared i-e steel framed building and concrete framed buildings. A life cycle inventory model is used to carry out the comparison of life-cycle energy consumption & environmental emission effects between the above-mentioned buildings. Results declared that the life-cycle energy consumption of building materials per area in the steel-framed building is 24.9% as that in the concrete-framed building, and on operational phase, the energy consumption and emissions of the steel-framed building are both larger than concrete-framed building on the total life cycle. The reason, which leads to that result, is the higher heat transfer coefficient due to high thermal conductivity of steel. Because in operational phase it is found that the energy consumption and environmental impact of air con are higher than the concrete framed building.

(Prasartkaew 2014) Aims in simplifying the estimation of CO_2 emissions over a building's life cycle in china. A comparison of the life cycle of CO_2 emissions was performed by dividing the analysis into three stages i-e construction stage (including processes such as raw material acquisition, building material production, transportation, and construction), operation stage and demolition stage. The results showed that the operational stage is the largest contributor to CO_2 emissions. Approximately 85.4% of the total carbon emissions were generated during operation. Thus, these findings indicate that the sufficient reduction in CO_2 emission can be achieved by targeting the operational phase of buildings. In the end limitations in performing LCA was also discussed in this paper. Due to the utilized method, assumptions, impact coverage, and lack of benchmarks (Peng 2016).in this paper actually, guides us that how to build a small sized (3.5kw or 2RT) steam absorption chiller and also we investigate the working of this chiller renovated by replacing cooling fluid and controller circuit. This steam absorption chiller was operated in a local weather condition and the concentration of the strong solution was used in this experiment. The findings indicate that to obtain a high coefficient of performance the chiller should be operated at 85c of hot water supplied to the generator.(Wang, Thakkar et al. 2016) Clearly, quantifies energy and environmental impact (GHG) of runway pavement design alternatives using life-cycle assessment approach. The current analysis focused on the comparison between asphalt and concrete runway pavement designs for new pavements and overlays on existing pavements. Life-cycle inventory data were used to compare the two pavement designs. Although there are no general conclusions on pavement type selection, the research findings bring awareness to airport authorities on the impact of pavement type on energy consumption and greenhouse gas emission. The results indicate that the expected pavement service life and maintenance treatments significantly affect the comparison between HMA and PCC pavements. Production of process fuels and electricity in the upstream process also plays a role in energy and emissions.(Ji and Chen 2016) developed a method by combining LCA and input-output analysis to calculate the overall carbon emission in the construction, operation and dispose of phase of a wind farm in china.as a result, the carbon emission for the lifetime of 21 years was calculated and found that the CO_2 emission in construction phase was more than all other phases Due to the smelting and pressing of steel and copper for the construction of wind farm. The results shows that the direct carbon emission is 10% of the embodied carbon for the three phases, which indicates the indirect emission of CO_2higher than the direct emission during operational phase

(Bukoski, Gheewala et al. 2014) Utilized Life cycle assessment (LCA) methodology to Assess the environmental impacts of using a solar/electric hybrid cooling system in a stadium of 15,000 seating capacity. The life cycle emissions of the solar-assisted absorption chiller (AC) system are compared to a conventional electricity-consuming vapor compression (VC) chilling system. It is found that use-phase has an impact on savings due to the cooling production of the solar Absorption chiller outweigh the higher non-use phase (raw material extraction, refining, unit manufacturing, transportation, and disposal) impacts of the solar-assisted Absorption cooling system, and thus the system is found to be environmentally advantageous than VC. The results can be applicable to similar cooling systems within Southeast Asia (Araújo, Oliveira et al. 2014) perform The study aims to evaluate the equivalence CO_2 emission by the steam absorption chiller in the operational phase by using life cycle assessment. The LCA of operational phase in the steam absorption chillers (SAC) is important to be assessed in order to calculate the life cycle effect on the environment due to hidden CO_2 emissions. Because the global warming potential (GWP) due to CO_2 emission is the most contributed to environmental effect as we have studied in previous papers on it. After the Life cycle assessment, we will be able to develop a simple LCA model which will help us to find out the amount of CO_2 released into the environment during the operational phase of SAC. From above literature review, we found that the operational phase of every process is responsible for more GHG emission and the energy wastage more than any phase. And this problem was found after every LCA application. And no any sufficient LCA modeling is done on operational phase.so we will start performing the LCA in the operational phase of steam absorption chiller to reduce CO_2 emission and reduce wastage of energy.

3. RESEARCH METHODLOGY

This methodlogy will follow the basic steps of life cycle assessment as defined by International Organization for Standardization (ISO 2006).
According to ISO 14044, there are four phases in an LCA study:
1) The goal and scope definition phase,
2) The inventory analysis phase,
3) The impact assessment phase, and
4) The interpretation phase.

1) Goal and scope phase: to identify the components of absorption chiller used during operational phase and to define the required level of detail.
2) Inventory analysis phase: to gather the technical data of absorption chiller during daytime as the cooling demand by UTP campus is higher in the day time as compared to night time.
3) Impact assessment phase:to calculate the technical, quantitative and qualitative efforts or impacts of the environmental issues (including the resources used, emission of CO_2.
4) Interpretation phase: interpretation phase includes the interpretation of results obtained during the operational phase of SAC at GDC.

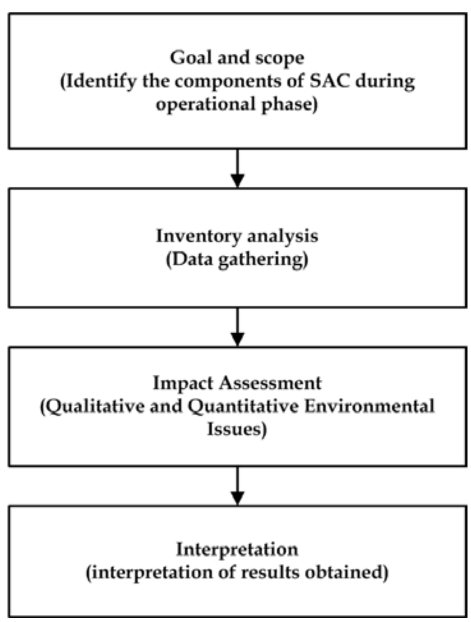

Figure 3. Research Methodology

4. EXPECTED RESULTS AND OUTCOMES

In this study LCA technique will be conducted in order to evaluate the amount of CO_2 equivalent released into the environment. During the operation phase of steam absorption chiller. The data from Saturdays and Sundays will be excluded from the analysis, as only the data of working days will be analyzed. Even though the data will be recorded 24 hours a day, but it will be analyzed from 8:00 am to 5:00 pm because between these times most of the rooms in the academic complex used frequently.

From the data, the given parameter of the steam absorption chiller that can be used for LCA will be from the operational phase only. Thus, from the data collected the heat loss during operational phase will be calculated through the formula stated in the methodology. Hence, the equivalent CO_2 emission by the SAC can be evaluated from the total amount of heat loss.

5. CONCLUSION

The study aims to evaluate the equivalence CO_2 emission by the steam absorption chiller in the operational phase by using life cycle assessment. The LCA of operational phase in the steam absorption chillers (SAC) is important to be assessed in order to calculate the life cycle effect on environment due to hidden CO_2 emissions. Because the global warming potential (GWP) due to CO_2 emission is the most contributed to environmental effect as we have studied in previous papers on it. After the Life cycle assessment, we will be able to develop a simple LCA model which will help us to find out the amount of CO_2 released to environment during operational phase of SAC.

6. REFERENCES

1. Araújo, J. P. C., J. R. Oliveira and H. M. Silva (2014). "The importance of the use phase on the LCA of environmentally friendly solutions for asphalt road pavements." Transportation Research Part D: Transport and Environment **32**: 97-110.
2. Beccali, M., M. Cellura, S. Longo and F. Guarino (2016). "Solar heating and cooling systems versus conventional systems assisted by photovoltaic: Application of a simplified LCA tool." Solar Energy Materials and Solar Cells.
3. Bukoski, J., S. H. Gheewala, A. Mui, M. Smead and S. Chirarattananon (2014). "The life cycle assessment of a solar-assisted absorption chilling system in Bangkok, Thailand." Energy and Buildings **72**: 150-156.
4. Christoforou, E., A. Kylili, P. A. Fokaides and I. Ioannou (2016). "Cradle to site Life Cycle Assessment (LCA) of adobe bricks." Journal of Cleaner Production **112**: 443-452.
5. Gebreslassie, B. H., G. Guillén-Gosálbez, L. Jiménez and D. Boer (2010). "A systematic tool for the minimization of the life cycle impact of solar assisted absorption cooling systems." Energy **35**(9): 3849-3862.
6. Guinée, J. and R. Heijungs (2017). Introduction to life cycle assessment. Sustainable Supply Chains, Springer**:** 15-41.
7. ISO, E. (2006). "14044: 2006." Environmental management-Life cycle assessment-Requirements and guidelines. European Committee for Standardization.
8. Ji, S. and B. Chen (2016). "LCA-based Carbon Footprint of a Typical Wind Farm in China." Energy Procedia **88**: 250-256.
9. Kua, H. W. and S. Kamath (2014). "An attributional and consequential life cycle assessment of substituting concrete with bricks." Journal of Cleaner Production **81**: 190-200.
10. Majid, A. and M. Amin (2011). "Thermal Storage at Universiti Teknologi PETRONAS Gas District Cooling Plant."
11. Olivier, J. G., J. A. Peters and G. Janssens-Maenhout (2012). Trends in global CO2 emissions 2012 report, PBL Netherlands Environmental Assessment Agency The Hague, The Netherlands.
12. Peng, C. (2016). "Calculation of a building's life cycle carbon emissions based on Ecotect and building information modeling." Journal of Cleaner Production **112**: 453-465.
13. Prasartkaew, B. (2014). "Performance Test of a Small Size LiBr-H 2 O Absorption Chiller." Energy Procedia **56**: 487-497.
14. Resta, B., P. Gaiardelli, R. Pinto and S. Dotti (2016). "Enhancing environmental management in the textile sector: An Organisational-Life Cycle Assessment approach." Journal of Cleaner Production **135**: 620-632.
15. Shafie, S., T. Mahlia, H. Masjuki and B. Rismanchi (2012). "Life cycle assessment (LCA) of electricity generation from rice husk in Malaysia." Energy Procedia **14**: 499-504.

16. Wang, H., C. Thakkar, X. Chen and S. Murrel (2016). "Life-cycle assessment of airport pavement design alternatives for energy and environmental impacts." Journal of Cleaner Production **133**: 163-171.
17. Williams, G. J. (2010). "SCHOOLS AND UNIVERSITIES-Greenhouse-Gas Impact of Various Chiller Technologies-As more colleges and universities strive for climate neutrality, a look at the fundamentals of carbon-dioxide production." Heating/Piping/Air Conditioning Engineering: HPAC: 36.
18. Xing, S., Z. Xu and G. Jun (2008). "Inventory analysis of LCA on steel-and concrete-construction office buildings." Energy and Buildings **40**(7): 1188-1193.

DEVELOPMENT OF A NEURAL NETWORK MODEL FOR PREDICTION OF CUI CORROSION RATE USING FIELD DATA IN A MARINE ENVIRONMENT

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Abstract: Corrosion under insulation (CUI) has been a major problem for oil and gas industries. As CUI remains hidden beneath the insulation so its accurate prediction, identification, and estimation is very difficult. The difficulty in corrosion monitoring has contributed by the scarcity of CUI corrosion rate data that is typically used for quantitative Risk-Based Inspection (RBI) analysis. For prioritizing RBIs, many companies have adopted and applied different methodologies for reducing failure risk levels. However due to complexity and less availability of quantitative thickness data for CUI, effective analysis is a tough task to be accomplish by using traditional quantitative techniques of risk analysis. In this study, field data of CUI from a marine environment industry, has been utilized for the development of a neural network (NN) based prediction model. Along with testing accuracy of the NN model, the main purpose of the proposed NN model is to predict CUI corrosion rates in order to facilitate the quantitative approach of RBI. The developed NN model has successfully given its outcomes with a standard error of 0.001 while having an overall accuracy of 76.23%. The results from the developed NN model would provide corrosion/inspection engineers to do necessary inferences in a more quantitative approach.

1. INTRODUCTION

One of the most serious external corrosion problems in oil and gas industries is the corrosion of under the insulations of piping systems, typically known as Corrosion under Insulation (CUI). CUI is one of the major reasons that contribute to unexpected failures of piping systems in many of today's plants. A study indicated that the highest incidence of leaks in the refining and chemical industries is due to CUI, not due to process corrosion while it takes 40% to 60% budget of the piping maintenance cost [1]. The failures can be disastrous or at least have a noticeable economic impact on the industry in terms of increasing downtimes and repairs [2]. Due to its varying nature, CUI is very difficult to detect/predict since corrosion occurs beneath the insulation, hence making corrosion detection/prediction process very complicated.

CUI typically remains undetected until, either insulation and cladding/jacketing is removed during inspection period or when some leakages from the pipes may occur. The difficulty in corrosion monitoring has contributed by the scarcity of CUI corrosion rate data that is typically used for quantitative Risk-Based Inspection (RBI) analysis.

The data for CUI cases presented in the American Petroleum Institute standard (API 581) is limited and vague for both stainless steels and carbon steels [3]. The proposed corrosion rates are deterministic and subject to a large uncertainty [3]. Various models in recent years have been developed to predict the failure progress of CUI corrosion rates. Among those data-driven models artificial neural network and fuzzy logic are the tools of artificial intelligence, which have been mostly utilized by the researchers [4].

Past studies have shown that predictions made by using ANN for different types of corrosion were very nearer to their original data (data from which those NN models were developed initially). That is why; the present study has utilized ANN for the development of a CUI corrosion rate prediction model, using field data of a marine environment.

Artificial neural network (ANN) is an intelligence processing pattern that is influenced by the way human brain processes information. ANNs consist of a number of interconnected processing nodes called neurons. The neurons are usually organized in a sequence of layers, including an input layer, one or two hidden layers, and an output layer. The input layer receives input data to the network but does not perform any computations. The output layer gives the network's response to the specified input. The hidden layers are typically connected to the input and output layers. Each neuron in the hidden and output layers receives the signals from all the neurons in a layer above it and then performs a weighted summation and transfer function of the inputs [5].

An artificial neural network is a generalized model, taking into account the experience of a set of training data and hence contains no explicit rules. It is reliable in the sense that, input pattern will always generate same answer. In this study, the multilayer feedforward neural network has been used. The term "feedforward" indicates that the network has links that extend in only one direction. When the inputs are introduced to the network, they will be multiplied by their flexible weights wi and in every processing element added and went over a transfer function f in order to generate the outputs, as mathematically expressed in Eq. (1). The data utilized as inputs is transmitted through the network, layer by layer, and a set of outputs is obtained.

$$y = f\left(\sum_{i=0}^{N} w_i x_i + b\right) \tag{1}$$

Where, x and y are the inputs and outputs of the network respectively. While i = 1,2,3,...N where, N is the number of neurons. In addition to this, a bias term b, is generally added to the input.

Artificial neural networks are better for estimate of relations among sensor based data, particularly among non-structured data, with a high degree of nonlinearity, erroneous and deficient data. This kind of data frequently happens in process of atmospheric corrosion. Neural networks (NNs) have the capacity to simulate conditions which can be not really understood by classic methods of statistic data evaluation and they find themselves able to express more complicated relations than these methods [6]. Jančíková et al. has developed a model using artificial neural network for the prediction of corrosion loss of auxiliary carbon steel using the input environmental measurements. It was confirmed that utilization of ANNs for the prediction of corrosion loss of materials is extremely perspective [7] . Author also suggested NN as beneficial, if it is important to show complex mutual relations among sensor based data [7].

Ren et al. applied the backpropagation neural network model to predict the corrosion rate of long distance gas pipeline. The results of model showed better fitting precision and forecasting result, and prediction of corrosion rate. Neural network algorithm is of fast convergence, with better prediction accuracy, which can predict effectively the corrosion rate than other methods [8]. Supriyatman et al. [5] proposed a program using ANN to determine the corrosion rates of carbon-steel materials containing flowing fluid. The data only had used having a high level of significance and the ones having very low level significances are excluded using equation. The model had the high accuracy results, if the sufficient data from fields is available [9]. Cai Jian-ping and Ke-wei [6] developed a ANNs based application for the prediction corrosion rate in the atmosphere. They have been good results and indicating the neural network in corrosion research has broad application prospects [10].

2. CUI CORROSION RATE BY API 581 FOR CARBON STEEL PIPING SYSTEMS

The relationship between CUI corrosion rate of insulated carbon steel with different operating temperature in marine type of environment is described by American Petroleum Institute in its standard API 581. The type of environment where the average rainfall is between 1000 mm/year to 1500 mm/year is classified as marine environment [11]. Table 1 shows CUI corrosion rate in marine environments at different operating temperatures, when type of insulation type is foamglass or calcium silicate while pipe complexity and insulation condition are average with the assumption that piping system are supported on beams or such a configurations that do not allow proper coating, as per given by API 581.

Table 1: CUI Corrosion rates in marine environment as per API 581[12].

Operating Temperature (°C)	**Corrosion Rate (mm/year) in Marine Environment**	
	When Insulation Type was "Foamglass"	**When Insulation Type was "Calcium Silicate"**
-12 to -8	0	0
-8 to 6	0.0375	0.0625
6 to 32	0.1905	0.3175
32 to 71	0.1905	0.3175
71 to 107	0.381	0.635
107 to 135	0.1905	0.3175
135 to 162	0.0765	0.1275
162 to 176	0.0375	0.0625
More than 176	0	0
Note: - Driver is defined as the atmospheric condition causing the corrosion rate. - Interpolation may perform for intermediate values of temperature.		

3. Methodology Adopted for the Conducted Research

Total 153 CUI corrosion rate data points were obtained from a local gas plant of Malaysia that was located in a marine environment. Type of Insulation which was utilized for piping systems in that industry was foamglass and calcium silicate.

Pipe complexity and insulation condition were consider as average with the assumption that piping system were supported on beams or such a configurations that did not allow proper coating. According to API 581 operating temperature, type of environment, pipe complexity, insulation condition, and type of insulation are the five factors which are most prone for the cause of CUI [12]. Therefore these five factors were selected as the input parameter while CUI corrosion rate was selected as the output parameter for the proposed NN prediction model. Among these five input parameters, 3 input parameters i.e. type of environment, pipe complexity, and insulation condition were constant while 2 input parameters i.e. operating temperature and insulation type were variable as shown in Figure 1.

Matlab R2013a software was utilized for the development of the proposed NN model. 103 data points were utilized for model development, while 50 data points were used for final validation of the developed model. The model was trained through Levenberg-Marquardt back propagation method by taking 1000 number of iterations. Figure 2 shows methodology followed for the development of the proposed NN model.

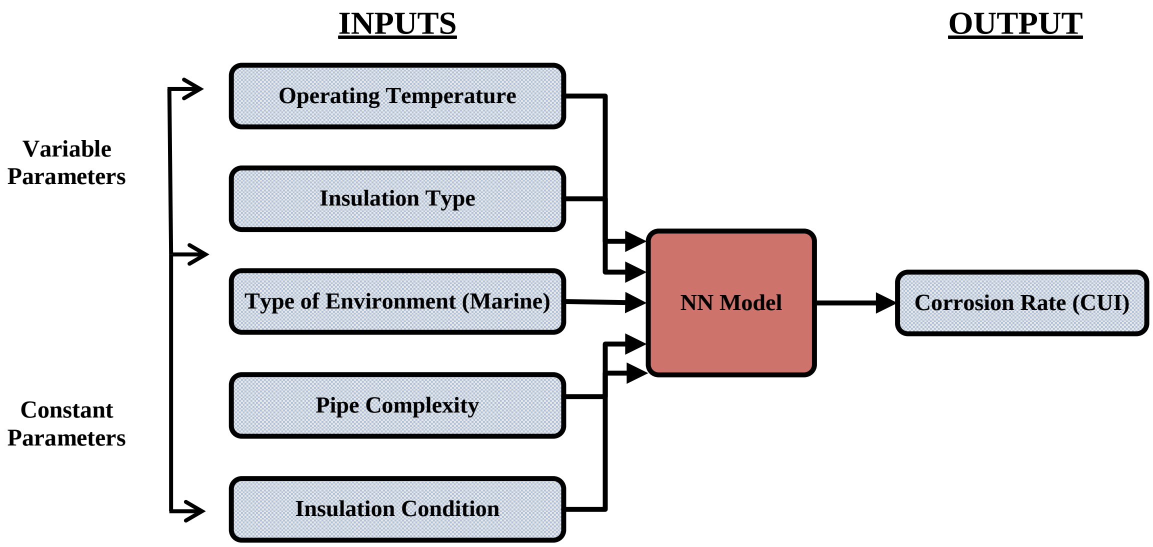

Figure 1: Input /Output parameters for NN model.

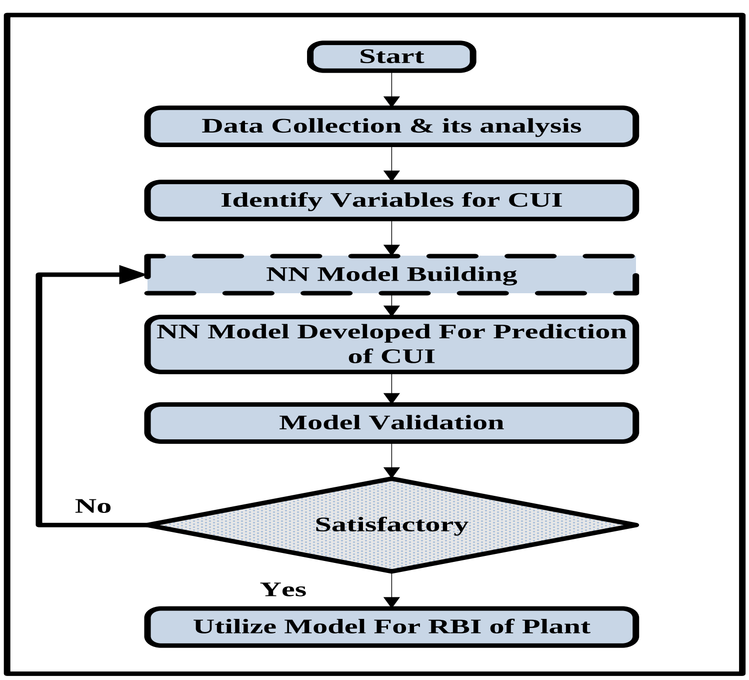

Figure 2: Methodology followed for the development of the proposed NN model.

4. Results and Discussion

In order to check the prediction capability of ANN modelling, API 581 CUI corrosion rate published data for a marine environment with both type of insulations i.e. foamglass and calcium silicate, was utilized. Insulation condition and pipe complexity were consider as “average”. The predicted results generated by NN model are shown in Table 2. When predicted results were compared with API 581 data, while having foamglass as insulation type, standard error of outcomes was found to be 1.61×10^{-6} and an overall accuracy of the NN model was found to be 99.29% as shown in Figure 3. When predicted results were compared with API 581 data when calcium silicate was the type of insulation, the standard error of outcomes was found to be 1.65×10^{-5} and an overall accuracy of the NN model was found to be 97.81% as shown in Figure 4.

Table 2: Results comparison of CUI corrosion rates generated by NN model with API 581 CUI corrosion rates for two different insulation types.

Operating Temperature (°C)	Corrosion Rate (mm/year) in Marine Environment			
	When Insulation Type was "Foamglass" (Actual API 581 data)	When Insulation Type was "Foamglass" (Prediction using NN Model)	When Insulation Type was "Calcium Silicate" (Actual API 581 data)	When Insulation Type was "Calcium Silicate" (Prediction using NN Model)
-12 to -8	0	0	0	0
-8 to 6	0.0375	0.037	0.0625	0.062
6 to 32	0.1905	0.19	0.3175	0.317
32 to 71	0.1905	0.1905	0.3175	0.3175
71 to 107	0.381	0.382	0.635	0.634
107 to 135	0.1905	0.1905	0.3165	0.3165
135 to 162	0.0765	0.0755	0.1275	0.1265
162 to 176	0.0375	0.0365	0.0625	0.0615
More than 176	0	0	0	0

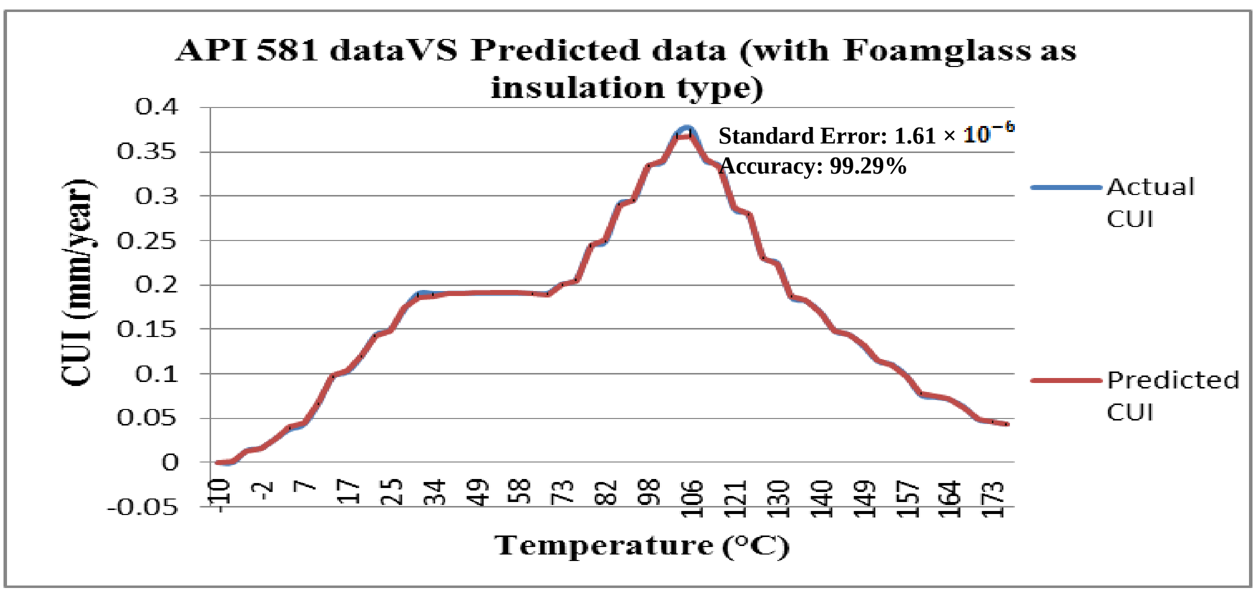

Figure 3: Comparison between CUI corrosion rates published by API 581 with API 581 data based NN prediction model when insulation type was “Foamglass”.

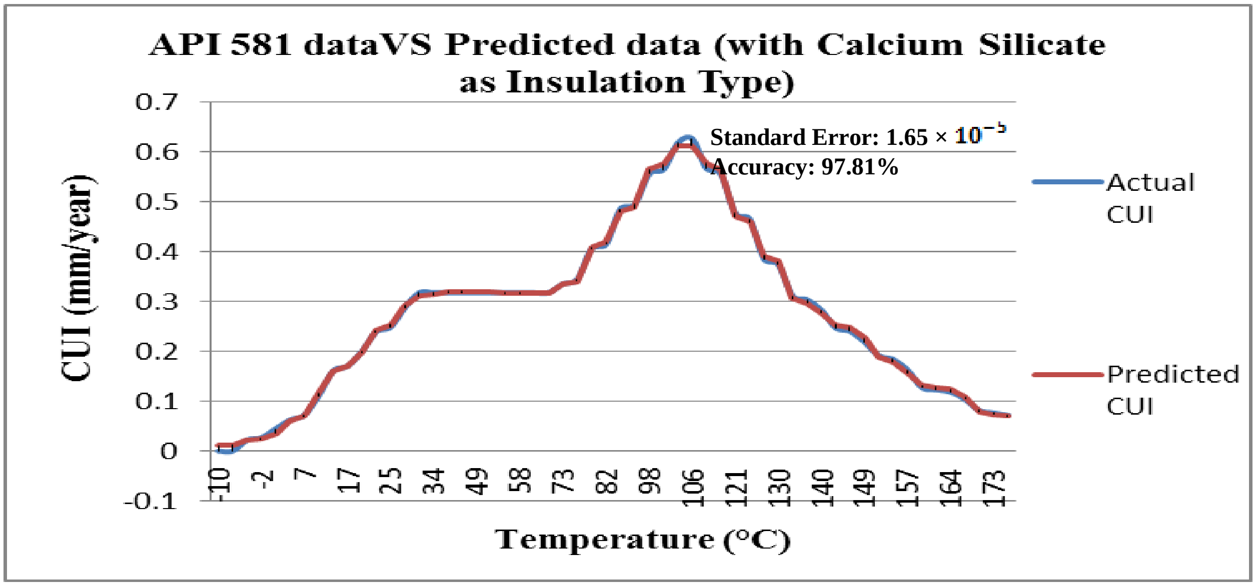

Figure 4: Comparison between CUI corrosion rates published by API 581 with API 581 data based NN prediction model when insulation type was "calcium silicate".

Table 3: A sample of available field data along with NN model's predicted CUI corrosion rates

S.No.	Operating Temperature (°C)	Type of Insulation	Type of Environment	Insulation Condition	Pipe Complexity	Field Data CUI (mm/year)	Predicted CUI using NN Model (mm/year)
1	-39	Foamglass	Marine	Average	Average	0.16	0.15
2	-12	Foamglass	Marine	Average	Average	0.22	0.16
3	-12	Foamglass	Marine	Average	Average	0.18	0.16
4	-12	Foamglass	Marine	Average	Average	0.15	0.16
5	-11	Foamglass	Marine	Average	Average	0.18	0.16
6	-11	Foamglass	Marine	Average	Average	0.16	0.16
7	-11	Foamglass	Marine	Average	Average	0.18	0.18
8	-11	Foamglass	Marine	Average	Average	0.15	0.16
9	-11	Foamglass	Marine	Average	Average	0.15	0.16
10	-11	Foamglass	Marine	Average	Average	0.16	0.16
11	-8	Foamglass	Marine	Average	Average	0.20	0.17
12	-8	Foamglass	Marine	Average	Average	0.20	0.16
13	-8	Foamglass	Marine	Average	Average	0.15	0.16
14	-8	Foamglass	Marine	Average	Average	0.15	0.16
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
149	135	Foamglass	Marine	Average	Average	0.18	0.18
150	135	Calcium Silicate	Marine	Average	Average	0.18	0.17
151	260	Calcium Silicate	Marine	Average	Average	0.18	0.14
152	380	Calcium Silicate	Marine	Average	Average	0.118	0.12
153	385	Calcium Silicate	Marine	Average	Average	0.1845	0.13

Table 3 shows a sample of available field data along with NN model's predicted CUI corrosion rates. It can be observe that available field data was also different for the same operating temperature, for instance at an operating temperature of -11 °C, the CUI corrosion rate was 0.15 °C, 0.16 °C, and 0.18 °C. On the other hand, according to API 581, the CUI corrosion rate for such a condition is found to be 0.0 mm/year. Moreover after -39 °C, the next available data was -12 °C. Similarly after 135

°C there was a direct jump to 260 °C, then to 380 °C and 385 °C. Missing data of operating temperature -11 °C to -8 °C is understandable (because there is a difference of only 2 units of temperature. It may be assume that CUI corrosion rate for these in between operating temperatures i.e. -10 °C and -9 °C will be somewhere between 0.15 mm/year to 0.18 mm/year. It should be noted that it is only a possible assumption). But there is no idea that what will be the CUI corrosion rate for an operating temperature range of -38 °C to -13 °C (temperature difference of 26 units), 136 °C to 259 °C (temperature difference of 124 units), and 261 °C to 379 °C (temperature difference of 119 units). Of course, these temperature ranges gaps can only be filled by the availability of field data.

Oil and gas industries typically used to do their plant rejuvenation after a time period of 20 years. CUI corrosion rate data which they obtained during their plant rejuvenation process, remains confidential mostly as per their company policies. The situation is such a worst, that even API 581 has also only offered CUI corrosion rates for an operating temperature range of -12 °C to 176 °C. API 581 assumes that there is 0.0 mm/year CUI corrosion rate before -12 °C and after 176 °C, which is an unrealistic fact as it is clearly indicated by the field data in Table 3 that there is some noticeable CUI corrosion rate before -12 °C and after 176 °C.

For such a complex and critical situation that has been explained above, the developed NN prediction model is a precious tool for assisting corrosion engineers for the purpose of RBI. The NN model which has been developed by using field data, has a standard error of 0.001, and overall accuracy of 76.23% as shown in Figure 5.

Table 4 and Table 5 are showing predicted CUI corrosion rates even for the operating temperatures which are neither available by API 581 nor by field data. Moreover available field data is specific to a particular insulation type for an operating temperature. For instance, for an operating temperature of -8 °C, the insulation type is foamglass while CUI corrosion rate is found to be 0.16 mm/year). It is not mention by field data that what will be the CUI corrosion rate for the same operating temperature i.e. -8 °C when insulation type will be “calcium silicate” for a given piping system. The developed NN model is predicting CUI corrosion rate for both types of insulation types i.e. “foamglass” and “calcium silicate” for the same operating temperatures as shown in Table 4, Table 5, and Figure 6.

An argument built-up here, that why corrosion engineers should trust on CUI corrosion rate predictions of developed NN model. This can be handled as, there is no other quantitative way researched yet. Up till now, corrosion engineers for such a situation are taking help with the qualitative approaches which are based on human expertise and skills. Still it’s very difficult for plant piping experts to decide that what will be a CUI corrosion rate of a piping system for a large number of same operating temperatures having different types of insulations.

By giving above given arguments, evidences and justifications, authors are trying to convince different oil and gas industries for sharing their CUI corrosion rate data. When more data will be available, accuracy of the developed field data NN model will increase definitely (just like the accuracy of the NN model which was developed for API 581 data i.e. 189 regular CUI data points). Consequently all the participating industries will get benefit enormously.

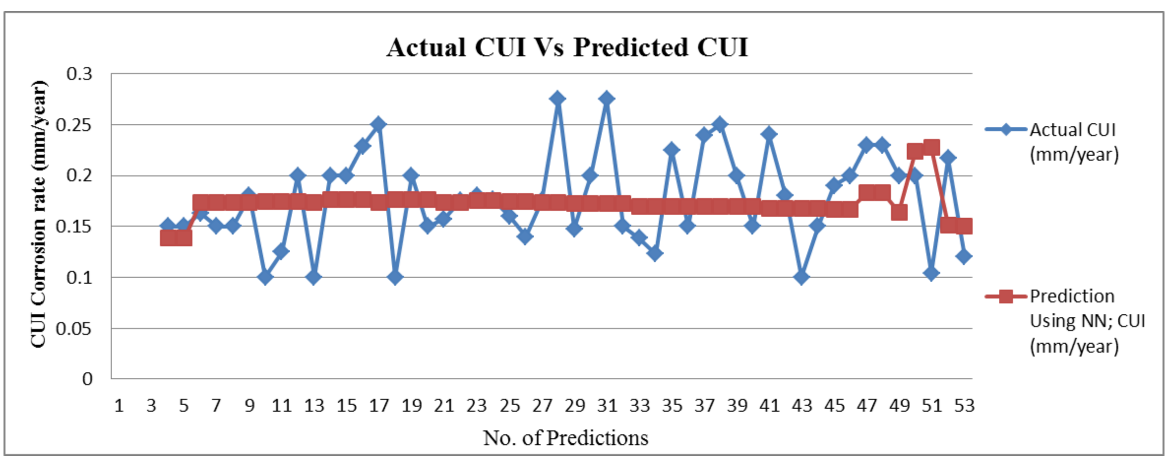

Figure 5: Comparison between CUI corrosion rates predicted by NN model with field data.

Table 4: CUI corrosion rates predicted by NN model when insulation type was foamglass.

S.No.	Temperature (°C)	Type of Insulation	Type of Environment	Insulation Condition	Pipe Complexity	Prediction Using NN; CUI (mm/year)
1	-40	Foamglass	Marine	Average	Average	0.136
2	-39	Foamglass	Marine	Average	Average	0.137
3	-38	Foamglass	Marine	Average	Average	0.138
4	-37	Foamglass	Marine	Average	Average	0.139
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
201	160	Foamglass	Marine	Average	Average	0.062
202	161	Foamglass	Marine	Average	Average	0.062
203	162	Foamglass	Marine	Average	Average	0.062
204	163	Foamglass	Marine	Average	Average	0.062
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
438	397	Foamglass	Marine	Average	Average	0.132
439	398	Foamglass	Marine	Average	Average	0.133
440	399	Foamglass	Marine	Average	Average	0.134
441	400	Foamglass	Marine	Average	Average	0.136

Table 5: CUI corrosion rates predicted by NN model when insulation type was calcium silicate.

S.No.	Temperature (°C)	Type of Insulation	Type of Environment	Insulation Condition	Pipe Complexity	Prediction Using NN; CUI (mm/year)
1	-40	Calcium Silicate	Marine	Average	Average	0.172
2	-39	Calcium Silicate	Marine	Average	Average	0.171
3	-38	Calcium Silicate	Marine	Average	Average	0.169
4	-37	Calcium Silicate	Marine	Average	Average	0.168
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
201	160	Calcium Silicate	Marine	Average	Average	0.179
202	161	Calcium Silicate	Marine	Average	Average	0.179
203	162	Calcium Silicate	Marine	Average	Average	0.179
204	163	Calcium Silicate	Marine	Average	Average	0.179
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
438	397	Calcium Silicate	Marine	Average	Average	0.047
439	398	Calcium Silicate	Marine	Average	Average	0.047
440	399	Calcium Silicate	Marine	Average	Average	0.047
441	400	Calcium Silicate	Marine	Average	Average	0.047

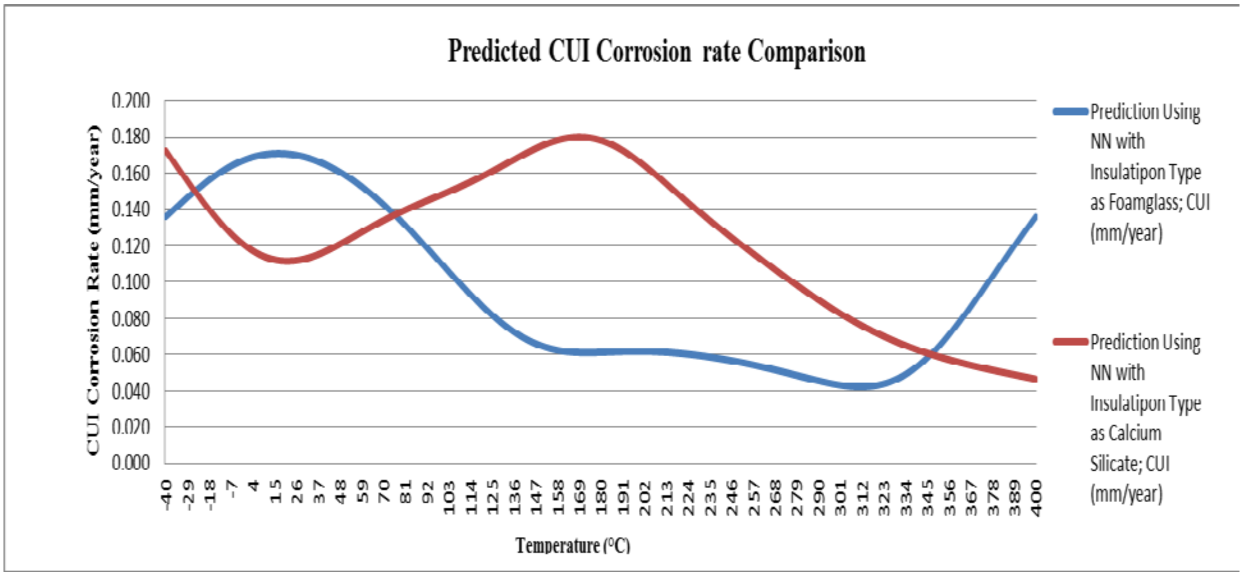

Figure 6: The CUI corrosion rates predicted by NN model for the same operating temperatures with different type of insulations.

5. CONCLUSION

CUI is a severe issue in oil and gas industries. Due to its abrupt, ambiguous, and hidden nature, its prediction is a tough job. In this study, field data of CUI from an industry having marine environment was utilized for the development of a NN based prediction model. The developed NN model was successfully predicting CUI corrosion rates with a standard error of 0.001 while having an overall accuracy of 76.23%. The results from the developed NN model will facilitate RBI quantitatively. Having these results corrosion/inspection engineers will able to do necessary implications for their plant maintenance while applying a quantitative approach rather than qualitative or semi qualitative.

6. REFERENCES

1. M. A. A. (2011), "Failure probability modeling for piping systems subject to corrosion under insulation (PhD thesis, UTP)," Retreived from Eectronic and digital database intellectual asset, UTPedia. Accession No. 2775.
2. A. A. M. M. M. Khan, and H. Hussin, "Prediction for corrosion under insulation subject to carbon steel pipes using anfis," ARPN Journal of Engineering and Applied Sciences, vol. VOL. 11, pp. 268-276, January 2016.
3. M. A.A and M. Che Ismail, "A Fuzzy-Based Model to Determine Corrosion Rate for Carbon Steel subject to Corrosion under Insulation," paper presented at NACE, East Asia regional conference 2008, Kuala Lumpure, Malaysia, 2008, May.
4. M. M. Khan, A. A. Mokhtar, and H. Hussin, "A Neural Based Fuzzy Logic Model to Determine Corrosion Rate for Carbon Steel subject to Corrosion under Insulation," in Applied Mechanics and Materials, 2015, pp. 526-530.
5. H. S. S. Xin and H. Jianchun, "BP Neural Network-based Prediction Model for Internal Corrosion Rate of Oil Pipelines," Oil & Gas Storage and Transportation, vol. 6, p. 016, 2010.
6. Z. JAN, V. R. ÍKOVÁ, and D. J. EK, "Application of artificial intelligence methods for prediction of steel mechanical properties," Metalurgija, vol. 47, pp. 339-342, 2008.
7. Z. Jančíková, O. Zimný, and P. Koštial, "Prediction of metal corrosion by neural networks," Metalurgija, vol. 52, pp. 379-381, 2013.
8. C.-y. Ren, W. Qiao, and X. Tian, "Natural gas pipeline corrosion rate prediction model based on BP neural network," in Fuzzy Engineering and Operations Research, ed: Springer, 2012, pp. 449-455.
9. D. Supriyatman, S. Sumarni, K. A. Sidarto, and R. Suratman, "Artificial Neural Networks for Corrosion Rate Prediction in Gas Pipelines," in SPE Annual Technical Conference and Exhibition, 2012.
10. G. Yuan, S.-G. Wang, and Y. Huang, "Application of markov chain in prediction of corrosion conditions for buried gas steel pipeline," Harbin Gongye Daxue Xuebao(Journal of Harbin Institute of Technology), vol. 42, pp. 1328-1331, 2010.
11. I. Stephen A. Anderson, "Out of sight, Out of Mind ?," Hydrocarbon Engineering, August, 2010.
12. R. API, "581 Risk-Based Inspection Technology," September 2008, 2008.

OCCUPATIONAL HEALTH AND SAFETY PRACTICES IN AUTOMOTIVE PARTS MANUFACTURERS SECTOR OF PAKISTAN

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Abstract: Organizations around the globe are bound by law to provide a safe work environment for people engaged at various workplaces. Unfortunately, Occupational Health and Safety (OHS); a field concerned with safety, health and welfare of people employed at workplaces, is one of the most neglected areas in Pakistan. Due to harsh working conditions, injuries occurring in the manufacturing sector; particularly the automotive parts manufacturing sector, are on the rise and workers' indifference towards safe work environments adds fuel to the fire. This study has been undertaken to observe the level of implementation of Occupational Health and Safety in automotive parts manufacturers sector of Pakistan and to identify the barriers that management personnel face in their efforts to establish a health and safety culture in their workplaces. As a result of this study, improvement measures to be taken in the wake of the said barriers are proposed.

1. INTRODUCTION

Occupational accidents are a matter of concern in many countries around the world. Workers are exposed to several different hazards and accidents due to rapid industrialization. Every year numerous of workers are fatally injured or permanently disabled due to a range of hazards such as electrical, chemical, mechanical or the ones related to radiation, Koradecka (2010). The costs of occupational accidents and ill-health are estimated to be around 3 to 4 percent of a country's gross national product, ILO. (n.d.). Direct and indirect costs associated with occupational accidents and injuries; such as, administration expenses, worker compensation, investigation costs and rehiring/training costs, make it immensely important to take preemptive measures in order to reduce the number of such accidents and injuries, Friend (2007). The indirect impacts of occupational injuries and ill-health are estimated to be four to ten times greater than direct impacts, ILO. (n.d.). The increase in the rate of occupational accidents and cases of injuries or deaths has raised the level of attention that is given to occupational health and safety. Moreover, employee awareness and pressure from trade unions and law enforcing authorities has also managed to increase the amount of concern that employers show towards the wellbeing of their employees.

Hazard-free work environments have a great impact on workers' efficiency, Hasle & Limborg (2006). The term "work environment" is used to describe all the surrounding conditions that act or react on the mind and body of a worker such as temperature, lighting or equipment etc. This entails that the primary aim of an employer is to create an environment that is hazard-free so as to ensure the safety and health of the workforce, Stamatis (2014). Although, the introduction of legislation related to the prevention and control of work related accidents and diseases has improved the overall state of occupational health and safety (OHS) practices followed around the globe, the developing countries are still struggling under the weight of an increasing number of cases related to occupational accidents and work related ill-health where the number of work related diseases and accidents is often miscalculated and the inherent operational risks are not dealt with effectively, Pain (2010).

The maintenance and promotion of a superlative degree of social, physical and mental well-being of workers by preventing unhealthy and risky behaviors in turn preventing accidents, controlling possible hazards and adapting the workplace to workers and workers to their work is what defines occupational health and safety, Stranks (2006). Like many other developing countries, the OHS related regulations in Pakistan are out dated and a general lack of interest with regards to OHS is prevalent in the society. A successful OHS practice involves considering issues related to industrial hygiene, occupational medicine, safety engineering, toxicology, ergonomics, ethics and psychology, to name a few. In order for an occupational health and safety practice to be successful, collaboration from both the employers and the employees is needed, Asbury (2007). Most of the companies belonging to the automotive parts manufacturers sector of Pakistan do not give due importance to health and safety and follow a responsive strategy which means that companies try to mitigate the effects after the accidents have occurred at their worksites.

This study was conducted to analyze the current status of health and safety in automotive parts manufacturers sector of Pakistan and also to highlight the barriers that management personnel in this sector face while implementing health and safety rules in their manufacturing facilities. Based on the findings of this study, some suggestions are provided for improving the status of health and safety and developing effective health and safety programs to decrease the risk of accidents.

2. METHODOLOGY

This preliminary descriptive and exploratory study was conducted in early 2016 as part of an undergraduate research project and the survey is still accepting responses to improve the authenticity of the results. After conducting a thorough literature review and market study, a survey questionnaire was developed using KPIs that included documented health and safety system, dedicated OHS teams/personnel, accident reporting, recording and investigation mechanism, health and safety trainings/meetings, effective emergency SOPs and health care/first aid provision. This structured questionnaire was carefully prepared to obtain relevant data from the respondents and contained a number of questions arranged in different sections. Three automotive parts manufacturing industries in Lahore, Punjab, Pakistan were visited to observe the health and safety arrangements in order to come up with these KPIs. During the visits in these industries, senior executives were also interviewed to know their views about the importance of OHS and the steps that they take to ensure the safety of workers in their workplaces. After preparing the questionnaire, officials from Pakistan Association of Automotive Parts and Accessories Manufacturers (PAPAAM) were contacted and the survey form was electronically sent to the member industries of PAPAAM. The responses were then analyzed to find problematics areas and provide suggestions to improve the status of health and safety.

Also, this study is primarily aimed at determining the current status of occupational health and safety in automotive parts manufacturing industries so the respondents were requested to answer questions related to the level of importance they gave to health and safety in workplaces and the problems they had to face while implementing health and safety rules and systems in their facilities and units. During the industrial visit, the laborers were also inquired about health and safety facilities, accident reporting channels and provision of appropriate safety gear.

2.1 Data Sources

The primary data was collected through interviews from senior executives of three automotive parts manufacturing industries in Lahore, Pakistan and by circulation of a structured electronic survey questionnaire among the member industries of Pakistan Association of Automotive Parts and Accessories Manufacturers (PAAPAM). In addition to the primary data, some secondary data was also obtained from available literature resources such as books, newspapers, articles, safety committee reports, journals, and international health and safety organizations' websites to support this study.

2.2 Sampling

There was no cap on the number of responses that could be received. Out of about 200 member industries of PAPPAM, only 10 responded to the survey. Thus, 10 responses were received in total. Moreover, the three industries that were visited during this study were selected based on convenience.

3. RESULTS

The survey was conducted among employees of automotive parts manufacturing industries in Pakistan. Most of the respondents had 5-10 years of work experience (50%). About 60% of the respondents were graduates and 40% had completed their Masters. The number of total employees, managerial as well as non-managerial, varied in different organizations as indicated in Table 1. Most of the respondents were of the view that all the employees in their organizations are aware of occupational health and safety (70%). About 80% of the respondents said that they provide a safe work environment to their employees whereas 20% said that they do not provide a safe work environment to their employees. Based on this study, it was found that most of the accidents occurred due to negligence of workers with regards to safety rules. Ineffective hazard communication, nonuse of personal protective equipment, lack of technology and training were some of the other main causes of accidents as indicated by the bar chart in Figure 1 which shows the main causes of injuries identified in this study.

The data in Figure 2 suggests that on an average 5.5 minor and 0.9 major accidents occurred in the past two years in any of the manufacturing facilities under this study. 60% of the respondents said that there were medical units and first-aid arrangements in their facilities. Only 40% organizations had a dedicated health and safety department and about 60% said that even if there was no dedicated department they had safety personnel who took care of matters related to workers' safety. Responses to some questions hinted at managerial commitment to provide health and safety facilities as 80% respondents said that contractual as well as non-contractual laborers in their organizations were provided safety equipment. Also, around 90% of the respondents agreed that their management is very committed towards health and safety.

Figure 1. Main causes of injuries in automotive parts manufacturing facilities

Most of the respondents feel that organizational profits are strongly linked with a safe and healthy work environment (90%). 50% respondents said that all employees in their organizations were insured, 40% remained neutral and 10% disagreed. Around 80% organizations under study had clearly marked emergency exit plans and paid for the treatment of their employees in case of work-related injuries and ill-health. 90% organizations under study had a separately allocated budget for health and safety. 90% of organizations had all risks associated with working in their facilities identified.

Table 1. Managerial/non-managerial employee segregation in automotive parts manufacturing facilities under study

Organization	No. of Management Personnel	No. of Engineers	No. of Supervisors	No. of Laborers	No. of Employees
1	5	3	5	40	50
2	15	5	2	30	50
3	5	0	6	60	70
4	13	2	8	100	123
5	16	2	6	136	160
6	60	35	52	400	600
7	14	7	42	566	629
8	53	22	66	950	1091
9	150	20	35	1000	1200
10	100	50	1000	3000	5000

Results suggest that safety training and meetings were frequently held in only some organizations (30%). Also, only 40% respondents said that the laborers in their organizations were provided formal training. 70% respondents said that their management provides safety gear whenever required. 60% respondents were of the view that laborers in their manufacturing facilities do not wear safety gear. 50% respondents said that all employees in their organizations were insured, 40% remained neutral and 10% disagreed. 40% respondents felt that health and safety conditions were satisfactory in their organizations and did not need further improvement.

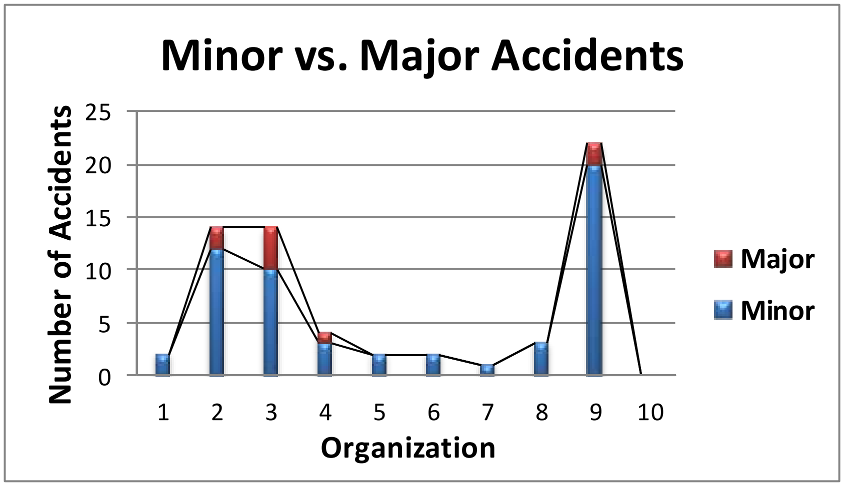

Figure 2. Minor and major accidents that occurred in past 2 years (2014-2015)

It was found that supervisors and managers also wear safety gear to encourage laborers. Also, 40% respondents said that performance appraisal of managers and supervisors in their organizations includes a health and safety component. The results also suggest that the level of different facilities such as lighting, ventilation and first-aid varies considerably among the organizations under study. Respondents were asked to rate the level of facilities available in their organizations and the percentage of responses against high, medium and low levels of certain facilities are shown in Figure 3. Almost all the respondents were of the view that ergonomic principles were considered while designing their workplaces and work methods and that the machines in their manufacturing facilities have sufficient clearance.

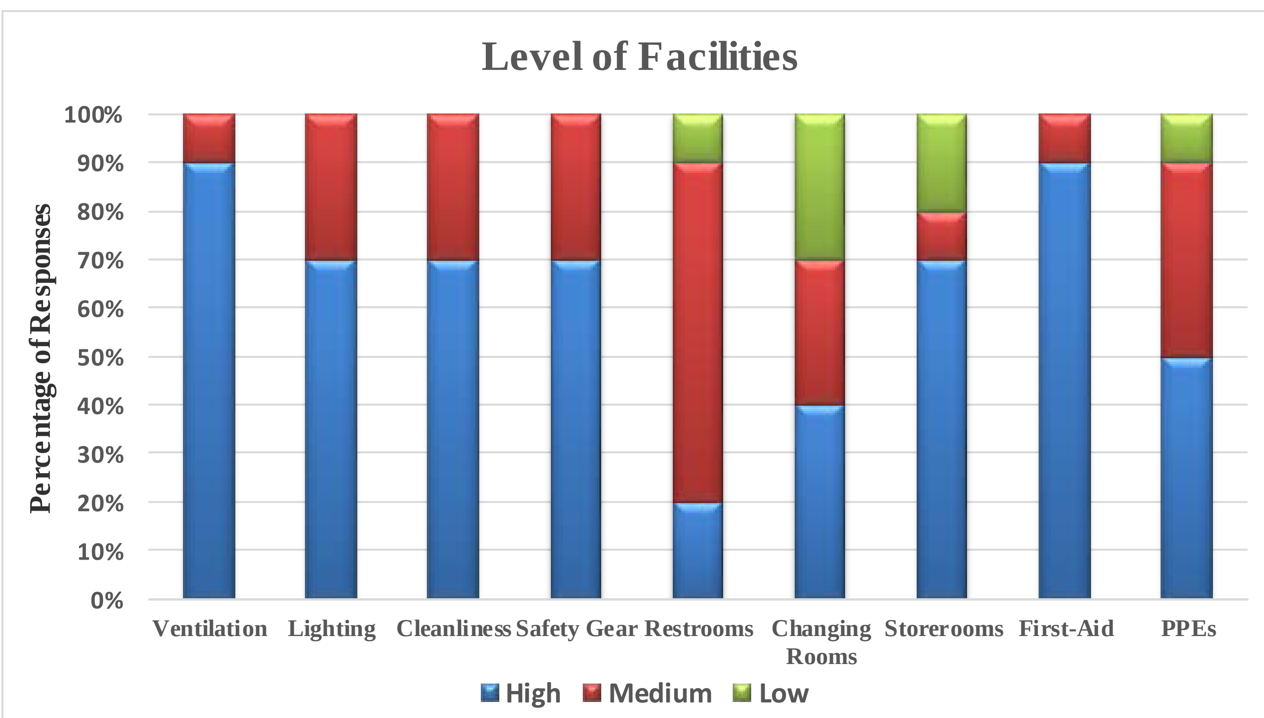

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Figure 3. Level of facilities in respondents' organizations

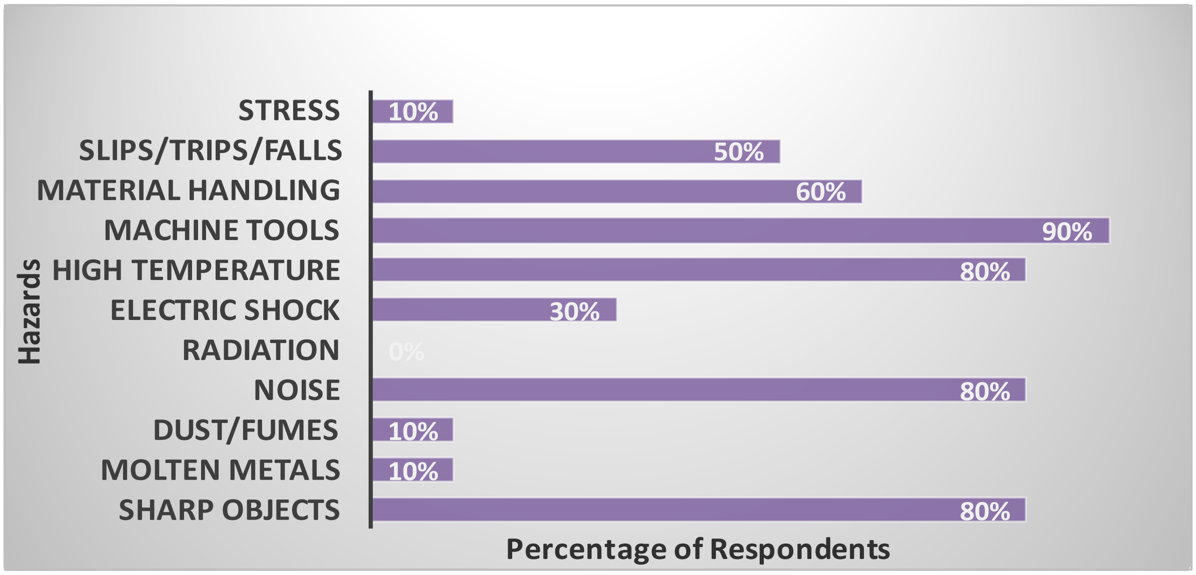

Figure 4. Possible hazards in automotive parts manufacturing facilities

The most common responses to possible hazards were machine tools, high temperature, noise, sharp objects and slips/trips/falls. The bar chart in Figure 4 represents these possible hazards and their relative occurrence in automotive parts manufacturing facilities identified during this study. It was found that hands/arms, fingers, eyes, ears, feet/legs and back/hip are more frequently affected in automotive parts manufacturing setups. Figure 5 shows the most affected body parts identified during this study. Responses also show that common PPEs such as jackets, gloves, hard hat, goggle and face shield are provided more often to the workers than the more sophisticated PPEs such as chaps, aprons, mitts and dust masks as shown in Figure 6. It was also observed during visits to some automotive parts manufacturing facilities that laborers were performing operations such as welding without wearing safety goggles even when they were provided the safety gear with proper instructions.

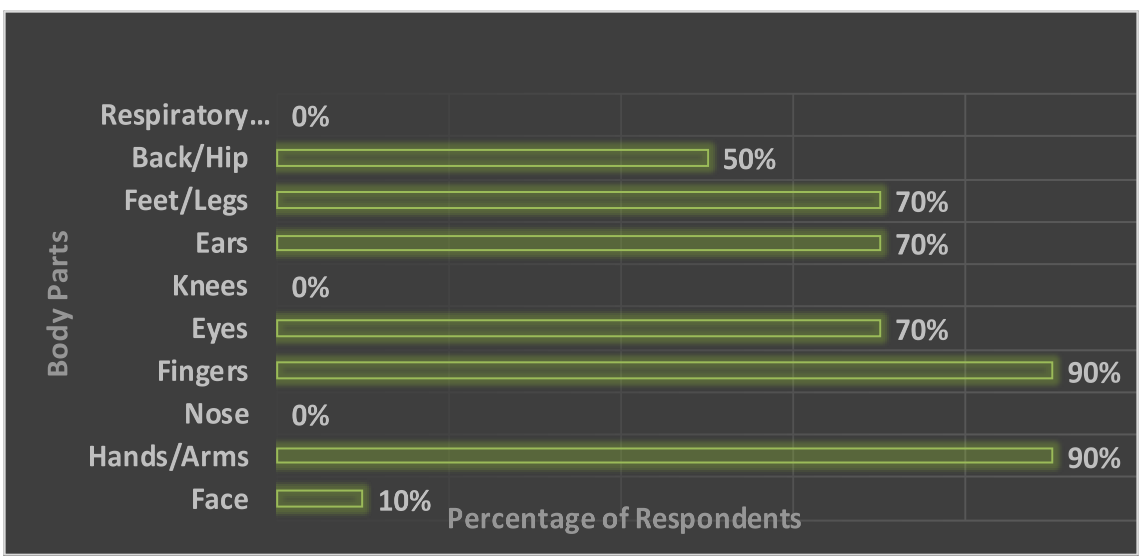

Figure 5. Body parts affected most often in automotive parts manufacturing facilities

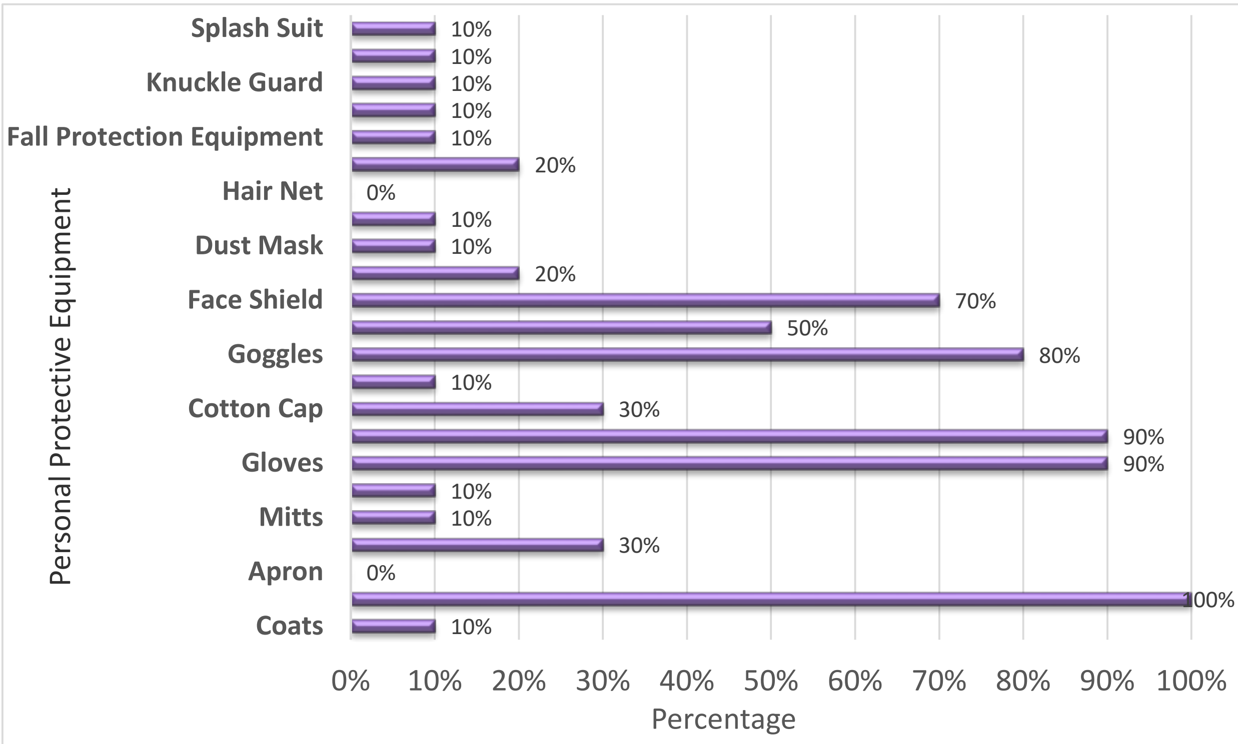

Figure 6. Personal Protective Equipment provided to workers in respondents' organizations

4. DISCUSSION

Workers' efficiency and productivity is linked with the environment they work in, Akpan (2011). Their performance is one of the main KPIs of an organization's success. Results of this study suggest that most of the respondents feel that organizational profits are strongly linked with a safe and healthy work environment (90%). A safe and hazard-free work environment has a positive impact on workers' performance and this makes occupational health and safety a pivotal factor in determining an organization's success, Friend (2007). Thus, it is important for the management to take every possible measure to ensure workers' health and safety in order to enhance their performance by optimally utilizing their prowess. This study is important in terms of its scope as no such data is available on health and safety practices in Pakistani industries. It is hoped that, in future, this study will help fellow health and safety students and practitioners to carry out research on topics related to occupational health and safety so that the level of general awareness about OHS could improve in the country. The findings would also clear any misconceptions about the apparently well-implemented health and safety systems in the industries and the suggestions would help the management personnel to take concrete measures to improve the status of OHS by enticing them to put in some effort for providing better working environment rather than just meeting the bare-minimum criterion.

Although the respondents and interviewees were of the opinion that mangers in their organizations are very committed towards health and safety, further responses to questions enquiring whether their organizations have certified and documented health and safety programs suggested otherwise as only 10% respondents said that their organizations have a certified and documented health and safety program. The fact that most of the member companies of PAAPAM did not send their responses indicates the level of importance given to health and safety practices and culture in this sector of the country. Automotive industry is considered as one of the most dangerous and risky industries with regards to occupational health and safety perspective (Chan et al. 2015). While working in automotive manufacturing setups, workers face a multitude of hazards such as noise, high temperatures, electric shocks, dust/fumes, sharp objects and slips/trips on daily basis as shown in Figure 4. Mental alertness is important because accidents and engineering systems failure due to human error has become a concern, Dhillon (2013). Since most of the workers spend at least eight or more hours in their workplaces, the work environment has to be safe and healthy in order for them to be physically and mentally fit.

Regrettably, some employers assume little responsibility for their workers' wellbeing. Employers are often unaware of the fact that they are morally and legally responsible for their workers' health and safety, Foster (2012). Due to this negligence on employers' part and all sorts of hazards occurring every day, occupational diseases and accidents are common in workplaces around the globe especially in developing countries. Some of the laws covering health and safety of workers in Pakistan are Factories Act (1934), Dock Laborers Act (1923), Miners Act (1923), Workmen Compensation Act (1923), Provincial Employees Social Security Ordinance (1965) and Boilers and Pressure Vessels Ordinance (2002). Practically, these laws are obsolete and do not conform to the present international standards and practices. Moreover, they do not cover the small- scale setups and seasonal workers. The only remotely applicable legislation on health and safety in Pakistan is the 'Hazardous Occupation Rule 1963' under the Factories Act 1934 which specifies some hazardous occupations. Chapter III of The Factories Act 1934 covers the statutory provisions for the health and safety of workers which are stated in sections 13 to 33 and include provisions for cleanliness, disposal of wastes, ventilation, temperature, dust and fumes, humidification, overcrowding, lighting, latrines and urinals, spittoons and fencing of machines. The chapter also covers provisions for machinery in motion, precautions in case of fire, employment of young persons and women, self-acting machines, hoists and lifts, cranes and rotating machinery, means of access, floors, and protection of eyes.

Most of the organizations under study have taken the health and safety measures according to the guidelines of the Factories Act 1934 but the laws need to be revised periodically to meet international standards of health and safety. The awareness level of workers particularly labor class is found to be very low which may be due to factors such as lack of education and increasing financial pressures. Results suggest 80% of the respondents expressed that workers do not comply with safety guidelines often resulting in accidents which was also observed during factory visits. Some of the workers like the fast pace of their jobs and thus give their consent to the increasing production demands and accompanying risks, (Arnetz et al. n.d.). They feel that their demanding jobs keep them healthy and active and that they are supposed to be able to adapt to their jobs. Majority of the workers feet that a good employee is someone who could endure the physical hard work and other health problems that come with the job. Occupational accidents can be classified as major or minor based on their severity, Gilbert (2008). Figure 5 shows that the most affected body parts are fingers and hands and yet minor accidents such as cuts, bruises and electric shocks of low intensity go unreported and workers think of them as a part of their job. Sometimes, the workers are silenced because of their gratitude for what they are paid. At times, they feel that safety gear limits their pace. Moreover, some employees are of the view that the only way to avoid physical stress is to leave the plant and move to lower paying jobs.

The safety ratio 1-10-30 implies that for every major accident, causing disability or death, there are 10 serious accidents reported, and for every 10 serious accidents there are 30 minor accidents reported, Bird (1969). Another study by Conoco Phillips Marine suggests that for every fatal accident, there are 300,000 at-risk behaviors such as behaviors and activities that are not consistent with the safety policies, guidelines or trainings. Accident reporting and investigation systems are found to be missing in most of the organizations under study and they did not have any record of the total number of accidents; whether near-miss, minor or major, making any analysis or audit impossible which also implies that they could not anticipate unwanted incidents using previous data let alone take measures to reduce the likelihood of occurrence of such incidents.

The increasing rates of occupational injuries and accidents calls for serious steps to be taken to improve the status of health and safety in the country. It is the need of the hour to enhance awareness about occupational health and safety in both the employers' as well as the employees' circles. In-order to improve the status of health and safety, the role of management takes precedence over all other measures. Effective disciplinary measures need to be adopted so that compliance to health and safety policies can be ensured. A system to report the accidents must be adopted so that timely action could be taken and records could be maintained. Using historic data from these records would enable the management personnel to forecast accident rates and devise mitigation strategies well in time. The data suggests that the following recommendations could be also be effective to improve the status of occupational health and safety in automotive parts manufacturing sector of Pakistan.

- Legislative bodies should devise new and relevant OHS laws benchmarked with international standards.
- Enforcement and implementation system should be strengthened in order to ensure that employers are actually following the laws regarding safe work environment, worker safety and compensation etc.
- Government should ensure that non-complying employers are strictly penalized so that they could be more vigilant towards health and safety concerns in their organizations.
- Employers should motivate the workers to use personal protective equipment by using these equipment whenever visiting worksites.
- Employees should be motivated with rewards and their appraisal must be done keeping in view how well they performed with respect to health and safety.
- Number of days before an accident occurs should be displayed and bonuses should be given for reaching certain milestones such as going a particular number of days without any accident.
- Safety drills should be held regularly to keep the workers alert and responsive so that they are prepared to face unexpected and risky situations.

- Safety trainings should be provided frequently to ensure that workers have up-to-date knowledge regarding their safety gears and personnel protective equipment.
- Safety meetings should be held regularly to make sure that the voice of workers is heard and their issues are addressed.
- Joint labor-management committees should be made so that management personnel and laborers could collaborate to resolve issues.
- Industry-Academia collaboration should be encouraged to conduct research and to create safe working procedures and environment.

5. CONFLICT OF INTEREST

There is no conflict of interest to be declared for this study.

6. ACKNOWLEDGMENTS

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7. REFERENCES

1. Akpan, E. I. (2011). Effective Safety and Health Management Policy for Improved Performance of Organizations in Africa. *International Journal of Business and Management*.

2. Arnetz, B., DeJoy, D. M., A., J., Zohar, D., & Scharf, T. (n.d.). Enhancing First Responders' Work and Safety through Safety Climate and Safety Management Systems.

3. Chan, Chen, Y. P., & Anita. (2015). Globalization of industry and Occupational Health Safety: A Case Study in China's Automobile Industry.

4. Dhillon, B. S. (2013). *Safety and Human Error in Engineering Systems.* CRC Press Taylor & Francis Group.

5. Foster, N. (2012). *Principles of OHS Law.* Safety Institute of Australia Ltd.

6. Gilbert, R. (2008). *Health and Safety - A quick guide.* Woodhead Publishing Limited.

7. Hasle, P., & Limborg, H. J. (2006). A Review of the Literature on Preventive Occupational Health and Safety Activities in Small Enterprises. *Industrial Health*.

8. ILO. (n.d.). Retrieved from International Labour Organization: http://training.itcilo.it

9. Koradecka, D. (2010). *Handbook of Occupational Safety and Health.* CRC Press.

10. Mark A. Friend, J. P. (2007). *Fundamentals of Occupational Safety and Health.* Government Institutes, an imprint of The Scarecrow Press, Inc.

11. Pain, S. W. (2010). Safety, Health and Environmental Auditing - A Practical Guide. CRC Press Taylor & Francis Group.

12. Stamatis, D. H. (2014). *Introduction to Risk and Failures Tools and Methodologies.* CRC Press Taylor & Francis Group.

13. Stephen Asbury, P. A. (2007). *Health and Safety, Environment and Quality Audits.* Butterworth-Heinemann.

14. Stranks, J. (2006). *The A-Z of Health and Safety.* Thorogood Publishing Ltd.

HEALTH ISSUES OF FLOUR MILLING INDUSTRY WORKMEN

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Abstract: Flour Milling began 6000 years ago and is considered the oldest trade and industry. It involves the breakdown of grain to separate its outer covering and grinding of inner endosperm to fine flour particles. Concerning the health and safety of the workers serving in the mentioned industry, they have been in an environment exposed to flour dust. After conducting several interviews and a questionnaire survey from the workers and sales managers of flour mills within Hyderabad's vicinity, the workforce was found suffering from sensitization, occupational asthma, allergic rhinitis and obstructive lung diseases due to flour dust swallowed and inhaled. Majority of the respondents highlighted improper flour milling process; including intake and final products collection systems as the main cause to health problems. As per the suggestions of labor and sales managers; these health issues could be resolved by improving feeding and collection systems and by using personal protective equipment.

Keywords: Flour milling industry, Personal Protective Equipment, Health issues, Sensitization, Allergic Rhinitis, Occupational Asthma, Obstructive Lung diseases.

1. INTRODUCTION

It began nearly 10,000 years ago; the period when man began to till the soil and experimented to breed grasses by wild plants' seeds. By changing time; man discovered that these seeds be crushed between grindstones. Firstly, the grains were ground by hand but around 3,000 B.C. the Egyptians introduced crucial progress to bread-baking: yeast. By utilizing warmth of sun; they mixed dough with yeast to a fermentation process that resulted as a pleasant-tasting loaf of bread after baking. After Egyptians; Romans were first among all to introduce grinding of corn on cone mills – gigantic structures which were turned either by animals or slaves. The millers of the middle ages used this invention but during 12th century, windmills were designed in European continent that possibly changed the era dramatically. And of course the beginning of the industrial era in 1879 in which the earliest steam mill was erected in London. Industrial mills are producing hundreds of different types of flour in unbelievable quantities: every year. If considering whole world; approximately 320 million tons of wheat flour run off the milling rollers. Bogasari Flour Mills Company in Indonesia has total daily capacity of 16 thousand tons of wheat flour that makes it world's biggest mill. Flour Milling has been a global industry that benefits one-third of the world's population.

Flour dust has been the imperative issue in Flour Milling process from day one. Several food industries including flourmills is facing the issue of exposure to flour dust. In developing countries; due to quick industrialization and fruitless measures for pollution control, Indoor air pollution has become a main problem. Further the lack of public awareness of the impacts of indoor air pollutants on human health has increased it. 8-10 hours per day is the usual average time the flour mill workers are expected to be exposed to such threats (Wagh et al 2006). Handful of studies has shown that exposure to flour dust causes respiratory symptoms and is highly related with damage of lung function. In mills, grinding operation is the initial point of danger in processing grains as grain is ground into the fine particles of dust-like size and flammable concentrations are unavoidable (Mittal, 2013). Studies also show that potential allergens implicated are the components of wheat flour: Flour contaminants, such as weevils, mite sand moulds, or flour additives, especially yeast and aspergillus derived amylase (Bohadana et al 1994). Flour dust can cause sensitization, occupational asthma, sensitization and allergic rhinitis among millers and bakers (Dhillon et al 2012).

Another leading problem in several industries including Flour Milling Industries is un-availability and unawareness of PPEs. Several Accidents occur because the workers do ignore the safety measures during working hours. In many of the industries of developing countries; un-availability of PPEs is found very common while in few of them PPEs are available but ignorant because there are no certain rules and regulations not even trainings are provided to ensure the use of Personal Protective Equipment. Study on some companies in Nigeria's North-Eastern states show that the causes of accidents in companies are due to carelessness of the workers and to some extent lack of maintenance of machine. There was no accident of material handling in other companies except in Savannah Sugar Company. Results also indicate that the production capacity of Ashaka Cement company declined by 18.56% because of accidents. Also Nigeria Bottling Company and Maiduguri Flour Mill laid their production capacity declined by 16.67% and 40% respectively (Inegbenebor 1999).

Current study on flourmills (Atta Chakis) of Hyderabad, Sindh revealed that workers are at high risk because of two main problems those causing severe health issues and accidents. Firstly, the improper flour milling process including intake and final products collection systems Secondly, unawareness and unavailability of personal protective equipment. The intake system of feeding the wheat and the final products (Flour and Suji) collection methods were the main cause of exposure to dispersed Flour dust. There was neither controlled mechanical system for opening the gate of Intake Hopper nor proper underground pits to place bulk amount of wheat. Workers were required to put wheat from the intake hopper simultaneously when the bucket elevator was lifting grains to drum sieve. During this whole process of feeding; intake Hopper's gate remained open and handsome amount of dust was found rushing out that was directly inhaled by workers. On the other side, the tanks that of concrete built to collect and store the final products (Flour and Suji) were un- covered. Packing was carried out simultaneously when the flour was rushing to the tank and it was directly absorbed, swallowed and inhaled by the workers during packing. Allergic Rhinitis, Occupational Asthma, Obstructive Lung Diseases and Sensitization were found common in workers of these flourmills, in different ratios which are elaborated in the result section.

In flour mills; there is potential exposure to grain dust also, i.e. material from the surface of the wheat which is removed prior to the milling process itself (Smith et al 2000). Individuals those working in dusty environments face the risk of inhaling particulate materials which may lead to adverse respiratory effects. In baking industry, exposure to wheat flour dust may cause respiratory illness of different nature and severity, ranging from simple irritant symptoms to allergic rhinitis or occupational asthma. Sensitization to such allergens may result in increased prevalence of respiratory symptoms and airway hyper responsiveness (Bohadana et al 1994).

Occupational hazards are inherent dangers for individuals working with machines, especially when the machines are rotating and are unprotected. Mishaps associated to flour mills are infrequent; most likely due to small setup involving less manpower or due to partition that is usually made between the machine and the visitors reducing the accidental involvement of customer in machine. Nevertheless, worker working in the setup may, at times, involve in accident causing morbidity and mortality (Bardale et al 2008).

Chronic Obstructive Pulmonary Disease (COPD) is a global health concern. According to the World Health Organization, it is presently the sixth leading cause of death in the world. Indoor and outdoor air pollution, tobacco exposure are the main reasons. The burden of COPD in Asia is at present greater than that in the developed western countries (Iftikhar et al 2004). There are about 75000 workers in the United Kingdom baking industry (unpublished data, Labour Force Survey) with some 24000 in occupations where exposure to flour is likely (Federation of Bakers, personal communication). A smaller but unidentified number are involved in milling and wheat processing. Results from the surveillance of work related and occupational respiratory disease (SWORD) project suggest an annual incidence of occupational asthma among bakery workers of at least one per 1000 (Cullinan et al 1994). Aerosols like fine particles, SO2 and CO gases can enter into the trachea-bronchial and create frustrating effects in respiratory tract. Degree of harm to respiratory tract is influenced by chemical nature of those pollutants whenever the individual is exposed to polluted air, respiratory system responds through general mechanism. Intensity of this response doesn't rely on sensitivity of individual only but on chronicity and acuteness of challenges too. Chronicity of exposure to low level of pollution can make life hard even if intensity is low. If exposed to pollution, usual response of an individual would be in form of bronchospasm, cough, excessive production of mucus etc. and it can lead to emphysema, fibrosis of the lungs i.e., chronic, if exposure is chronic (Latha et al 2015).

2. RESEARCH METHODOLOGY

Numbers of researches related to the current study were reviewed before going any step advance; all the papers were taken under consideration by taking related information and statistics related to health issues of flour milling workmen in order to solidify the study. The factors, those contribute to the increase in accidents and health issues at flourmills were identified from the previous studies. Un-Structured interviews of workers, technicians and managers of flourmills were also part of study in order to map out other factors if not present in questionnaire. Questionnaires were then prepared by considering all those factors. It contained the factors to analyze their severity level and workers were asked to fill up the. Collaboration of Flour Milling: technical, administrative and working staff helped us to map out possible recommendations for future studies.

3. ANALYSIS

Several factors those contribute to accidents and health issues at flourmills are analyzed by using frequencies and percentages with the SPSS software .Those frequencies and percentages of each factor are merged in a single table by using MS Excel software. Factors, contributing up to considerable level of severity, are highlighted separately too with Bar chart, Pi-chart and line chart through MS Excel.

Table 1. Highlighting the factors and severity levels those contribute to accidents and health issues at flourmills.

Factors	**Rank**	**Mean**
Dispersed Flour Dust	1	4.4250
Unavailability of PPEs	2	3.1000
Failure to use PPEs	3	3.0000
Unawareness of PPEs	4	2.9000
Carrying Heavy Loads	5	2.5250
Poor Physique	6	2.5250
Improper Lifting	7	2.4750
Foot injuries due to dropped articles	8	2.1750
Strains to wrist or fingers	9	2.1500
Objects having sharp edges	10	2.1000
Sprains, wounds hernias, fractures	11	2.0750
Slipped disc due to improper posture in lifting on objects	12	2.0750
Men getting hit by falling objects from overhead	13	2.0500
Improper Gripping	14	1.7750
Men falling in open tank without cover in level Floor	15	1.5250
Lifting Greasy objects	16	1.4000
Incident of Electrical Shock	17	1.3500
Noise Sparking	18	1.3000
Sparking	19	1.2000
Accidents due to poor lighting	20	1.1250

4. RESULTS & DISCUSSION

Analysis has shown that dispersion of flour dust is found common in all flourmills with highest severity level. Unavailability, unawareness and failure to use personal protective equipment are imperative factors with 2nd highest severity levels up to mean values 3.1, 2.9 and 3 respectively. Most imperative issue according to data collected from the workers is Dispersed flour that that is inhaled, swallowed and absorbed by workers. Results revealed that the reasons behind dispersion of flour dust were improper feeding system of grain and improper final products collection system.

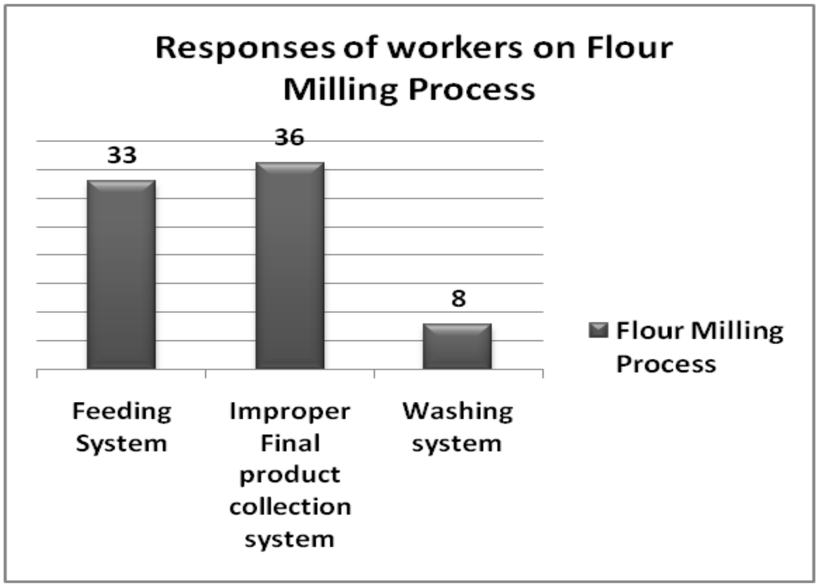

Figure 1. The systems, those contribute in dispersion of flour dust.

Highlighting three main processing systems those contribute in dispersion of flour dust. Respondents were allowed to mark various options if more than one system that contributes to the indoor air pollution. 36 responses highlighted improper final products collection system the reason behind dispersion of flour dust while 33 responses showed Feeding system and 8 of those marked washing system as responsible system for dispersion of flour dust into surrounding environment. These all systems come under category of Flour milling process and nearly all the workers, technicians and sales managers marked flour milling process as cause of flour dust dispersion.

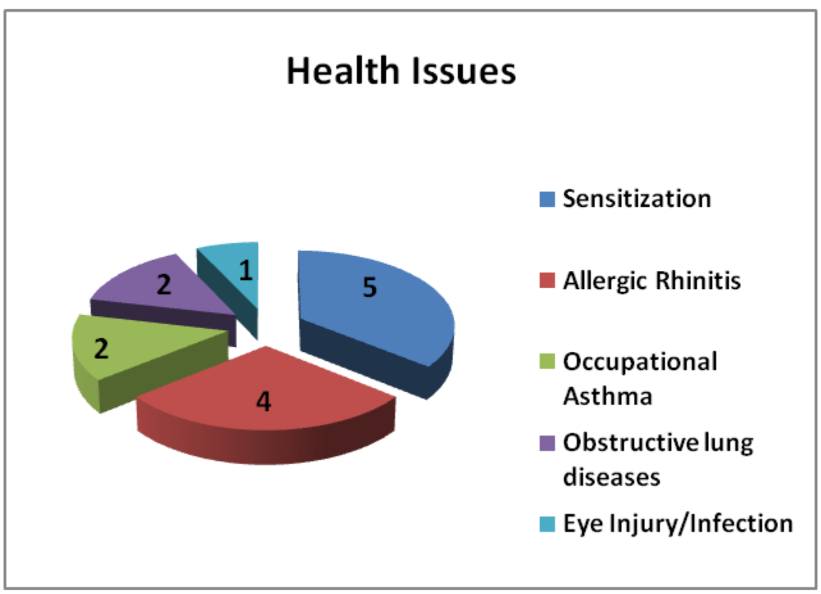

Figure 2. Common diseases at Flourmills.

Out of total 40 respondents; considerable numbers of respondents were found suffering from health issues. Results indicate that workers are at high risk in working hours. 7 out of every 20 respondents were found suffering from different health issues as Allergic rhinitis, Sensitization, Occupational Asthma and Pulmonary lung diseases because of flour dust inhaled, swallowed and absorbed by different parts of body. Sensitization and Allergic rhinitis is found very common in workers of flourmills. Obstructive lung diseases, eye injuries/infections and occupational asthma are also seen up to considerable numbers.

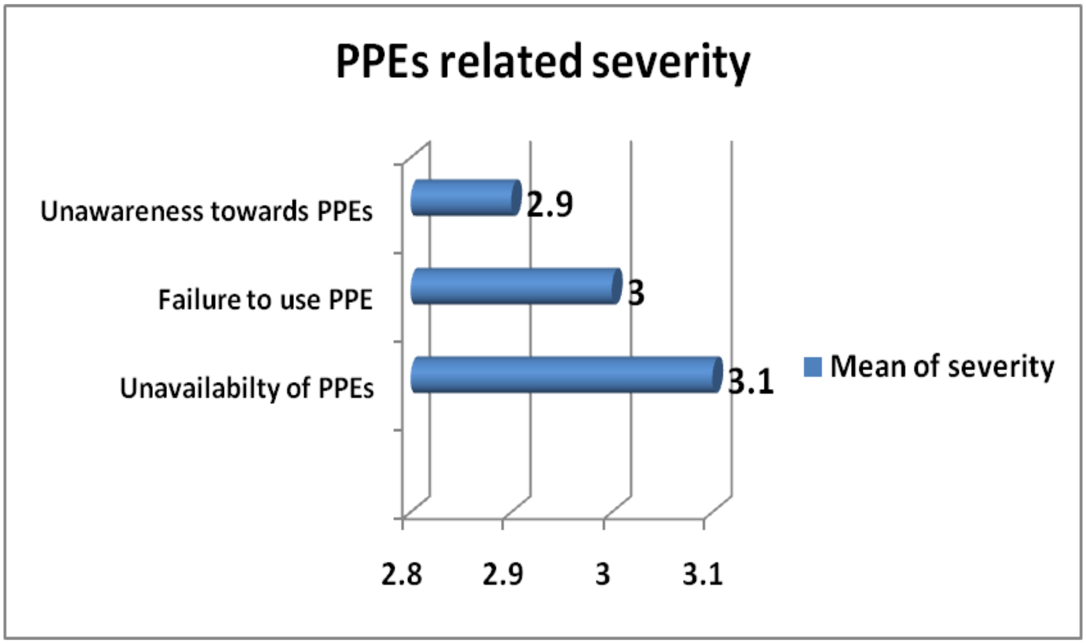

Figure 3. Mean of factors related to PPE

Accidents occurring at flour mills are mainly because of unavailability, unawareness and failure to use personal protective equipment. According to current study; severity levels are very high when discussing about PPEs at flourmills and that's the reason behind severe health impacts on workers. Mean value for severity levels ranges from 2.9 to 3.1 that is 2nd highest range after that of dispersed flour dust and much higher than other factors.

5. REMEDIAL MEASURES

After the survey the counteract measures are suggested such as that the workers should go for the usage of personal protective equipment like masks, helmets, full sleeves clothes, gloves and shoes to minimize the risk of accidents. Intake and collection system should be modified and proper use to PPEs should be ensured by owners of flourmills. Processing facility should be designed in a way that there should be proper mechanical system of opening the gate of Intake Hopper. Underground Pits of reasonable height should be built or grain intake pits on the ground should be designed in order to feed bulk amount of wheat at once to reduce continuous exposure of worker to dust. Tank, where final products (Flour and Suji) are collected and packed should be covered as to prevent flour dispersion in surrounding environment. Simultaneous packing and production should be avoided by increasing the size of final products collection tanks without compromising demand and supply.

6. CONCLUSION & FUTURE RECOMMENDATION

This cross sectional study is based on Un-structured interviews and Questionnaires, carried out in order to identify the Health issues of Flour milling industry (Atta Chakis) workmen of Hyderabad, Sindh. Out of numerous factors, mainly dispersed flour dust and ignorance towards personal protective equipment are highly ranked, workers did suffer from severe health impacts like Allergic rhinitis, Occupational Asthma, sensitization and pulmonary lung diseases. Reason behind not using PPEs was un-availability of those at industry and sources for dispersion of flour dust were feeding and final products collection systems.

By considering literature review and results evaluated during this study; all problems should be addressed accordingly and after implementation of remedial measures provided in current study, monitoring system should be developed for particular period to analyze the results of modified system.

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8. REFERENCES

1. Bardale, R., & Dhawane, S. Case Report Fatal avulsion of scalp: Unusual occurrence at flourmill. *J Indian Acad Forensic Med*, *30*, 3.

2. Bohadana, A. B., Massin, N., Wild, P., Kolopp, M. N., & Toamain, J. P. (1994). Respiratory symptoms and airway responsiveness in apparently healthy workers exposed to flour dust. *European respiratory journal*, *7*(6), 1070-1076.

3. Cullinan, P., Lowson, D., Nieuwenhuijsen, M. J., Sandiford, C., Tee, R. D., Venables, K. M., ... & Taylor, A. N. (1994). Work related symptoms, sensitisation, and estimated exposure in workers not previously exposed to flour. *Occupational and Environmental Medicine*, *51*(9), 579-583.

4. Dhillon, S. K., Bassi, R., & Thamman, R. G. (2012). Effect of flour dust on lung volumes and capacities in flour mill workers.

5. Inegbenebor, A. O. (1999). The Effect of Accidents On The Productivity Of Some Companies In North-Eastern States Of Nigeria. *J. Soc. & Mgt. Sci*, *6*, 46-52.

6. Iftikhar, B., Khan, M. H., Hussain, H., Iqbal, M., & Jadoon, G. S. (2004). Relationship between silica dust exposure and chronic obstructive pulmonary disease in workers of dust generating industries of district Peshawar. *Gomal Journal of Medical Sciences*, *7*(1).

7. Latha, G. M., Sarala, K., & Gouroju, S. (2015). Effect of Construction and Flour Mill Air Pollution in Rural Area. *Int J Intg Med Sci*, *2*(2), 49-54.

8. Mittal, M. (2013). Explosion Hazard and Safety in Industries Handling Grain Products. *Journal of Engineering Research and Studies*.

9. Smith, T. A., Parker, G., & Hussain, T. (2000). Respiratory symptoms and wheat flour exposure: a study of flour millers. *Occupational medicine*, *50*(1), 25-29.

10. Wagh, N. D., Pachpande, B. G., Patel, V. S., Attarde, S. B., & Ingle, S. T. (2006). The influence of workplace environment on lung function of flour mill workers in Jalgaon urban center. *Journal of occupational health*, *48*(5), 396-401.

ASSOCIATION BETWEEN PSYCHOSOCIAL FACTORS AND PREVALNCE OF UPPER MUSCULOSKELETAL DISORDERS.

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Abstract: Introduction: Upper Musculoskeletal Disorders are one of the major cost occurring disorders in workplace. Previous longitudinal and cross sectional studies indicate the association of physical factors are associated with the upper musculoskeletal disorders (UMSDs). The goal of current study was to examine association of psychosocial factors with upper musculoskeletal disorders (UMSDs).
Objective: The focus here is limited to see the association of psychosocial factors and work related upper musculoskeletal disorders (WRUMSDs).
Methods: 246 operational workers of petrochemical plant completed the self-administrated questionnaire. The questionnaire is a combination of Nordic musculoskeletal questionnaire and QPS: General Nordic questionnaire for psychological and social factors at work.
Conclusion: It's safe to conclude that there is a relationship has been found between psychosocial factors and WRUMSDS.
Keywords: Upper musculoskeletal disorders, psychosocial factors, work-related.

1. INTRODUCTION

Preventing musculoskeletal disorders (MSDs) is one of the priorities for ensuring the workplace health and safety. The work-related upper extremity disorders (WRUMSDs) affecting organizations and workers, due to the diverse set of psychological, physical, legal, financial and social challenges they are experiencing. From the past few decades' comprehensive investigations have found that physical, psychosocial, medical and ergonomic factors are correlated with the predictors of these disorders (Kraatz, Lang, Kraus, Münster, & Ochsmann, 2013). The recent reviews on WRUMSDs show strong associations of psychosocial work factors (job control, job satisfaction, work demand) in developing MSDs at the workplace to the employees(Bergsten, Mathiassen, & Vingård, 2015; da Costa & Vieira, 2010) . World Health Organization characterized WRUMSDs as complex or multi-factored to assess that various risk factors (psychosocial, individual, physical characteristics, socio-cultural and work organization) contributed to these ailments. Additionally, WRUMSDs are a major cause of disability in the working population(Alipour, 2008).

Whilst various studies conducted few years back shows the evidence of psychosocial association in developing MSDs (Bergsten et al., 2015; Carroll et al., 2008; Kraatz et al., 2013), in contrast with physical factors, psychosocial stress lasts more which do not let the affected person to "take rest" to relax the muscles at instant(Toomingas, Theorell, Michélsen, & Nordemar, 1997; van der Windt et al., 2000; Van Rijn, Huisstede, Koes, & Burdorf, 2010).

Consequently, psychosocial factors are likely to prevent the muscle rest during work. Work-related stress due to low job contentment, job losing threats, and unfriendly/conflicted condition is affecting the individuals continuously. Whereas the psychosocial factors are likely preventive for the muscle rest while work. The psychosocial factors contribute an unfavorable work rest equilibrium is of keen importance in workplace health and safety.

WRMSDs (work-related musculoskeletal disorders) are affecting Malaysian workers at large. Report by The social security organization of Malaysia involving MSDs is almost 10,000 cases per year(Zakerian & Subramaniam, 2009). Moreover, past research indicates a strong, association between, musculoskeletal symptoms related to the psychosocial work factors and the resulting poor health effects at work(Macfarlane, Hunt, & Silman, 2000; Macfarlane et al., 2009).

Work-related upper-musculoskeletal disorders are frequently occurring in workers in general. Various researches support the empirical results of the autogenic factors related to such problems of health and safety (Armstrong et al., 1993; Carayon, Smith, & Haims, 1999).

This issue found that high job demands and higher levels of stress related to job were the most frequently identified as having an association with WRUMSDs. A similar review of the epidemiological literature(Carayon et al., 1999) Indicated that there is evidence that perception of heavy workload, monotonous work and low support from supervisor all plays a role in developing work-related upper musculoskeletal disorders.

The study concluded that, after physical demands are taken into account; psychosocial factors contribute to such disorders either partially or completely independent of physical characters(J. J. Devereux, Buckle, & Vlachonikolis, 1999; Feveile, Jensen, & Burr, 2002) . Various epidemiological reviews have indicated an integrated relation of psychosocial risk factors at work in the development of WRUMSDs(J. J. Devereux et al., 1999; Drennan & Edwards, 2012). A study conducted in UK investigates that is there possibilities of more risk due to the association of physical and psychosocial work-related risk factors (J. J. Devereux et al., 1999). Research elaborated that high exposure to multiple factors like psychosocial factors, low mental demands; high job demands, low job control and poor social support had an effect on WRUEDs. Such an influence of psychosocial factors has a crucial implication for preventive actions(Hemingway & Marmot, 1999).

Problems such as neck/shoulder, some prospective epidemiological studies have shown a positive relationship between symptoms of stress/psychological strain (Conway, 1999; Hogg-Johnson et al., 2008). Anxiety and depression have also been shown to develop WRUMDs(Hopkins, 1990).

This situation is the starting point of the current study. The study focuses on the influence of psychosocial workplace factors on upper extremities/limb/musculoskeletal complaints in study populations. Specifically, it addresses the question whether psychosocial workplace factors have an independent, incremental effect on the development of neck and/or shoulder complaints, as described in previous research.

2. WORK RELATED UPPER MUSCULOSKELTAL DISORDER

There is evidence, which shows the association of different aspects,of, work organization that strengthen the possibilities of work-related stress which may lead towards adverse health conditions. Numerous review papers show the possibilities that such factors may contribute in ,the, development ,of WRUMSDs (Davis & Heaney, 2000).

The work-related upper musculoskeltal disorders (WRUMSDs) affecting organizations and workers, due to the diverse set of psychological, physical, legal, financial and social challenges they are experiencing. From the past few decades' comprehensive investigations have found that physical, psychosocial, medical and ergonomic factors are correlated with the predictors of these disorders (J. J. Devereux et al., 1999).

The recent studies on WRUMSDs show strong associations of,psychosocial,work,factors (job,control, job satisfaction, work demand) in developing MSDs at workplace to the employees(Theorell & Karasek, 1996; Toomingas et al., 1997).

WRUMSDs can notably disturb or create discomfort in activities of the important body region's performance because upper extremities such as shoulder, neck, hand and arm are vital parts of the body. WHO characterized WRUMSDs as complex or multi-factored to assess that various risk factors (psychosocial, individual, physical characteristics, socio-cultural and work organization) contributed to these ailments (World Health Organization, 1985). Additionally, WRUMSDs are, major cause,of,disability in the working population. Health consequences due to work-related stress have a great concern in ensuring health and safety because the resulting health consequences from work-related stress effecting employees at large. Musculoskeletal pain has strong association with psychosocial factors. Factors like decision-making, decision latitude, work demands, perceived stress and psychological distress. Monotonous work, high-perceived workload and unsatisfactory job contribute to WRUMSDs.

Therefore, it is important to study the issues regarding work related upper musculoskeletal disorders and its association with psychosocial factors in order to achieve more close view of the symptoms of this health and safety problem.

3. METHOD

Samples for this study was obtained from the operational workers I.e. Technical workers in a petrochemical plant. Main focus was those who were working in confined work space and those who were working on monotonous pace for longer period. The questionnaire is a combination of Nordic musculoskeletal questionnaire (Kuorinka et al., 1987) and QPS: general Nordic questionnaire for psychological and social factors at work (Lindström et al., 2000).

Subjects were asked to fill up the questionnaire. Each respondent chooses the options from (1- 5) using Likert scale. Questionnaire was highlighting three major areas for assessing the UMSDs complaints. First part was dictating the pain intensity within three different time paces; 1Pain experienced within past week, 2: Pain experienced within the 12 months and third was checking the intensity of discomfort in these areas which was making that person to stop/in able to do particular tasks.

The complete Nordic musculoskeletal questionnaire was used for assessing the pain intensity in subjects. For the musculoskeletal symptoms The complete NMQ used targeting the musculoskeletal symptoms in the 6 different parts of upper body(neck, shoulder, arm, wrists/hands, elbows).NMQ can be used for different occupational groups (Kuorinka et al., 1987) and helps in assessment of UMSD complaints within the targeted subjects of this study.
General Nordic questionnaire for psychological and social factors at work was modified and used for the assessment of psychosocial factors. QPS Nordic is standardized tools for assessing the psychosocial factors at work (Wännström, Peterson, Åsberg, Nygren, & Gustavsson, 2009). It consists of multiple choice questions to assess psychological and social factors at work like control and demand, monotonous work, leadership, organizational commitment, social interactions at work.
Third part is consisting questions about ergonomic condition at work place. Bearing in mind the essence of the study, less focus given to the ergonomic and physical factors.

4. RESULTS

Table 1. Demographics of the participants.

	Frequency	Valid %
Gender		
Male	183	74.4
Female	63	25.6
Total	246	100
Ethnic Background		
Malay	229	93.1
Chinese	7	2.8
Indian	4	1.6
Others	6	2.4
Total	246	100
Education		
Primary	0	0
Secondary	14	5.7
College/polytechnic	121	49.2
Graduate/postgraduate	111	45.1
Total	246	100

Table 2. Pain experienced by respondents in past 7 DAYS/WEEK.

Body Region	**Yes (%)**	**No (%)**
Neck	133(54.1)	113(45.9)
Shoulder	64(26)	182(74.0)
Elbow	34(13.8)	212(86.2)
Hand/Wrists	30(12.2)	216(87.8)
Upper back	138(56.1)	108(43.9)

Table 3. Pain experienced by respondents in past 12 months.

Body Region	**Yes (%)**	**No (%)**
Neck	126(51.2)	120(48.8)
Shoulder	103(41.9)	143(58.1
Elbow	73(29.7)	172(69.9)
Hand/Wrists	82(32.9)	164(66.7)
Upper back	143(58.1)	(10341.9)
Upper back	143(58.1)	(10341.9)

Table 4. Prevalence of general UMSDs.

Yes	139	56.5%
No	107	43.5%

Table 5. Psychosocial factors assessment: descriptive score.

Psychosocial Factors	Never	Seldom	Sometimes	Often	Frequently	Total
Job Demands	8.14	40.57	104.86	73.86	18.57	246
Monotonous Work	14.20	47.40	88.90	90.80	29.30	246
Control at Work	28.25	57.00	78.88	71.63	10.25	246
Leadership	27.00	50.00	70.43	47.29	16.14	246
Commitment with the Organization	5.14	10.57	33.00	37.29	19.43	246

5. DISCUSSION

several Several studies identified the association of psychosocial factors in the, occurrence of MSDs work related psychosocial factors seem to have association with MSDs factors like monotonous work, job satisfaction, social support and high or low job demands leads towards MSDs risk(Davis & Heaney, 2000).

Neck, shoulder, pain might be associated with the factors like high or low job demands(Macfarlane et al., 2000). It was further concluded by (Carroll et al., 2008) that job insecurity, low social support and high job demands are the risk factors of neck pain. Several reviews supported psychosocial factors such as low supervisor supports, high individual distress, monotonous work, high and low job demands considered as major risk factors for the occurrence of upper extremity disorders(Harkness, Macfarlane, Silman, & McBeth, 2005).

Several epidemiological studies stated the association of work-related stress and WRUMSDs(Armstrong et al., 1993; J. Devereux, Vlachonikolis, & Buckle, 2002). This issue found that high job demand and higher levels of stress related to job were the most frequently identified as having an association with WRUEDs.(FEUERSTEIN, 1996) Indicated that there is evidence that perception of heavy workload, monotonous work and low support from supervisor all plays role in developing work-related upper extremity disorders. Further, the study concluded that, after physical demands are taken into account, psychosocial factors contribute on such disorders either partially or completely independent of physical characters(FEUERSTEIN, 1996).

Psychosocial factors evaluated comprised job demands, monotonous work, control at work, leadership and organizational commitment. Results obtained on the frequency of exposure to the above mentioned psychosocial factors on a 5 point Likert scale ranging from 1 to 5, which was from 1 never and to 5 frequently. The evaluation was done by using statistical package for social sciences SPSS (IBM.com).

Problems such as neck/shoulder, some, prospective epidemiological studies have shown a positive relationship between symptoms of stress/psychological strain(Conway, 1999).

A recent study identified that there are different perceptions and beliefs about the causes and consequences of psychosocial factors, which subsequently predict psychological well-being and improved performance. Personality factors and individual psychological differences have not been widely research for adequate results(Feuerstein, Shaw, Nicholas, & Huang, 2004). Social support has been researched as a coping resource in the response towards stress (Cole, Ibrahim, Shannon, Scott, & Eyles, 2001). According to(Cole et al., 2001) low social support from superior may increase the risk of MSDs and social support also work as an independent variable in the preventive measures for WRUEDS Karasek’s job demand control model(Karasek Jr, 1979) also influences the occupational health and safety research. Demand and control latitudes are significantly defined in the model. Specifically, job demand control model depicts that high job demands and the lower control over these demands responsible for the adverse health effects like WRUEDs.

Various studies have shown positive link of monotonous work and WRUED.(Ryan & Bampton, 1988) In a study found that monotonous work was highly associated with neck pain. (Linton, 1990) Found that monotonous work was associated with neck/shoulder pain. Studies (Waluyo, Ekberg, & Eklund, 1996) revealed that absence due to fatigue and shoulder pain is associated with (low quality work and boredom at work). Monotonous work seems to have strong association with neck/shoulder pain (Hopkins, 1990).

Despite a significant body of research documenting the association between psychosocial risk factors and WRUMSDs among operational workers petrochemical plants, there is limited research with regards to the operational workers population in Malaysia. Hence, this study aims to explore the association of psychosocial risk factors in developing WRUMSDs and to investigate the relationship between psychosocial risk factors in the workplace and sustaining WRUMSDs prevention among workers in general. Our results agree on the presence of UMSD complaints in the targeted group. Although studies are heterogeneous when it comes to the prevalence of UMSDs(Karwan, Azuhairi, & Hayati, 2015)

6. CONCLUSION

According to the findings in this study, there is a subsequent evidence of psychosocial factors association with the occurrence of WRUMSDs. Still seems to be contradiction in studies in relate to strong association of the psychosocial factors in developing WRUMSDs. It is necessary to be aware that researchers have not used the non-work characteristics which may lead towards the biased end results. Moreover, physical factors were not being collectively measured/ investigated as an intervention towards the problem. Based on findings, it is observed that future research which more towards the analysis of symptoms development and prevalence should be considered. For a complete insight, longitudinal study is recommended. However, such studies may provide a better insight to the stakeholders in identifying the severity of the disorder and to formulate the new and more effective policies towards better psychosocial health of workforce.to investigate the predictive role of different psychosocial factors in the development of WUMSDs among Operational workers of petrochemical plants of Malaysia. Overall the findings of this study enhanced understanding of psychosocial work factors on the development of musculoskeletal discomforts within the working population.

It can be concluded that the results obtained from this study support the idea about the association of psychosocial factors with upper musculoskeletal disorders.

7. REFERENCES

1. Alipour, A. (2008). *Neck and shoulder pain: Prevalence, incidence and risk factors The IKCo cohort study*: Institutionen för klinisk neurovetenskap/Department of Clinical Neuroscience.
2. Armstrong, T. J., Buckle, P., Fine, L. J., Hagberg, M., Jonsson, B., Kilbom, A., . . . Viikari-Juntura, E. R. (1993). A conceptual model for work-related neck and upper-limb musculoskeletal disorders. *Scandinavian journal of work, environment & health*, 73-84.
3. Bergsten, E. L., Mathiassen, S. E., & Vingård, E. (2015). Psychosocial Work Factors and Musculoskeletal Pain: A Cross-Sectional Study among Swedish Flight Baggage Handlers. *BioMed research international, 2015*.
4. Carayon, P., Smith, M. J., & Haims, M. C. (1999). Work organization, job stress, and work-related musculoskeletal disorders. *Human Factors: The Journal of the Human Factors and Ergonomics Society, 41*(4), 644-663.
5. Carroll, L. J., Hogg-Johnson, S., Côté, P., van der Velde, G., Holm, L. W., Carragee, E. J., . . . Guzman, J. (2008). Course and prognostic factors for neck pain in workers. *European Spine Journal, 17*(1), 93-100.
6. Cole, D. C., Ibrahim, S., Shannon, H., Scott, F., & Eyles, J. (2001). Work correlates of back problems and activity restriction due to musculoskeletal disorders in the Canadian national population health survey (NPHS) 1994–5 data. *Occupational and environmental medicine, 58*(11), 728-734.
7. Conway, F. T. (1999). Psychological mood state, psychosocial aspects of work, and musculoskeletal discomfort in intensive video display terminal (VDT) work. *International Journal of Human-Computer Interaction, 11*(2), 95-107.
8. da Costa, B. R., & Vieira, E. R. (2010). Risk factors for work-related musculoskeletal disorders: a systematic review of recent longitudinal studies. *American journal of industrial medicine, 53*(3), 285-323.
9. Davis, K. G., & Heaney, C. A. (2000). The relationship between psychosocial work characteristics and low back pain: underlying methodological issues. *Clinical biomechanics, 15*(6), 389-406.
10. Devereux, J., Vlachonikolis, I., & Buckle, P. (2002). Epidemiological study to investigate potential interaction between physical and psychosocial factors at work that may increase the risk of symptoms of musculoskeletal disorder of the neck and upper limb. *Occupational and environmental medicine, 59*(4), 269-277.
11. Devereux, J. J., Buckle, P. W., & Vlachonikolis, I. G. (1999). Interactions between physical and psychosocial risk factors at work increase the risk of back disorders: an epidemiological approach. *Occupational and environmental medicine, 56*(5), 343-353.
12. Drennan, F., & Edwards, R. (2012). Preventing Musculoskeletal Disorders: Five Essential Processes to Build a Fit Workforce. *Professional Safety, 57*(6), 52.
13. FEUERSTEIN, M. (1996). Definition, Empirical Support, and Implications for Prevention, Evaluation, and Rehabilitation of Occupational Upper-Extremity Disorders. *Beyond Biomechanics: Psychosocial Aspects Of Musculoskeletal Disorders In Office Work*, 177.
14. Feuerstein, M., Shaw, W. S., Nicholas, R. A., & Huang, G. D. (2004). From confounders to suspected risk factors: psychosocial factors and work-related upper extremity disorders. *Journal of Electromyography and Kinesiology, 14*(1), 171-178.

15. Feveile, H., Jensen, C., & Burr, H. (2002). Risk factors for neck-shoulder and wrist-hand symptoms in a 5-year follow-up study of 3,990 employees in Denmark. *International archives of occupational and environmental health, 75*(4), 243-251.
16. Harkness, E., Macfarlane, G., Silman, A., & McBeth, J. (2005). Is musculoskeletal pain more common now than 40 years ago?: Two population-based cross-sectional studies. *Rheumatology, 44*(7), 890-895.
17. Hemingway, H., & Marmot, M. (1999). Evidence based cardiology-Psychosocial factors in the aetiology and prognosis of coronary heart disease: systematic review of prospective cohort studies. *Bmj, 318*(7196), 1460-1467.
18. Hogg-Johnson, S., Van Der Velde, G., Carroll, L. J., Holm, L. W., Cassidy, J. D., Guzman, J., . . . Carragee, E. (2008). The burden and determinants of neck pain in the general population. *European Spine Journal, 17*(1), 39-51.
19. Hopkins, A. (1990). Stress, the quality of work, and repetition strain injury in Australia. *Work & stress, 4*(2), 129-138.
20. Karasek Jr, R. A. (1979). Job demands, job decision latitude, and mental strain: Implications for job redesign. *Administrative science quarterly*, 285-308.
21. Karwan, M., Azuhairi, A., & Hayati, K. (2015). PREDICTORS OF UPPER LIMB DISORDERS AMONG A PUBLIC UNIVERSITY WORKERS IN MALAYSIA. *International Journal of Public Health and Clinical Sciences, 2*(3), 133-150.
22. Kraatz, S., Lang, J., Kraus, T., Münster, E., & Ochsmann, E. (2013). The incremental effect of psychosocial workplace factors on the development of neck and shoulder disorders: a systematic review of longitudinal studies. *International archives of occupational and environmental health, 86*(4), 375-395.
23. Kuorinka, I., Jonsson, B., Kilbom, A., Vinterberg, H., Biering-Sørensen, F., Andersson, G., & Jørgensen, K. (1987). Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Applied ergonomics, 18*(3), 233-237.
24. Lindström, K., Elo, A., Skogstad, A., Dallner, M., Gamberale, F., Hottinen, V., . . . Orhede, E. (2000). QPS Nordic: General Nordic Questionnaire for Psychological and Social Factors at Work: User's Guide. *Copenhagen: Nordic Council of Ministers*.
25. Linton, S. J. (1990). Risk factors for neck and back pain in a working population in Sweden. *Work & stress, 4*(1), 41-49.
26. Macfarlane, G. J., Hunt, I. M., & Silman, A. J. (2000). Role of mechanical and psychosocial factors in the onset of forearm pain: prospective population based study. *Bmj, 321*(7262), 676.
27. Macfarlane, G. J., Pallewatte, N., Paudyal, P., Blyth, F. M., Coggon, D., Crombez, G., . . . Smeets, R. J. (2009). Evaluation of work-related psychosocial factors and regional musculoskeletal pain: results from a EULAR Task Force. *Annals of the rheumatic diseases, 68*(6), 885-891.
28. Ryan, G. A., & Bampton, M. (1988). Comparison of data process operators with and without upper limb symptoms. *Community health studies, 12*(1), 63-68.
29. Theorell, T., & Karasek, R. A. (1996). Current issues relating to psychosocial job strain and cardiovascular disease research. *Journal of occupational health psychology, 1*(1), 9.
30. Toomingas, A., Theorell, T., Michélsen, H., & Nordemar, R. (1997). Associations between self-rated psychosocial work conditions and musculoskeletal symptoms and signs. *Scandinavian journal of work, environment & health*, 130-139.
31. van der Windt, D. A., Thomas, E., Pope, D. P., de Winter, A. F., Macfarlane, G. J., Bouter, L. M., & Silman, A. J. (2000). Occupational risk factors for shoulder pain: a systematic review. *Occupational and environmental medicine, 57*(7), 433-442.
32. Van Rijn, R. M., Huisstede, B. M., Koes, B. W., & Burdorf, A. (2010). Associations between work-related factors and specific disorders of the shoulder—a systematic review of the literature. *Scandinavian journal of work, environment & health*, 189-201.
33. Waluyo, L., Ekberg, K., & Eklund, J. (1996). Assembly work in Indonesia and in Sweden—ergonomics, health and satisfaction. *Ergonomics, 39*(2), 199-212.
34. Wännström, I., Peterson, U., Åsberg, M., Nygren, Å., & Gustavsson, J. P. (2009). Psychometric properties of scales in the General Nordic Questionnaire for Psychological and Social Factors at Work (QPSNordic): Confirmatory factor analysis and prediction of certified long-term sickness absence. *Scandinavian Journal of Psychology, 50*(3), 231-244.
35. Zakerian, S. A., & Subramaniam, I. D. (2009). The relationship between psychosocial work factors, work stress and computer-related musculoskeletal discomforts among computer users in Malaysia. *International journal of occupational safety and ergonomics, 15*(4), 425-434.

RESIDENT'S PERCEPTION TOWARDS MUNICIPAL SOLID WASTE MANAGEMENT AND GIS BASED METHODS FOR LANDFILL SITE SELECTION

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Abstract: Municipal solid waste management (MSWM) has risen to be a big issue all human being throughout the world. Rapidly increasing population, urban expansion and accelerating living standards have boosted the generation of solid waste in developing countries. As, householders are the major generators of solid waste in the municipality. Therefore, study aim was to investigate the perceptions, and attitudes of Sindh university colony's residents about the services rendered by the municipal solid waste management department. Further, study provides a mini review about the GIS based methods of MSWM for the landfill site selection. For conducting the present investigation, questionnaire survey and random sampling technique with descriptive analysis were utilized to identify the perceptions of people towards various issues about solid waste generation, management, and its impacts. This study is significant because it provides the information about present situation of MSWM in study area and guide the administrative agencies about the MSWM.

1. INTRODUCTION

Waste means unwanted or unusable material which is commonly known as rubbish, trash, refuse, garbage or junk (Janet & Kelechi, 2016). Internationally, solid waste is a term used for the waste which is in the solid state arising from domestic, trade, commercial and other waste which because of its nature and composition is similar to household waste. (Haider, Amber, Ammara, Mahrukh, & Aisha, 2015);Environmental Protection Agency, 2009). Furthermore, Inter government panel on climatic change (IPCC) distinguished the municipal solid waste (MSW) as the waste which includes food waste; garden (yard) and park waste; paper and cardboard; wood; textiles; nappies (disposable diapers); rubber and leather; plastics; metal; glass (pottery); and other (e.g., ash, dirt, dust, soil, electronic waste) (Hoornweg & Bhada-Tata, 2012). Rapidly Increasing population, urban expansion and increasing living standards have boosted the generation of solid waste in developing countries (Warunasinghe & Yapa, 2016). This situation illustrates the need of putting more consideration on municipal solid waste management (Hoornweg, 1999). As, the main concern of solid waste management is to safeguard human health and the environment (Vučijak, Kurtagić, & Silajdžić, 2015). Therefore, it is considered as one among the basic essential services provided by municipal authorities in the country to keep urban centers clean (unep, 2001).

Pakistan has a population over 160 million including 35% of people living in urban areas that contribute more than 55,000 tons/day solid waste. (Haider et al., 2015). In this way, solid waste management issue has become a major environmental and health hazard in the urban areas of developing nations like Pakistan (Mohsin, Anwar, & Iqbal, 2016). Instead, People suffered with environmental hazards (Mohsin et al., 2016) (Schuhmacher, Xifro, Llobet, Kok, & Domingo, 1997), aesthetic nuisance (Akaateba & Yakubu, 2013) and health issues (Mohsin et al., 2016) (Karijia, Shihua, & Lukaw, 2013) due to poor waste management (Vidanaarachchi, Yuen, & Pilapitiya, 2006). The only way to solve these problems is Solid Waste Management which can be done more accurately by selecting a suitable site for solid waste disposal and land fill. If this is not done at right time then everybody have to pay a great cost in future. In broad view if we take retrospective view a question comes in our mind that; how Geographic Information system (GIS) is used as a tool to find solid waste and land fill sites, which are environmentally safe and acceptable for people. Particularly GIS is used to view, understand, question, interpret and visualize huge amount of spatial and non-spatial data in many ways that reveals relationships, patterns and trends in the form of maps, reports and charts which will be important for critical decision making (Duve, Deshmukh, & Kolhe, 2015). As, householders are the major generators of solid waste in the Municipality and it is important to investigate their perceptions about the services rendered by the municipal solid waste management department (Akaateba & Yakubu, 2013). Therefore, this research was aimed to identify the perceptions of the residents about service delivery dimensions of solid waste management and to highlight the problems of study area. The study is momentous in a sense that it addresses the mismanagement of solid waste collection in the study area and describes the public about solid waste management. By taking into account the resource factor and time, study focuses only on investigating the peoples' perception about the garbage collection services.

2. REVIEW OF GIS BASED METHODS FOR LANDFILL SITE SELECTION

The Geographic Information System (GIS) is one of the new tools which have a considerable measure in a brief timeframe traverse to waste management (Oyinloye & Fasakin, 2013). Eskandari, Homaee, Mahmoodi, Pazira, & Van Genuchten (2015) used GIS for their study conducted to determine the landfill site selection. They used environmental, economic and socio cultural criteria for land suitability analysis. Furthermore, they adopted a sensitivity analysis through GIS in order to assess the stability and rankings of alternative sites selected for landfill. In another study for solid waste management, Yadav (2013) developed GIS based environmental decision support system under Indian socio-economic and regulatory conditions. Alternative sites for waste management were selected through the weighted scores by using Analytical Hierarchy Process (AHP). In a research conducted for solid waste site selection in Kandy district Sri Lanka, Balasooriya et al., (2014) utilized both GIS based analysis and semi quantitative risk assessment. They prepared eight map layers using GIS as a tool such as surface water bodies, distance from transportation routes and urban areas, land use/land cover, soil, rainfall, population density and elevation were formed in order to complete the research. (A. Ahmad et al., 2016) made an empirical study on the topic "GIS based Landfill Site selection for Faisalabad City" in which they utilized GIS tools (Thematic layers and Tabular data) Multi-criteria Decision analysis (MCDA) as methodology for selecting a suitable landfill site with less impact on environment. A study on the topic "GIS and Multi-criteria Decision Analysis for Landfill Site Selection in Al-Hashimyah Qadaa" by (Alanbari, Al-ansari, & Jasim, 2014) was made to decide a suitable land fill site in which the researchers have used Multi-criteria Decision Analysis (MCDA) and Geographic Information System (GIS) tools as methodology to achieve their objective of selecting a suitable landfill site for solid waste disposal. A study was made for preliminary site assessment for landfill area for their identification and ranking so for that purpose (Everett, 2014) used spatial-AHP. (Malczewski, 2016) made a detailed study on the topic "GIS-Based Multi-criteria decision analysis" in which they have discussed integration of GIS and Multi-criteria decision analysis. The paper provides taxonomy of different articles and identifies trends and developments in GIS- MCDA. Further a study was made to site a new landfill site by using a Multi-criteria decision analysis (MCDA) and overlay analysis using geographic information system (GIS) on district Pondicherry (India). Several factors were considered in the siting process including geology, water supply resources, land use, sensitive sites, air quality and groundwater quality (Balasooriya et al., 2014). As there is increasing use of GIS in several fields which are sensitive to environment and human life so a review was made about allocation of landfill site using Multi-criteria decision analysis MCDA by (Duve et al., 2015). The existing system of selecting a landfill site in Kenya, Nakru town is effort consuming and expensive as well so (Kirimi & Waithaka, 2014) employed GIS-based Multi-Criteria Decision Analysis (MCDA) such as Analytical Hierarchy Process (AHP) in his study to select a suitable landfill site for the proper disposal of solid waste at a specific landfill site in Nakuru Town. In developing countries like Pakistan most of the landfill sites are selected without any aim and waste is burned in air which puts damaging impacts on nature and human lives as well. So (S. R. Ahmad & Mahmood, 2015) explained the concept of selecting a suitable site for solid waste disposal without burning it in a detailed study in which he used Geographic Information System (GIS) as a tool to aid the decision making process for the suitable landfill site selection with less impact on environment for Faisalabad city and to achieve the aim, thematic layers, and different tabular form data such as topography, land use, roads network, ground and surface water and infrastructure of urban areas were collected. Thematic maps were used to form the vulnerability map for the area and the results were compiled to the buffer zones around sensitive areas. Multi-criteria analysis (MCA) was used as a methodology to measure the relative importance weighting for each criterion. (Babalola & Busu, 2011) made a study on topic "Selection of Landfill Sites for Solid Waste Treatment in Damaturu Town-Using GIS Techniques" they made this study to determine a proper site for disposal of solid waste in Damaturu town Nigeria, for that purpose they combined geographic information system (GIS) and a Multi-criteria decision making method (MCDM) known as the analytic network process (ANP) for the determination of the relative importance weights of factors (criteria). A case study was made on the topic "A GIS-based multi-criteria evaluation system for selection of landfill sites" in Abu Dhabi, United Arab Emirates in which municipal area was determined by integration of geographic information systems (GIS) and multi-criteria evaluation (MCE) analysis. So for that purpose eight input map layers including proximity to wells and water table depth, proximity to urban areas, geology and topography, distance from roads network, proximity to touristic and archeological sites, distance from drainage networks and land slope are used in constraint mapping. A final map was generated which identified potential areas which were suitable for the location of the landfill site (Sensing & Sciences, 2012). A study was done on Polog Region, Macedonia by (Management & Ss, 2012) in which they used Multi-criteria decision analysis approach for evaluating the suitability for landfill site selection. The Multi-criteria decision framework considers environmental and economic factors which are standardized by fuzzy membership functions and combined by integration of analytical hierarchy process (AHP) and ordered weighted average (OWA) techniques. The OWA scenarios are intended to quantify the level of risk taking (i.e., optimistic, pessimistic, and neutral). The usefulness of the approach is illustrated by different OWA scenarios that report landfill suitability on a scale between 0 and 1. (Molero & Grindlay, 2008) made a study in which they have used landfill siting method, which is based on EVIAVE (GIS) technology. They have used this technology to generate spatial data for site assessment. The method described in this study has been used to evaluate an area in Granada (Spain) where there is a currently operating landfill. (Whitenett et al., n.d.) made a review study in which, literature related to the developments of 64 models and their procedures in the past 18 years (from 1997 to 2014) were comprehensively surveyed. Potential improvement in Geographic information systems GIS modelling parameter for landfill sites via utilizing multivariate analysis (MVA) instead of Conventional method (CM) through DLSIC (e.g., Input variables, Accuracy, objectivity, reliability of criteria, time consumption, cost and comprehensiveness) were emphasized. A study was made on the topic "Integrating spatial multi criteria evaluation and expert knowledge for GIS-Based habitat suitability model" with the aim of developing a method by means of which it is possible to produce georeferenced ecological information about the habitat requirements of different species. The integrated habitat suitability index approach included the steps of constructing habitat suitability models, producing data needed in models, evaluation of target areas based on habitat factors, and combining various suitability indices (Store & Jokimäki, 2003). A study was made in which Chang's fuzzy AHP-based multiple attribute decision-making (MADM) method for selection of the best site of landfills based on a set of decision criteria was applied. The Fuzzy Analytic Hierarchy Process (FAHP) was designed to make pairwise comparisons of selected criteria by domain experts for assigning weights to the decision criteria (Sciences, 2012). (Management, Sener, Sener, & Karag, 2014). In another study made on Koniya, Turkey in Lake Bey sehir (AHP) Analytical hierarchy process combined with a geographic information system (GIS) was utilized to select an appropriate landfill site for solid waste disposal. Several criterions were used to select a landfill site and each criterion was evaluated with the aid of AHP and mapped by GIS.

3. MATERIAL AND METHODS

Study provides an informational base about landfill site selection using GIS tools and techniques. For this research, Sindh University Jamshoro residential colony was selected which is located at Jamshoro, District Dadu at the distance about 18 km from Hyderabad City. The study area is adjacent to the Super high way, having 5,550 persons residing in it. (Gopang, Khushik, Begum, & Saeed, 2012). As, the Sindh university residential colony is situated in urban area, it may have the problems of poor waste collection which puts adverse effects on health, environment and physical well-being of people living there. Due to this situation, research objective is carefully chosen as to determine the residents' perception regarding the municipal waste collection services.

In order to collect data from field, on-site questionnaire survey was nominated for this research (Chandio, Talpur, & Khahro, 2012). For collection of information through close ended questionnaires, the household survey was progressed by face to face interview of the respondents in their houses (Batool & Ch, 2009). In addition to proceed survey in a scientific way, random sampling method is utilized (Liyanage, Gurusinghe, Herat, & Tateda, 2015; Warunasinghe & Yapa, 2016). Descriptive statistics (Frequency analyses) was adopted (Addo, Adei, & Acheampong, 2015) to identify the perception of residents about the municipal solid waste collection services presented in the area.

3.1. Socio-demographic details of site

Sindh university residential colony was facilitated with three Schools, two middle schools and one vocational school for girls, two mosques, two dispensaries, one post office and two Banks. The population of Sindh University Colony is around 5550 souls, of which 3050 are male and 2500 are female. This population lives in 510 housing units (14 are vacant) of which 71 are bungalows and 439 are quarters as shown in pie charts. (Gopang et al., 2012)

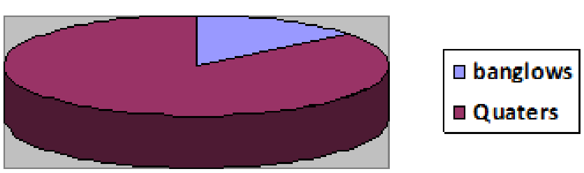

Figure 1 Total no of houses in the colony

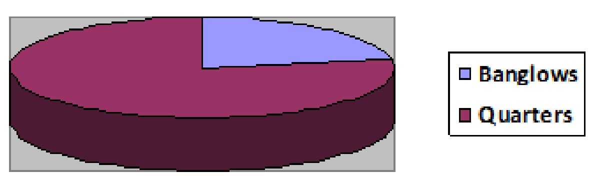

Figure 2 Residing population in houses

3.2 Questionnaire survey

In order to obtain both qualitative and quantitative data, a random sampling method was adopted and a questionnaire survey was conducted (Liyanage et al., 2015). A random sample of 100 households totalling 1000 residents were selected for survey proceedings in Sindh university colony area. This decision was made due to the fact that lowest number to be used in data analyses is 100-150 (Mahmoudi, Ahmad, & Abbasi, 2015). The survey focused on the present MSW disposal practices of the residential community and their habits and attitude to solid waste.

4. RESULTS AND DISCUSSION

In order to determine the perception of residents about solid waste management descriptive statistical analysis (frequency analyses) was done and attributes of questioner were set accordingly. From questioner survey it was estimated that 95% of source of solid waste generation was from house hold trash which mainly included the peals of vegetables, fruits and plastic bags as well and at some areas the commercial refuse was also the source of solid waste generation which came up to be approximately 5% so from this result it was concluded that there was severe lacking of public dust bins in the colony which must be provided to the residents as soon as possible. According to 100% residents the attribute of the present situation of solid waste management organization was found worst due to absence of waste collectors and disposal bins. So it was concluded that there was a critical need of proper working solid waste management organization. Research analysis highlighted 5 most pressing problems of the area which were having varied percentages according to their effect due to polluted environment. In which unsanitary conditions were estimated as most pressing problem about 29% and other problems like pollution, hazardous conditions, unhealthy conditions, infinite mosquitos and spread of different diseases also got their percentage ranges from 21 to 16%. From this estimate it was concluded that polluted environment caused many damaging impacts on the residential situation of the colony. Moreover in the attribute of diseases Malaria was estimated as most common disease in the area whose percentage of occurrence was about 95% and its main cause was spread of mosquitoes due to polluted environment. 70% population reported that they disposed of their garbage in plastic bags or paper bags due to unavailability of proper dustbins outside their house peripheries. So proper dustbins must be equipped nearby the house peripheries at a suitable place not too far from their houses so that residents feel free to dispose of their waste in the bins easily. By considering the attribute of place of dumping it is clear that 55% residents use to dump their refuse in open plot due to unavailability of proper dumping site so the concerned waste management authority must take a solid step to arrange a GIS based survey in the colony to select a proper dumping site for dumping the waste of colony at a suitable landfill site. 40 to 45% population use to dump their refuse beside their houses and at road side bushes. Due to mismanagement of solid waste management organization there were no any sweepers in the community for waste collecting activity. So the authority must become active to note the existence sweepers and should make them responsible by applying strict rules and regulations on waste collection activity.

5. CONCLUSION

The purpose of this study was to get an idea about the perceptions of people towards the mismanagement of solid waste in sindh university colony jamshoro through a scientific way i.e random sampling method. Study provides a wide range of case studies related to GIS based techniques for landfill site selection, in this way, study brings the focus of government and policy makers towards the use of modern technologies i.e. GIS for solid waste management. Hence the objective of this research was retrieved through the analysis of questioner survey. A close ended questioner was designed and face to face interviews from the respondents were conducted to cater the information about the perception of residents towards solid waste management and the generation, causes and its impacts on the people. So, results revealed that the solid waste management organization present there was in bad condition and its careless attitude adversely affected the lives of people living there.

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6. REFERENCES

Addo, I. B., Adei, D., & Acheampong, E. O. (2015). Solid Waste Management and Its Health Implications on the Dwellers of Kumasi Metropolis , Ghana. *Current Research Journal of Social Sciences*, *7*(3), 81–93.

Ahmad, A., Javaid, U., Javed, M. A., Ahmad, S. R., Jaffri, M. A., & Ashfaq, M. (2016). Landfill Sites Identification Using GIS and Multi-Criteria Method : A Case Study of Intermediate City of Punjab , Pakistan, (February), 40–49.

Ahmad, S. R., & Mahmood, K. (2015). GIS based Landfill Site selection for Faisalabad City, *6*(4), 67–72.

Akaateba, M. A., & Yakubu, I. (2013). Householders ' Satisfaction Towards Solid Waste Collection Services of Zoomlion Ghana Ltd in Wa , Ghana. *European Scientific Jurnal*, *9*(32), 198–213.

Alanbari, M. A., Al-ansari, N., & Jasim, H. K. (2014). GIS and Multicriteria Decision Analysis for Landfill Site Selection in Al-Hashimyah Qadaa, (March), 282–304.

Babalola, A., & Busu, I. (2011). Selection of Landfill Sites for Solid Waste Treatment in Damaturu Town-Using GIS Techniques, *2011*(March), 1–10. http://doi.org/10.4236/jep.2011.21001

Balasooriya, B. M. R. S., Vithanage, M., Nawarathna, N. J., Kawamoto, K., Zhang, M., & Herath, G. B. B. (2014). Solid Waste Disposal Site Selection for Kandy District, Sri Lanka Integrating GIS and Risk Assessment. *International Journal of Scientific and Research Publications*, *4*(10), 1–6.

Batool, S. A., & Ch, M. N. (2009). Municipal solid waste management in Lahore City District, Pakistan. *Waste Management*, *29*(6), 1971–1981. http://doi.org/10.1016/j.wasman.2008.12.016

Chandio, I. A., Talpur, M. A. H., & Khahro, S. H. (2012). Problems of boarding students at Universiti Teknologi Malaysia (UTM), Malaysia: A case study. *Research Journal of Applied Sciences, Engineering and Technology*, *4*(18), 3391–3398.

Duve, J. R., Deshmukh, N. K., & Kolhe, P. R. (2015). A Review on Solid Waste Site , Landfill Site Allocation Using GIS , Multi, (August).

Environmental Protection Agency. (2009). *Municipal Solid Waste – Pre-treatment & Residuals Management An EPA Technical Guidance Document*.

Eskandari, M., Homaee, M., Mahmoodi, S., Pazira, E., & Van Genuchten, M. T. (2015). Optimizing landfill site selection by using land classification maps. *Environmental Science and Pollution Research*, *22*(10), 7754–7765. http://doi.org/10.1007/s11356-015-4182-7

Everett, J. W. (2014). Landfill Siting Using Geographic Information Systems : A Demonstration, *9372*(February). http://doi.org/10.1061/(ASCE)0733-9372(1996)122

Gopang, N., Khushik, A. G., Begum, S., & Saeed, S. (2012). an Analysis of Socio-Economic Conditions of Widows Living in Sindh University Colony Jamshoro, Sindh. *THE WOMEN-Annual Research Journal*, *4*, 97–117.

Haider, A., Amber, A., Ammara, S., Mahrukh, K. S., & Aisha, B. (2015). Knowledge , Perception and Attitude of common People towards Solid Waste Management-A case study of Lahore , Pakistan. *International Research Journal of Environment Sciences*, *4*(3), 100–107.

Hoornweg, D. (1999). *What a Waste : Solid Waste Management in Asia*.

Hoornweg, D., & Bhada-Tata, P. (2012). *WHAT A WASTE: A GLOBAL REVIEW OF SOLID WASTE MANAGEMENT. Urban development series-knowledge papers*.

Janet, O. W., & Kelechi, H. (2016). Microorganisms associated with dump sites in Port Harcourt Metropolis, Nigeria. *Journal of Ecology and The Natural Environment*, *8*(2), 9–12. http://doi.org/10.5897/JENE2015.0522

Karijia, M. K., Shihua, Q., & Lukaw, S. Y. (2013). The Impact of Poor Municipal Solid Waste Management Practices and Sanitation Status on Water Quality and Public Health in Cities of the Least Developed Countries : the Case of Juba , South Sudan. *International Journal of Applied Science and Technology*, *3*(4), 87–99.

Kirimi, F. K., & Waithaka, E. H. (2014). Determination of Suitable Landfill Site Using Geospatial Techniques and Multi-Criteria Decision Analysis : A Case Study of Nakuru Town , Kenya, *3*(11), 500–505.

Liyanage, B. C., Gurusinghe, R., Herat, S., & Tateda, M. (2015). Case Study : Finding Better Solutions for Municipal Solid Waste Management in a Semi Local Authority in Sri Lanka. *Journal of Civil Engineering*, *5*(March), 63–73. http://doi.org/doi.org/10.4236/ojce.2015.51007

Mahmoudi, M., Ahmad, F., & Abbasi, B. (2015). Livable streets: The effects of physical problems on the quality and livability of Kuala Lumpur streets. *Cities*, *43*, 104–114. http://doi.org/10.1016/j.cities.2014.11.016

Malczewski, J. (2016). GIS - based multicriteria decision analysis : a survey of the literature, *8816*(December). http://doi.org/10.1080/13658810600661508

Management, W., Sener, S., Sener, E., & Karag, R. (2014). Combining AHP with GIS for landfill site selection : A case study in the Lake Bey ş ehir catchment area (Konya , Turkey), (March). http://doi.org/10.1016/j.wasman.2010.05.024

Management, W., & Ss, K. R. D. (2012). Integrating Multicriteria Evaluation Techniques with Geographic Information Systems for Landfill Site Selection : A case study ..., (February). http://doi.org/10.1016/j.wasman.2011.09.023

Mohsin, M., Anwar, M. M., & Iqbal, M. J. (2016). Practice and Conditions of Solid Waste Management in Ahmedpur East , Bahawalpur , Pakistan : A Way Forward. *SINDH UNIVERSITY RESEARCH JOURNAL (SCIENCE SERIES)*, *48*(1), 95–100.

Molero, E., & Grindlay, A. L. (2008). Evaluation of a municipal landfill site in Southern Spain with GIS-aided methodology, (April). http://doi.org/10.1016/j.jhazmat.2008.03.023

Oyinloye, M. A., & Fasakin, J. O. (2013). Application of Geographical Information System (GIS) for Siting and Management of Solid Waste Disposal in Akure , Nigeria. *IOSR Journal Of Environmental Science, Toxicology And Food Technology*, *4*(2), 6–17.

Schuhmacher, M., Xifro, A., Llobet, J. M., Kok, H. A. M. De, & Domingo, J. L. (1997). E nvironmental C ontamination a n d T oxicology PCDD / Fs in Soil Samples Collected in the Vicinity of a Municipal Solid Waste Incinerator : Human Health Risks. *ARCHEIVES OF ENVIRONMENTAL CONTAMINATION AND TOXICOLOGY*, *246*, 239–246.

Sciences, E. E. (2012). Landfill site selection by decision-making tools based on fuzzy multi-attribute decision- making method, (February 2014). http://doi.org/10.1007/s12665-011-1137-2

Sensing, R., & Sciences, S. I. (2012). International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XXXIX-B2, 2012 XXII ISPRS Congress, 25 August – 01 September 2012, Melbourne, Australia, *XXXIX*(September), 133–138.

Store, R., & Jokimäki, J. (2003). A GIS-based multi-scale approach to habitat suitability modeling, *169*, 1–15. http://doi.org/10.1016/S0304-3800(03)00203-5

unep. (2001). *Integrated Solid Waste Management*. (F. R. McDougall, P. R. White, M. Franke, & P. Hindle, Eds.), *Journal of environmental health* (Vol. 74). Oxford, UK: Blackwell Publishing Company. http://doi.org/10.1002/9780470999677

Vidanaarachchi, C. K., Yuen, S. T. S., & Pilapitiya, S. (2006). Municipal solid waste management in the Southern Province of Sri Lanka: problems, issues and challenges. *Waste Management (New York, N.Y.)*, *26*(8), 920–30. http://doi.org/10.1016/j.wasman.2005.09.013

Vučijak, B., Kurtagić, S. M., & Silajdžić, I. (2015). Multicriteria decision making in selecting best solid waste management scenario: A municipal case study from Bosnia and Herzegovina. *Journal of Cleaner Production*. http://doi.org/10.1016/j.jclepro.2015.11.030

Warunasinghe, W. A. A. I., & Yapa, P. I. (2016). A Survey on Household Solid Waste Management (SWM) with Special Reference to a Peri-urban Area (Kottawa) in Colombo. *Procedia Food Science*, *6*(Icsusl 2015), 257–260. http://doi.org/10.1016/j.profoo.2016.02.038

Whitenett, G., Stewart, G., Atherton, K., Adegbotolu, U. V, Njuguna, J., & Pollard, P. (n.d.). Optical fibre instrumentation for environmental monitoring applications GIS modelling for new landfill sites : critical review of employed criteria and methods of selection criteria. http://doi.org/10.1088/1755-1315/37/1/012053

Yadav, S. K. (2013). GIS Based Approach for Site Selection in Waste Management. *International Journal of Environmental Engineering and Management*, *4*(5), 507–514.

Determination of Nature and Characteristic of Potential Hazards Correlated with Helicopter Operation: Asian-Arabian Offshore Oil and Gas Industries Prospective

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Abstract: As per the statistical report of HSE UK, 38 drilling crew staff has been died from year 1995-2013 and hundreds has been injured during offshore helicopter operation due to the negligence of safety preventives. This paper discussed about characteristics of potential hazards with their hazardous nature during offshore helicopter operation at Malaysia and Saudi Arabia. In this study explanatory (Quantitative Leading to Qualitative) research design has been used for data collection and analysis process. While, 160 respondents for quantitative and 06 respondents for quantitative research has been participated in this study from targeted industries of Malaysia and Saudi Arabia. Likewise, descriptive statistical approach (Mean, Standard Deviation and Percentage) has been adapted for quantitative study and thematic analysis method has been used for qualitative part of this research. According to the descriptive statistical findings, respondents from Malaysian and Saudi Arabian oil and Gas industries are mutually considered Mechanical failure; Bad weather condition and pilot mistake are the major cause of offshore helicopter accidents with overall mean range 3.48 from Malaysia and 3.43 from Saudi Arabian respondent. Similarly, from qualitative results, respondent have highlighted mechanical and environmental hazard characteristics as a major cause of life threatening accidents and injuries during offshore helicopter operation at targeted industries.

1. INTRODUCTION

According to center of disease control and prevention (CDC) offshore oil and gas drilling industries are seven times deadlier then the rest of all manufacturing and production industries (CDC,2016). Several operations are involved in offshore extraction process but helicopter operation is one of the major operations at offshore oil and gas drilling sites which starts from rig assembling until the final production activities (Skogdalen, 2012). As per the statistical data from year 2003-2010, helicopter crashes caused 75 % of all transportation related oil and gas drilling crew fatalities. There are several unexpected and unpredictable hazards are involved during transportation of drilling crew from offshore to onshore sites (Barkat, 2010).

Numerous technical and safety concerns has been reported by previous researchers such as lack of maintenance, difficulty in landing at offshore due to bad weather and human error (Rowe, 2005). These potential hazards can be eliminated and reduced through implying sufficient hazard identification approaches and techniques (Lees, 2012). Similarly, through recognizing the potential hazards which are associated with helicopter operation the severity of accidents can be minimize by adopting suitable controls for particular activities (Vinnem, 2014). Consequently, this paper also focus on the identification of nature and potential hazards characteristics related to helicopter operation at Malaysian and Saudi Arabian oil and gas drilling sites through explanatory research design.

2. PROBLEM STATMENT

Oil and gas offshore drilling operation is one of the most hazardous jobs in the world (Russo, 2015). Every year hundreds of people have been critically injured and several have been died during offshore oil and gas extraction activities (Benner, 2015). According to Offshore Energy report September (2016), four drilling crew were died and two were missed after a helicopter bound for a Chevron offshore platform in Angola crashed. From year 1983–2009, the National Transportation Safety Board (NTSB) database recorded a total of 178 helicopter crashes associated to oil and gas operations with an average of 6.6 crashes per annum. The crashes resulted in a total of 139 fatalities, including 41 pilots (Baker, 2011).

Thus, there is a sheer need of the effective approach for the identification of characteristics and nature of potential hazards correlated with helicopter operation at offshore drilling sites (Utvik, 2016). Likewise, there is also a requirement for pooling of data from different oil and gas industries for controlling or minimizing the rate of injuries and accidents in effectual way (Lakhiani, 2016).Therefore this paper illustrate about the characteristics and nature of potential hazards related with helicopter operation by adopting mix method data analysis approach for Malaysian and Saudi Arabian oil and gas industries. The outcome of this paper will help and facilitated the safety and health professionals or practitioners to avoid such potentially hazardous activities or events with suitable emergency or action plan prior to helicopter operation.

3. STUDY OBJECTIVES

This study seeks to achieve the following research objectives:

- To classify the nature of helicopter operation during offshore drilling process among Malaysian and Saudi Arabian oil and gas industries.
- To examine the characteristics of related potential hazards associated with the helicopter operation at Malaysian and Saudi Arabian oil and gas industries.

4. METHADOLOGY

In this sequential l explanatory research design, eighty (80) oil and gas drilling crew members have been chosen through random sampling approach from two targeted oil and gas industries from Malaysia and Saudi Arabia (names has been kept conferential) for quantitative research (Survey instrument) as shown in table 1. Whereas, for the qualitative research analysis, a total of three (03) health and safety drilling professional experts from each country have been conveniently selected for in-depth semi structured interview from each focused industry. For the detailed analysis of quantitative data, descriptive statistical technique (Mean, Standard deviation and Percentage) has been employed through statistical package of social sciences SPSS.22.Whereas, for the interpretation of qualitative research, thematic analysis method has been used for analyzing the characteristics of the most common potential hazards during helicopter operation.

Table 1. Study Participants

Country/Industry	**No of Respondent**	
	Quantitative	**Qualitative**
Malaysia	80	03
Saudi Arabia	80	03
Total	160	06

5. QUANTITATIVE RESULTS

To answer the first and second research objectives descriptive statistical research approach has been adopted for the identification of hazardous nature of helicopter operation among offshore oil and gas industries in Malaysia and Saudi Arabia. Consequently, for the validation of results and findings a table of specifications is adapted from Landlell 1997 as shown in table 2.This table of specification has been used to measure the nature of hazardous activities based on the level of mean range (Landlell, 1997).

Table 2. Level of Hazardousness

Category	Mean Range	Hazardousness Level
1	1.00-2.33	Low
2	2.34-.3.67	Moderate
3	3.68-5.00	High

According to the response from drilling crew and health and safety professionals from Malaysian oil and gas industry as shown in table 3, during helicopter operation mechanical hazards and pilot error is considered as one major hazardous factors and cause of accident which are under moderate level of mean range which as indicated in table 2. Likewise, response from Saudi Arabian oil and gas industries considered that the bad weather during helicopter activity and also pilot error with low competence in handling aircraft are cause of major injuries which are leading to death and life time disabilities which are also under moderate range of mean score.

Table 3: Mean and Standard Deviation Score for On and Offshore Rig Assembling Operation

Items	**Malaysia**		**Saudi Arabia**	
Helicopter Operations	Offshore		Offshore	
Mechanical Hazards during helicopter operation at offshore drilling operation?	3.50	.599	3.400	.671
Bad weather is hazardous factor of helicopter accidents?	3.40	.496	3.425	.675
Pilot mistake is the hazardous factor and cause of major offshore helicopter accidents?	3.55	.503	3.475	.640
Total	**3.48**	**.532**	**3.43**	**.662**

5.1 Potential Hazard associated with Helicopter Operation

Table 4, specified the results of potential hazard associated with helicopter operation at Malaysian and Saudi Arabian oil and gas industries. According to the descriptive findings 50% respondent from Malaysian oil and gas industry and 28% from Saudi Arabian oil and gas industry highlighted mechanical hazards as potential hazards during helicopter operation. Similarly, 50% of them from Malaysian and 72% from Saudi Arabian oil and gas industries specified that the environmental hazards are highly contribute for unexpected accidents at offshore drilling sites.

Table4: Hazard Associated with Offshore Helicopter Operation

Potential Hazards	**Malaysia**	**Saudi Arabia**
	Offshore	Offshore
Mechanical Hazard	50 %	28%
Environmental Hazard	50%	72%
Total	**100%**	**100%**

6. QUALITATIVE RESULTS

In order to analyze the perception of health and safety drilling professionals regarding potential hazards which occur mostly during helicopter operation at offshore drilling sites semi-structured interview has been conducted. For the analysis of qualitative data, thematic analysis approach has been implemented for semi structure interviews from targeted respondents by assigning code numbers for recognizing their industries, as shown in table 5.

Table 5. Respondents Interview Code

S.NO	**Malaysia**	**Saudi Arabia**
1	MY01	SA1
2	MY02	SA2
3	MY03	SA3
Total	**03**	**03**

- ***Environmental Hazard associated with Helicopter Operation***

In the perception of potential hazards during helicopter operation at offshore drilling activities, participants from Malaysia and Saudi Arabia has mostly emphasized on bad weather as one of the cause of majority of accidents in the offshore drilling sites as shown in figure 1. Likewise, participant SA2 from Saudi Arabian offshore oil and gas industry also informed about the statistics of helicopter accidents accounted for 128 fatalities from 2007-2012, making up 75 percent of all transportation related deaths for oil and gas workers mostly due to unconditional and bad weather during offshore landing. Similarly, participant MY1 from Malaysia also directed that the helicopter operation during heavy weather is hazardous; therefore if there is no emergency then safety professionals and management stop the transportation process immediately during this scenario.

- ***Mechanical Hazard associated with Helicopter Operation***

Correspondingly, helideck structure damage and failure has also specified as reason of accidents as participants mentioned during interview sessions from targeted industries. Response from Participant MY1 from Malaysia and SA2 from Saudi Arabia have reflected that the damaged helideck can also make problems during landing on offshore rig site and high possibility to damage helicopter parts and injured passengers as well.

- ***Human Hazard associated with Helicopter Operation***

  Lastly, respondent from Malaysian and Saudi Arabian offshore drilling industry also recognized unprofessional flying crew as one of the potential hazard which can also lead to unsuccessful landing and helicopter crash in sea during landing procedures. According to the interview, participant MY3 from Malaysia and SA1 from Saudi Arabia emphasized that pilot error is also cause of accidents, if flying crew is not fully aware about the helicopter emergency plans during aircraft engine failure as shown in figure 1. Therefore, pilot should have broad safety and technical knowledge before dealing with this risky operation.

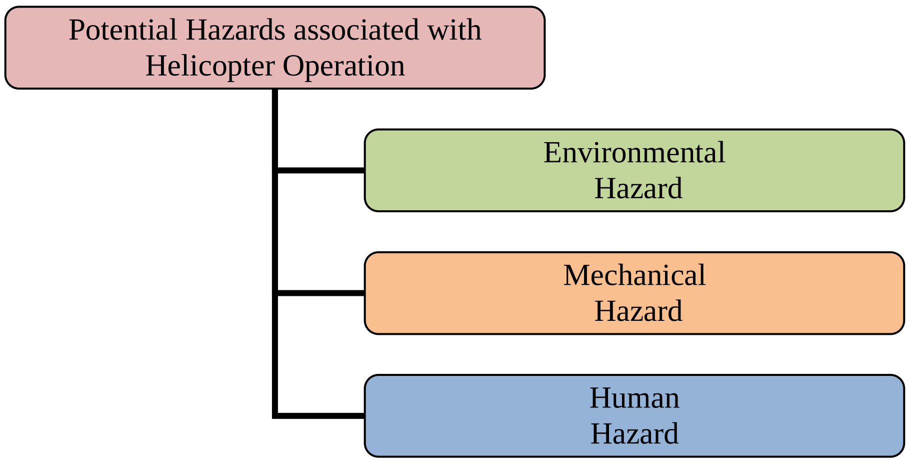

Figure 1. Potential Hazards Associated with Helicopter Operation

7. CONCLUSION

According to overall fining and results, health and safety practitioners and oil and gas drilling crew from Malaysian and Saudi Arabian oil and gas industries has been reported helicopter operation as moderately hazardous operation at offshore drilling sites with mean score 3.48 from Malaysian and 3.43 from Saudi Arabian offshore domain.

Similarly, the participants from both targeted countries have point of agreement on environmental such as heavy wind and bad weather which can disturb the helicopter operation badly. Also, respondents indicated mechanical hazards such as derrick structural problem or damage as a big threat for property and workers lives. Lastly, study respondents also highlighted pilot error as major cause of accidents during helicopter operation at offshore oil and gas drilling sites.

8. REFERENCES

1. Division of Quarantine. (2016). *Health information for international travel*. US Dept. of Health, Education, and Welfare, Public Health Service, Center for Disease Control, Bureau of Epidemiology.

2. Skogdalen, J. E., & Vinnem, J. E. (2012). Quantitative risk analysis of oil and gas drilling, using Deepwater Horizon as case study. *Reliability Engineering & System Safety*, *100*, 58-66.

3. Barakat, E. R., Barber, J. C., & Wood, J. (2010, January). Achieving Sustainable Incident-Free Operations Through Managing the Human Factor: A Success Story of Applying E-Colors. In *SPE Annual Technical Conference and Exhibition*. Society of Petroleum Engineers.

4. Rowe, S. J., Howson, D., & Sparkes, P. (2005). Research improving the safety of offshore helicopter operations. *Marine Technology*, *42*(1), 34-42.

5. Lees, F. (2012). *Lees' Loss prevention in the process industries: Hazard identification, assessment and control*. Butterworth-Heinemann.

6. Vinnem, J. E. (2014). *Offshore Risk Assessment vol 2*. London: Springer.

7. Russo, A. (2015). The Importance of Continuous Improvement in Occupational Health and Safety Management and Regulation in the Oil and Gas Industry. *Franklin Business & Law Journal*, *2015*(3).

8. Bennear, L. S. (2015). Offshore Oil and Gas Drilling: A Review of Regulatory Regimes in the United States, United Kingdom, and Norway. *Review of Environmental Economics and Policy*, reu013.

9. Baker, S. P., Shanahan, D. F., Haaland, W., Brady, J. E., & Li, G. (2011). Helicopter crashes related to oil and gas operations in the Gulf of Mexico. *Aviation, space, and environmental medicine*, *82*(9), 885-889.

10. Utvik, T. I. R., & Jahre-Nilsen, C. (2016, April). The Importance of Early Identification of Safety and Sustainability Related Risks in Arctic Oil and Gas Operations. In *SPE International Conference and Exhibition on Health, Safety, Security, Environment, and Social Responsibility*. Society of Petroleum Engineers.

11. Lakhiani, S. D., & Sala, J. B. (2016, April). Addressing the Gaps Between Occupational and Process Safety Culture. In *SPE International Conference and Exhibition on Health, Safety, Security, Environment, and Social Responsibility*. Society of Petroleum Engineers.

12. Landell K. 1997. “Management by Menu.” London:Wiley and Sons Inc.

A CASE STUDY ON THE USE OF DECISION SUPPORT SYSTEM (DSS) IN BANKS

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Abstract: A decision support system (DSS) is a computer program application that analyzes business data and presents it so that users can make business decisions more easily. It is an "informational application" (to distinguish it from an "operational application" that collects the data in the course of normal business operation).Typical information that a decision support application might gather and present would be 1) Comparative sales figures between one week and the next, 2) Projected revenue figures based on new product sales assumptions, 3) The consequences of different decision alternatives, given past experience in a context that is described. This paper describes the use of decision support system in banks. Decision support system serves the management, planning, and operation based on various levels of an organization (usually middle and higher management) and help to make decisions. This paper also discusses how statistical history helps managers in pitching right product for the customer by viewing their past history, income (pay slip for working employees), what their age is, family size, and many other factors that are evaluated by the bank on the basis of what product it wants to pitch to the customer at that time. This paper also performs the two way ANOVA (Analysis of Variance) test at 5% level of significance to analyze the effect of activities performed in banks using DSS on the rate of increase in efficiency. The analysis proof the hypothesis with the downsell activity has the maximum rate of 45%.
Keywords: Anova Analyze, Banks, Customer, Decision, Operational, Product

1. INTRODUCTION

A decision support system may present information graphically and may include an expert system or artificial intelligence. It may be aimed at business executives or some other group of workers. Decision Support system serve the management, planning, and operation based on various levels of an organization (usually middle and higher management) and help to make decisions.

1.1 Components of DSS:

There are three major components of DSS as shown in Figure 1.

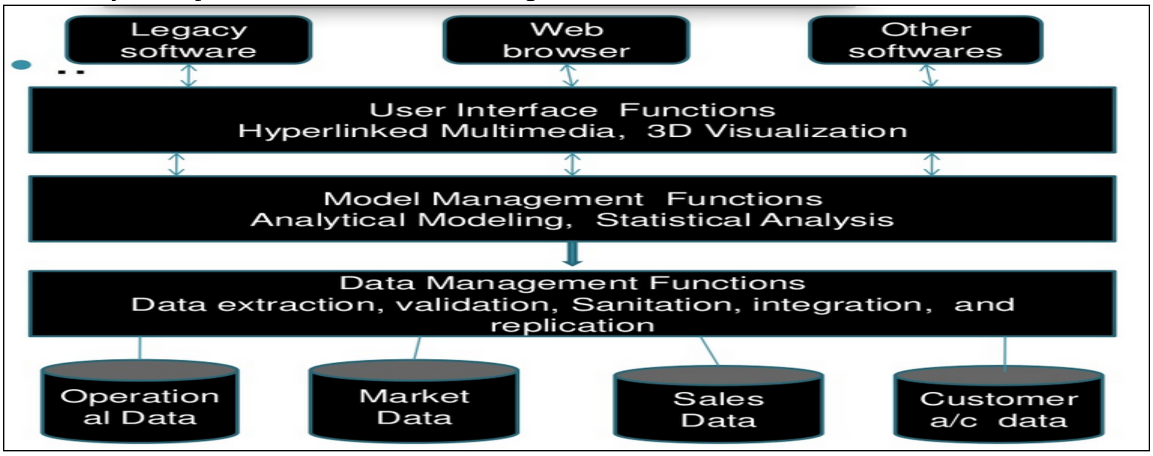

Figure 1. Components of DSS

1.1.1 Data Management Component:

The information required by the DSS is stored and maintained by data management component. The information used by DSS comes from one or any of the three sources as shown in Figure 2.

Organizational information	External information	Personal information
• DSS sometimes uses the information that is available in the organization. • Sometimes DSS database copied the specific information to save searching time.	• DSS sometimes require information from external sources to take decisions	• Incorporations of one's own insight and personal information experience is also possible into the DSS. • It is kept in perosnal database that can only be access by DSS.

Figure 2. Sources of Information for data management component

1.1.2 Model Management Component:

It consist of both the DSS Model management system and decision Support models as shown in Figure 3.

DSS Models	DSS Model Management
• In order to analyze the information in a number of ways, DSS models is used.	• The maintainence and storage of the DSS models is performed. • By the help of DSS model management we can manipulate and create the models in a quick and easy manner although it cannot suggest the best model.

Figure 3. Model Management Component

1.1.3 User Interface Management Component:

The user – DSS interface for communication is facilitated by this component. The stored and processed capabilities of computer are combined with user's know-how with the help of this component.

1.2 DSS Development:

There are usually four phases through which companies develop DSS as shown in Figure 4..

1. Planning
2. Analysis
3. Design
4. Implementation

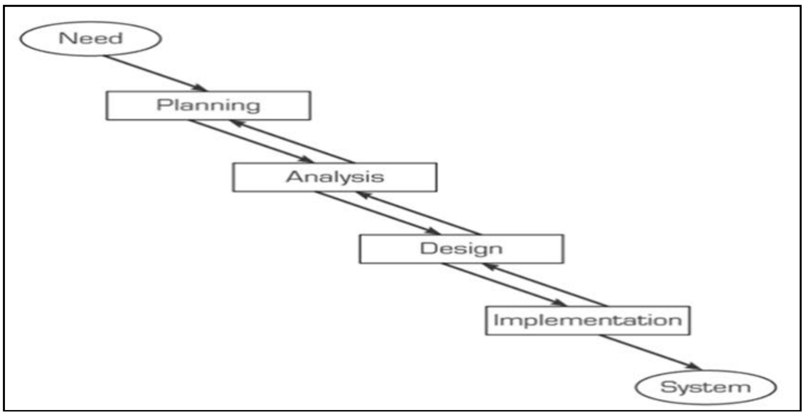

Figure 4. Phases of Development of DSS

1.2.1 Planning:

This phase involves the feasibility context i.e. organization, economic, technique and operation. Moreover the persons involved in this project, how much financial resources are implied for the project and the project deadline is also defined in this phase.

1.2.2 Analysis:

In order to gather, understand and document the requirement of a new system, IT specialist and end users are involved. In this stage the transformation of the physical model to logical model is done.

1.2.3 Design:

Based on the constraints and requirements identified in the previous stage, this phase defines the solution for the proposed system. The design of the system model and the design of the technical architecture is the most essential activities of the phase.

1.2.4 Implementation:

DSS is distributed to the final users in this stage. The activities involved in this phase are the documentation, writing details, program exploitation, functionality testing and integration of modules.

1.3 Alternate way of DSS development:
Now there are very few companies that who make DSS system that is customized for them. Usually companies PROTOTYPE DSS systems from various companies and adopt there models to minimize their own costs as shown in Figure 5. Therefore majority of the companies do not share their system info with other companies and keep all records as secret. Some ways are;

1. Rapid development of portions of project for user by just defining input and modifications
2. Small working model or may become functional part of final system
3. Some do pilot testing to develop platform

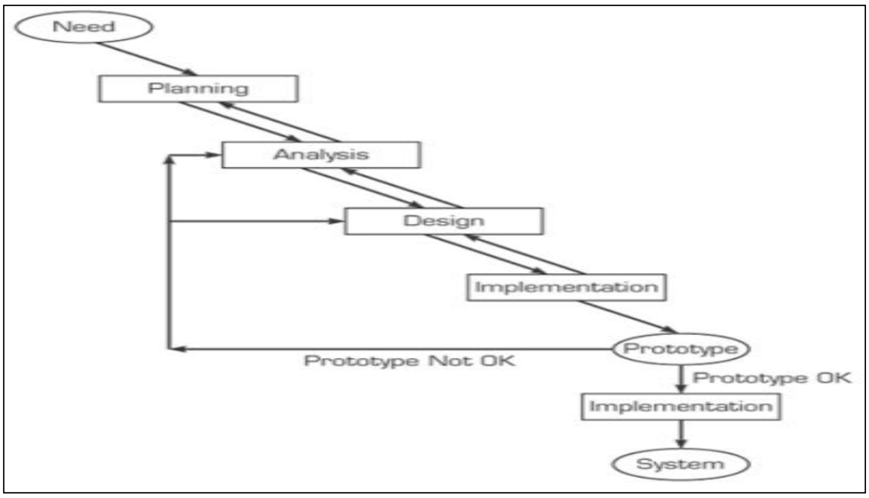

Figure 5. Alternate way of development of DSS using Prototype

2. RELATED WORK

Three possible decision support methods are considered methods are considered for the cyber securing investment challenge. Game theory, combinatorial optimization are the combination of the above two strategies are considered. A decision support tool was built along with the current govt. guidelines to compare these approaches (Fielder et.al, 2016). Theoretic foundations of Decision Support system has been investigated (Arnott et.al, 2004). DSS research that is relevant professionally is focused in this paper. It concluded that in decision making and judgement, the published DSS research is poorly grounded and the most influential judgement is the work of Herbert Simon. The DSS proposed (Conejar et.al, 2014) is capable of suggesting comprehensive set of recommendations based on the estimation of health situation and diagnosis. The proposed DSS for health care can be applied at any place, any time and in any hospital and it helped the doctors and clinicians to explore the medical knowledge and to familiarize with the new methods of prescription. Detailed analysis of 1020 DSS articles is the basis of the investigation (Arnott, et.al, 2005). All articles considered are published in 14 major journals from 1990 to 2003. The most web dominate research in this field is of personal DSS and group support system. The poorly grounded area in research is the client and users identification for various DSS application. It also suggested some improvement for DSS research. The development of clinical DSS and its impact on clinical guideline adherence was described (Antonio et.al, 2014). About 16-35% increment in guideline adherence is found out which in turn improved the quality of health care. Likewise an attempt was made to find and analyze the relevant parameters for development of DSS framework in Indian banking sector. It is a useful study for the person engaged in development and design of DSS. It concluded that for better management and planning, the need of DSS is very important. For development of efficient and effective DSS, the capabilities and user skills should be focused at maximum (Bhatia, 2011). In order to achieve marketing creativity, the investigation as aimed for the use of DSS in commercial banks. The questionnaire was distributed among the commercial banks operated in Jordan (Hashem, 2016). The author concluded that for achieving the higher marketing creativity, there is a need to focus on the development of DSS in an efficient way. The design of OLAP and data mining strengths which link up the DSS of banking sector is proposed. The author focused on the working of proposed model for improving the efficiency. It concluded that within the fraction of second, the large amount of data can be search vastly using OLAP cube. It can also work for solving banking related queries (Mathur et.al, 2016). Bank sealer, a DSS was proposed for online banking fraud analysis and investigation (Carminati et.al, 2015). Firstly, with respect to the customer profile the anomaly of each transaction is quantified. Secondly, it search for the customers with the similar spending habits, globally and in last, a temporal threshold system was used to find out the current spending pattern of each customer with the past spending behavior. The system ranked with up to 4 mins daily computation time and 98% detection rate. Analysis of loan price differentiation impact on the behavior of potential borrowers of banks for consumer lending in the market is carried out. Based on the use of continuous loan price function, a DSS is proposed. It concluded that fuzzy logic has a potential to be applied in a DSS system based on the continuous price function (Romanyuk, 2015).

3. DSS USED IN BANKS

Statistical history helps RM in pitching right product for the customer by viewing their past history, income (pay slip for working employees), what their age is, family size, and many other factors that are evaluated by the bank on the basis of what product it wants to pitch to the customer at that time. These factors vary and depend from case to case.

3.1 Upsell:

To whom the bank will try to sell the credit cards
If any person has 25,000+ income and has been working for at least 6 months, and has a permanent job then he is entitled to get a simple Master Visa Credit Card the limit of which will depend on his salary.
CRM will evaluate the bank balance of all his customers and then refer those clients to the Credit Card department who he feels meet the criteria of being given a credit card
If a customer is a priority customer then he is entitled to get titanium or platinum card and the limit of that can reach up to a maximum of Rs 3Million CRM will evaluate the bank balance of all his Priority Customers and then refer those clients to the Credit Card department who he feels meet the criteria of being given a credit card and the limit of it will be based on how much the income of the customer is, what balance he maintains with the bank, and many other factors.

3.2 Downsell:

If a customer keeps a balance of Rs 5MN for more than 3-4 months, then he will automatically be upgraded to priority, and vice versa as well, but if you fail to maintain the minimum Rs 5MN with the bank for 1 year, then you will be downgraded, and your facilities will be reduced accordingly. You will be made a normal customer then and your status changed from Priority Customer. It is the job of the Customer Relationship Manager and Relationship Manager that they regularly evaluate the accounts that they are monitoring and if any client needs to be upgraded or downgraded, they send a request to the IT department which then changes the status of the customer accordingly.

3.3 Crosssell:

To whom the bank will try to give car loans.
If any person has income greater than 60,000 and has been working for at least 12 months, and has a permanent job then he is entitled to get a simple car loan the limit of which will depend on his salary
CRM will evaluate the bank balance of all his customers and then refer those clients to the Car Loan department who he feels meet the criteria of being given a Car Loan. All the factors will be evaluated, and if it is found that he meets those, he will be approached to take a car loan from SCB.

3.4 Bank Branch Target:

The target that is set for all the branches is on the basis of DSS. This is a very detailed process and involves a lot of various calculations that include the neighborhood, how many families live there, potential that exists amongst the customers, other banks that exist in the neighborhood and many other factors. The target for every branch as a result varies and each branch is given a monthly target by the head office. If for the first month, the target is Rs 1 Million, so for the next month the target will be Rs 1.5 Million and so on for all the following months. At the end of the year, all these budgeted amounts will be totaled and the forecasted figures for all the branches be generated in this way. This future forecast is done by senior to middle management who is based in head office for all the branches that exist of the SCB bank in all of Pakistan. This is a very complex process and the bank people refused to share any data about it, terming it as very confidential and saying they would be fired if they gave us these figures.

3.5 Red Flag:

It is state bank policy that each and every bank has to have complete knowledge about his clients before opening and account. Therefore banks are bound to confirm all possible information about clients from their pay slip to their home address. Nowadays banks ask for references before opening account.
All this exercise is done by state bank because state banks want to monitor each account and know that the money deposited is not earned my illegal means.
Red Flag is a term used in banks that gives intimation to bank if any clients balance exceeds its limit mentioned in account opening form. For e.g. if a client’s salary is Rs60, 000/- a month then his average balance would be Rs300,000/-. And suddenly if he transfers Rs4, 000,000/- in his account which not possible for a person whose salary is Rs60,000/-
So in that case the Customer Repetitive who brought that account o the branch will be asked to make sure from where this customer got that amount. The customer has to prove that he got it from legal means e.g. he sold his property, in that case Customer Relationship Officers will ask for a copy of sale deed to give as a prove of ownership of property. Later on this sale deed will be submitted to state bank to comply with statutory requirement; otherwise state bank has a right to cease

that person's account. This entire intimation thing is done my DSS which makes Customer representatives easy to monitor each account.

4. RESEARCH METHODOLOGY

The experimental framework presented in this paper for analysis of effect of activities performed in banks using DSS and rate of increase in efficiency is divided into two stages:

1. Data Collection Method
2. Two way Analysis of Variance (ANOVA) on Minitab.

4.1 Data Collection Method:

4.1.1 Research Design:
A descriptive research using survey questionnaire is conducted in order to find the effect of activities using DSS on rate of increase in efficiency.
4.1.2 Corpus for Data Collection:
A survey questionnaire was circulated via email in IT department of 3 selected banks in Karachi. The research is based on primary data. The questionnaire was structured and based on the questions regarding the above mentioned scenario. The respondents were asked to tell the activities and rate of increase in efficiency of those activities using DSS as shown in Table 1.

Table 1. Response of Questionnaire

Activities Performed	Rate of increase in efficiency of activities (%) using DSS		
	Bank 1	Bank 2	Bank 3
Upsell	30	50	40
Down sell	40	35	60
Cross sell	15	20	35
Bank Branch Target	45	35	50
Red Flag	20	25	45

4.1.3 Sample Size:
The sampling unit is the banks. The total sample size was individuals from IT department of 3 banks head offices in Karachi. The respondent answers were analyzed on Minitab.
4.1.4 Research Hypothesis:
The hypothesis formulated is as follows:
Null Hypothesis (H_o) : The effect of activities performed in banks using DSS on rate of increase in efficiency is statistically significant.
Alternate Hypothesis (H1): The effect of activities performed in banks on rate of increase in efficiency is not statistically significant.

4.2 Two way ANOVA testing:

Two-way Analysis of Variance (ANOVA) testing is used to determine the significant effect of activities performed in banks using DSS on the rate in increase of efficiency of activities. The influence of the independent variables on dependent variable is examined by using Two way Analysis of Variance (ANOVA). It not only examined the main effect of each independent variable but also the interaction between them if exist.
The general model of equation of Two way ANOVA is represented in (1).

$$\mu+\alpha_i+\beta_u+(\alpha\beta)_{iu} \text{---} (1)$$

Where,
$_i$=1, 2……………….n,
$_u$=1, 2,…………….m = Independent factor, consider as activities
μ= Constant value
α_i = Main effect of first factor, considered as activities,
β_u = Main effect of second factor, consider as rate of increase in efficiency
$\alpha\beta_{iu}$ = Two factor interaction effect.

The following preliminaries are defined in two way ANOVA testing:
4.2.1 Degree of freedom (DF): the number of values in the final calculation of ANOVA that are free to vary is called degree of freedom. It is the number by which a dynamic system can move in independent way without violating any constraint imposed on it.
4.2.2 Adjusted Sum of Squares (Adj SS): It is the measure of variation from the mean. In ANOVA, the total variation that can be attributed to various factors is expressed by sum of squares.

4.2.3Adjusted Mean Squares (Adj MS): dividing the sum of squares value by corresponding degree of freedom yields the mean squares value. It is used to determine whether factors have significant effect or not.
4.2.4 F-value: The ratio of the two mean squares is called F-value. This value is close to 1 most of the time, if the null hypothesis is true. It determines whether the particular factor is significant or not.
4.2.5 P-value: Each F-value corresponds to a particular Pvalue. The cut off point for the alpha level of significance is usually represented by the critical value i.e. 0.05 and it is the p-value associated with certain F-statistics. If P-value is less than 0.05 then factor has significant effect.
4.2.6 R-square value: The closeness of data to the fitted regression line determines statistically R-square value.
4.2.7 R-square (adjusted): According to the number of preedictors in model the value of R-square is adjusted.
Table 2 shows the two way ANOVA statistics from Minitab.

Table 2. Anova Statistics

Sources	DF	Adj SS	Adj MS	F	P
Activities	4	1040.00	260.00	4.08	0.043
Bank	2	723.33	361.67	5.67	0.029
Error	8	510.00	63.750		
Total	14	2273.33			
S= 7.984 R-sq=77.57% R-sq(adj)= 60.74%					

5. RESULTS

From Table 2, it is clear that the P value is less than level of significance (α) so as P value< α, the activities using DSS has significant effect on the rate of increase in efficiency and with respect to the bank it is also significant. The residual plots shown in Figure 6. Shows that:

1) The values of rate of increase in efficiency are normally distributed, although there are some outliers “normal probablity plot of residuals”.
2) The residuals are divergent from the mean value in “residual versus the fitted values” graph, indicates that the rate of increase in effcieincy has constant variance.
3) The residuals are dependent on each other as they are showing a specific pattern in “residuals versus the order of data”.

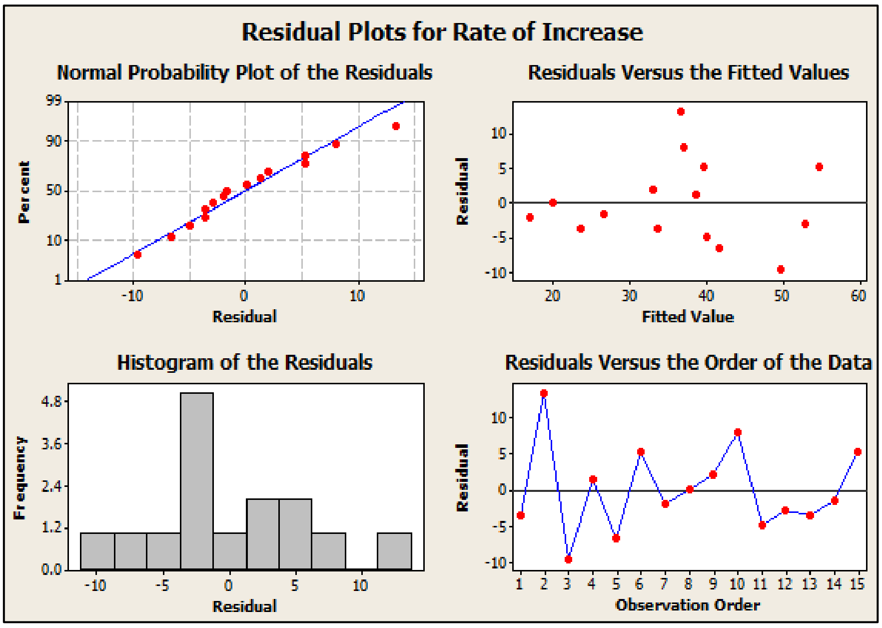

Figure 6. Residual Plots for rate of increase in efficiency

The main effect plots are shown in Figure 7. It is shown that:

1) In main effect plot of activities, the downsell activity has the maximum effect in rate of increase in efficiency i.e. about 45%
2) In main effect plot of banks, the bank 3 has shown the maximum efficiency of 47%.

The interaction plot is shown in Figure 8. It is clear that downsell and bank branch target activity has maximum and only interaction in Bank 2.

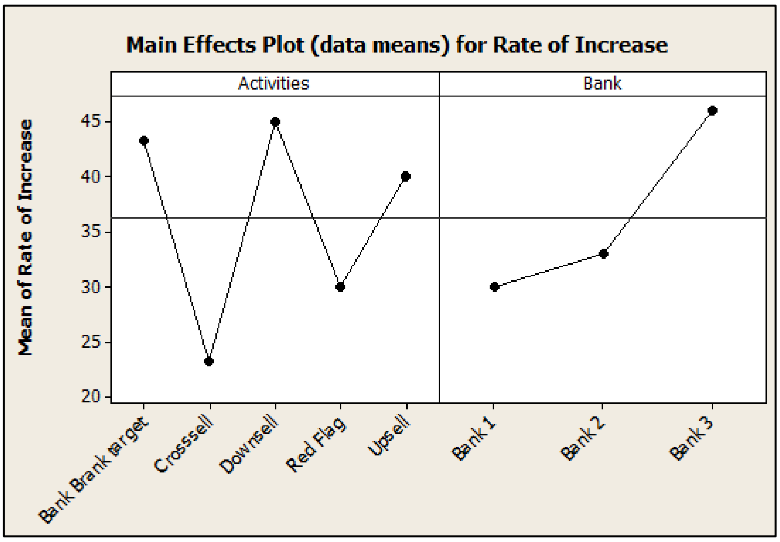

Figure 7. Main Effect Plot of Rate of Increase in efficiency with respect to activities and banks

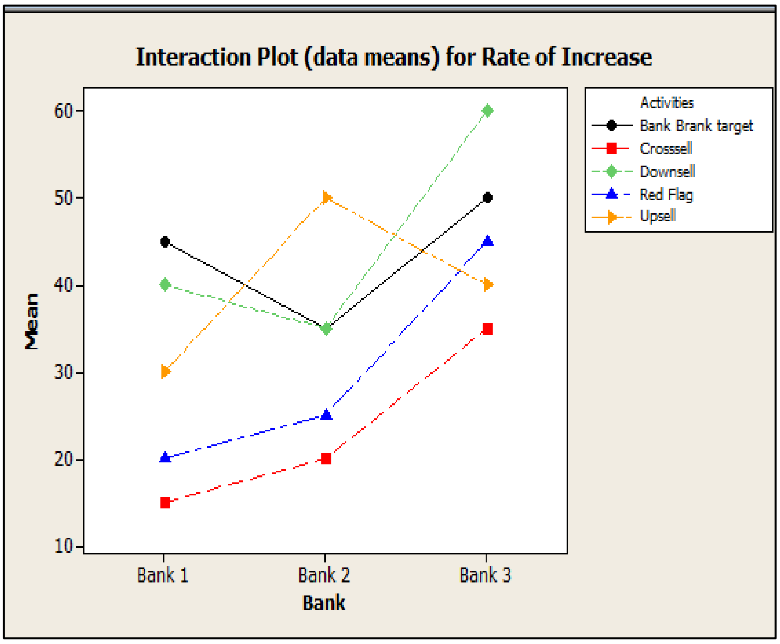

Figure 8. Interaction Plot of Rate of Increase

6. CONCLUSION

A case study on the use of Decision Support system (DSS) is presented in this paper. Our three observed mainly banks has only headquarters DSS practice with authority, but branches have no authority for DSS. So, Banks should consider DSS department of every branch. Employee engagement needs to be properly designed in order to feed a large number of customers retaining satisfaction at the same time. Customer satisfaction survey must be made before applying DSS. Training scheme should be build up for employee management. Only not to employee but also to customers to introduce those to the new technology and system and services to acquire profit easily. The Anova Statistics is also discussed in this paper which shows that the activities performed using DSS has significant effect on the rate of increase in efficiency. Downsell activity has the maximum 45% increase in efficiency.

7. REFERENCES

1. Fielder,A. , Panaousis, E., Malacaria, P., Hankin, C. and Smeraldi, F. (2016). Decision Support System approaches for cyber security investment. *Decision support System, Elsevier,* 86, pp. 13-23.
2. Arnoth, D., Pervan, G., Donnell, P.O.,and Dodsorrn, G. (2004), "An analysis of Decision Support systems Research, Preliminary Results", *Journal of Information Technology,* pp. 25-38.
3. Conejar, R.J and KonKim, H.,(2014), "A Medical Decision support System for ubiquitous healthcare diagonosis system", *International Journal of Software E ngineering and its application,* 8(10), pp. 237-244.
4. Arnott, D and Pervan,G., (2005) "A critical analysis of Decision Support System Research", *Journal of information Technology,* 20, pp. 67-87.
5. Antonio, M.,Rodrigues, F., Santos, N.D., Tygesen,H., Eriksson,H,Herlitz,J.,(2014), "Clinical Decision support system (CDSS)- effects on care quality", *International journal of Healthcare Quality Assurance,* 27(8),pp. 707-718.
6. Bhatia, Dr. A., (2011) ,"A framework for Decision Support system for the banking sector- An emperical study of state bank of Patialia", *International Journal of Computer Technology and Applicatuions,* 2(5), pp. 1368-1378.
7. Hashem, Dr, T.N,(2016), "Commercial banks use of decision support system to achieve marketing creativity", *International Review of Management and Business Research,* pp. 1059-1067.
8. Mathur, Dr. A, Mathur, N. (2016), "Design of OLAP cube for banking system of India", *International Journal of Computer trends and Technology,* 35, pp. 154-156.
9. Carminati, M. et.al, (2015), "Banksealer: A decision support system for online banking fraud analysis and investigation", *Computer and Security,* pp.1-12.
10. Romanyuk, K. , (2015) " Concept of a DSS for a loan granting based on Continuous Price function" ,*Proceedings of the conference of SAI intelligent system conference,*London, UK, pp. 105-111

Leveraging Six Sigma in gaining process excellence by reducing MIG Welding defects through Process Optimization in Automotive Industry

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Abstract: Six sigma is a breakthrough methodology, it can lead to business and quality excellence. It is a philosophy which enables processes to produce defect free products. A multi-national automotive company was facing increased operational cost, low quality, and increased lead time due to high defect rate in MIG Welding. This paper presents an empirical study about the implementation of six sigma DMAIC methodology in MIG Welding facility of Distributors in that HVAC manufacturing plant. Critical factors were identified and analyzed through cause and effect diagram and hypothesis testing. Fitted linear model was used to identify optimal setting of process parameters. After-effects of project reduced the defect rate up to 25% operations cost by US $ 0.8 Million, and a Customized sigma level from 2 to 4 sigma. Study will entitle Six Sigma enthusiastic and researchers to better understand and apply six sigma tools and techniques to achieve process excellence.

Key Words: MIG Welding, Six Sigma Process, Excellence, Cause and Effect Diagram, Hypothesis Testing, DMAIC**,** Fitted Linear Model.

1. INTRODUCTION

In competitive and fast growing market, organization are looking for the ways to improve their business process in order to stay in competition and win a delightful customer stream. In this regard, six sigma has been a key methodology which has not only attracted the world-classes business giants to adopt this business excellence methodology, but also the researchers to fulfill their quest for knowledge.

Six sigma is a highly structured process which focuses on manufacturing nearly perfect products and services with great stability. Since the development of six sigma business excellence methodology (1999), it is defined as, "a business excellence methodology that focuses on elimination of variations or defects in any business process focusing on the outputs which are vital for customer". [11]. Sigma σ, is a Greek alphabet which is used by the statisticians in order to measure variability in any business process. An organizations process is analyzed by the sigma level at which its business processes are operating [10]. Six sigma came into its existence by Bill Smith at Motorola in 1980s and it achieved a difficult target of gaining 3.4 defects per million defects [1]. Six sigma achieved its excellence in improving business process in 1995, when General Electric Co applied it in its business processes. Six sigma application was firstly limited to the manufacturing sector but in the recent era its application has covered almost every department and every sector of any organization aiming at diminishing the variations which are the real devils in any process [6].

Most common perception when talking about six sigma methodology is DMAIC methodology. DMAIC methodology is used when existing processes are not clinching the customer specifications. There are two six sigma methodologies, one which focuses on process improvements is well known as DMAIC (define, measure, analyze, improve and control). The other one targets the robust design ameliorations is defined as DFSS (design for six sigma). Originally developed business improvement strategy was DMAIC. DMADV (define, measure, analyze, design, verify) was instituted by

General Electric. There are various strategies which are used in use besides DMAIC and DMADV such as IDOV (identify, design, optimize and validate) and DIDES (define, initiate, design, execute and sustain) [2].

When most people talk about the Six Sigma, they are thinking about the DMAIC methodology. This method is used for improving an existing process when it is not meeting customer needs. There are basically two methodologies in practice for Six Sigma improvement strategy. The process improvement technique is popularly known as DMAIC (define-measure-analyze-improve-control) and another one aiming for design improvement is known as DFSS (design for Six Sigma). The original problem solving process for Six Sigma developed by Motorola was MAIC. Later, DMAIC instead of MAIC was advocated by GE where D stands for “definition”. For DFSS methodology, there are different approaches in use such as DMADV (define-measure-analyze-design-verify), IDOV (identify-design-optimize-validate) and DIDES (define-initiate-design-execute-sustain).

2. LITERATURE REVIEW

A literature review was undertaken with an objective of identifying the past history of various improvement initiatives carried out to address process-related problems. A detailed literature review was undertaken in Six Sigma with an objective of identifying the type of improvements carried out by different people in various organizations to address process-related problems.

Shashank Soni, Ravindra Mohan, Lokesh Bajpai and S K Katare in (2013) study on “reduction of welding defects using six sigma techniques” and found that Systematic application of six sigma DMAIC tools and methodology within an automotive parts production results with several achievements.

The achieved results are:

- Reduced possibility of failure.
- Reduced costs of poor quality (CORQ).
- Reduced labors expenses.
- Improved customer satisfaction.
- Closure of potential failure mode.

Also, the significant results are achieved by two indexes that are not dependent on the volume of production:

- Production time reduction.
- Index cost/volume reduction. [8]

Yousaf, F. and Ikramullah Butt (2013) work on “Reduction in Repair rate of Welding Processes by Determination & Controlling of Critical KPIVs” and found that SMAW process has improved from 3.3 sigma to 4.3 sigma which has also improved combined Sigma Value of overall Facility from 4.0 to 4.3 sigma Level. [5]

Jayakumar Narasimhan and Erick C. Jones (2004) “Reduction of variation in a Welding Process using Operational Six Sigma Methodology” A new statistical Process Control (SPC) was proposed to improve the existing system. The disadvantages of this system were;

- The occurrence of defective part lead to scraping the whole batch.
- There was no standard procedure to rectify the problem when it occurs.
- The sample testing procedure is destructive in nature and the tested components cannot be used further. [3]

Thakar SinghP, Dinesh Kumar, Pradeshi Ram (2015) a Case Study “An Implementation Of Six-Sigma In Steel Tube Welding.” The theoretical result of steel tube welding with Six-Sigma technique, and use of nitrogen gas and changes the welding pressure then increase strip thickness, and reduce welding speed to increased yield stress and tensile stress check the mechanical properties tube strength (yield stress and tensile stress) but maximum optimization result show in thickness v/s yield stress and tensile stress (yield=350Mpa, tensile stress=417Mpa) in graph to solve the steel tube welding leakage problem at the flow of fluid in the steel tube, improve customer satisfaction. [9]

Mr. Mahesh S. Shinde, Dr. K. H. Inamdar (2014) work on “Reduction In TIG Welding Defects For Productivity Improvement Using Six Sigma” and a result The TIG welding process on MDN 250 material is analyzed and the expected failures are noted. From the analysis it is found that Lack of Fusion is the most risky defect in TIG welding with MDN 250 materials and improper shielding is also a serious issue while welding. The Root causes, effects and the preventive measures of all the possible failures are given along with the priorities. This analysis will be very much useful as a reference guide of TIG welding MDN 250 material failures. The integrated approach of RCA with FMEA serves as a better way to maintain the work piece defect free. [4]

Mahesh S. Shinde, Dr. K. H. Inamdar (2014) “Improving TIG Welding Quality using DMAIC” Defect ratio after six sigma implementation calculated as 0.5 % This Defect ratio is transformed to Sigma level as follows:

Yield = 100- Defective ratio = 100 - 0.5 = 99.5%

Sigma level after implementation =φ-1(0.995) + 1.5 = 3.5

The results indicated that, for the year of 2012-13 the calculated Defect ratio 1.1% and yield was 98.9%, from this yield, the sigma level was calculated and found to be 2.98.

Using the company's target of 0.4% defect ratio, the target sigma level was calculated to be 3.7 and as per design yield of 99.6% as mentioned earlier. After applying Six Sigma methodology the yield after the improvement efforts reached 99.5% corresponding to a sigma level of 3.5. [7]

3. DMAIC METHODOLOGY

Define phase includes Business case, problem statement, scope and objective of Study. Measure phase is about measurement of current situation by collecting data relevant to both process and problem. Analyze the problem by cause and effect in order to segregate the vital few input variables. Improve phase develop countermeasures i.e. by optimizing the key input variables. Control phase is about sustainability of improvements by building robust process controls. All this study includes Aluminum material which is used in manufacturing of distributors in HVAC.

3.1. Define Phase

Define phase includes problem statement, business case, project selection, drawing assumption about the potential key performance indicators, scope of the project. All the assumptions were based upon historical data.

<table>
<tr><td>PROJECT TITLE:</td><td colspan="5">Leveraging Six Sigma in gaining process excellence by reducing MIG Welding defects through Process Optimization.</td></tr>
<tr><td>BUSINESS CASE:</td><td colspan="5">From (Dec2015 to 1st Week of March 2016) due to high defect rate company faces loss of revenue, customer satisfaction and reputation. High defect rate resulted into an average loss of US $2 million monthly (Total number of defects*Total time of repaire*Piece rate). By lowering the defect rate upto 30% we can save upto US $0.8 million Per month.</td></tr>
<tr><td>PROBLEM STATEMENT:</td><td colspan="5">Defect rate in the MIG welding of distributor in Condenser Assembly in a renowned HVAC Manufacturing organization was very high. Penetration of MIG welding joints into the distributors and Large Spatters on the Distribuor surface resluted in huge reworking and defective product in most scenarios.</td></tr>
<tr><td>OBJECTIVE:</td><td colspan="5">Reducing defect rate upto 30% of total defect rate.</td></tr>
<tr><td>METRICS:</td><td colspan="5">Primary Metric Defect Rate= Total defects/ total inspected*100
Secondary Metric= Productivity</td></tr>
<tr><td>PROJECT SCOPE:</td><td colspan="5">MIG Welding of distributors in Automobile HVAC Manufacturing</td></tr>
<tr><td>PROJECT TEAM:</td><td colspan="5">Amar Abbas, Gohar Ali, Sibtain Abbas, Munir Ahmed</td></tr>
<tr><td rowspan="2">MILESTONE LIST:</td><td>Define Phase</td><td>Measure Phase</td><td>Analyze Phase</td><td>Improve Phase</td><td>Control Phase</td></tr>
<tr><td>2nd Feb 2016</td><td>16th Mar 2016</td><td>24th April 2016</td><td>30th May 2016</td><td>6th July 2016</td></tr>
</table>

Table 1. Project Charter

3.2 Measure Phase

The vital function of measure phase to efficiently measure the current performance of business processes and begin assessing it. For better understanding the current situation process mapping was used (Figure 2. SIPOC diagram).

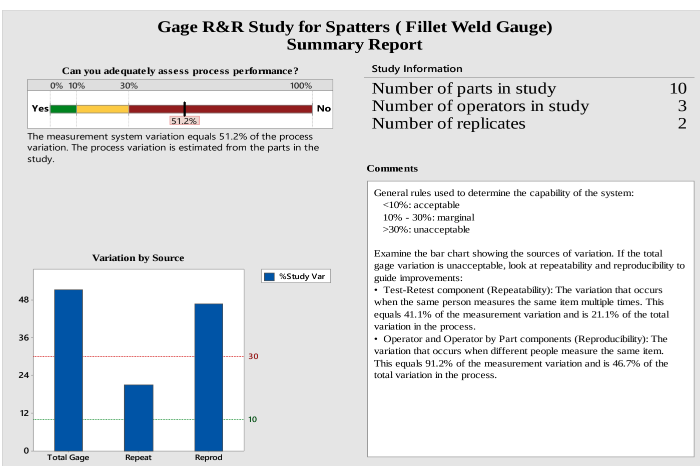
To measure whether or not our measurement system is capable in assessing process performance or evaluating potential process improvements gauge R& R Study (Figure 3. Gauge R&R Study) was conducted. By looking at the Results. It can easily be concluded that our measurement system is not capable. Total gauge variation is greater than general standard and so doe's reproducibility (Figure 3. Gage R&R Study).

Process Capability was measured by taking 50 different samples of defects and performing Poisson process capability analysis. TEST 1. One point more than 3.00 standard deviations from center line. Test Failed at points: 17, 18, and 19(Figure 4.Poissions process capability analysis).Pareto Analysis shows Spatters and Welding Penetration contributed almost 80% of total defects that's why they were targeted to get bigger financial impacts (Figure 5. Cause and Effect Diagram).

Cause and Effect Diagram identified the potential causes of MIG Welding process defects by using brainstorming.Through Expert Judgement and concensuses between team voltage, current, flow rate of gas and angle of the MIG welding gun were finalized for further analyses (Figure 6. Casue and Effect Diagram).

Supplier	Input	Process	Output	Customer
W.H Supplies CKD to MIG Welding	Welding Jigs	Setting jigs on Workstation	Jig Setting	Mounting of CKD on Jig
Jig Station	Distributor A & B	Clamping of Jigs on Distributor	Distributor Clamping	Setting of D-Brackets on Jigs
D-Bracket Supply	Distributor Brackets	Setting distributor Brackets on Jig	Bracket Clamping	Gun Positioning for MIG Welding
Bracket Clamping	MIG Welding Gun	Gun –Preposition	Gun prepositioning for Welding	MIG Welding
Gun Pre-Positioning	Gun Angle Setting	MIG Welding Spatters A & B	Welding of Distributor A&B	MFC Assembly

Table 2. SIPOC Diagram



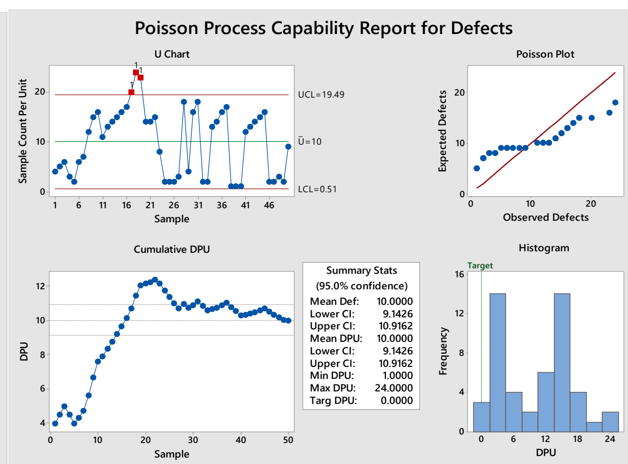
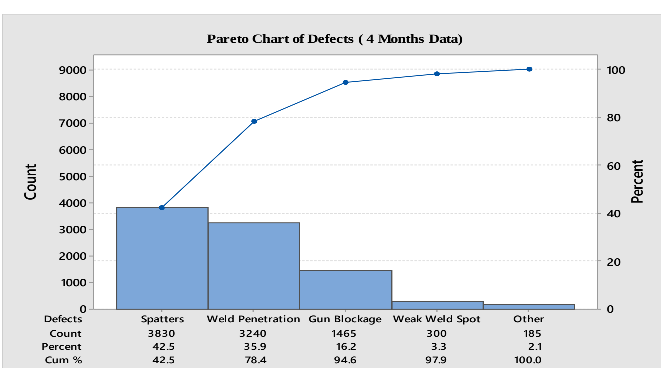


Figure 1. Gage R &R Study

Figure 2. Poisson Process capability Analysis



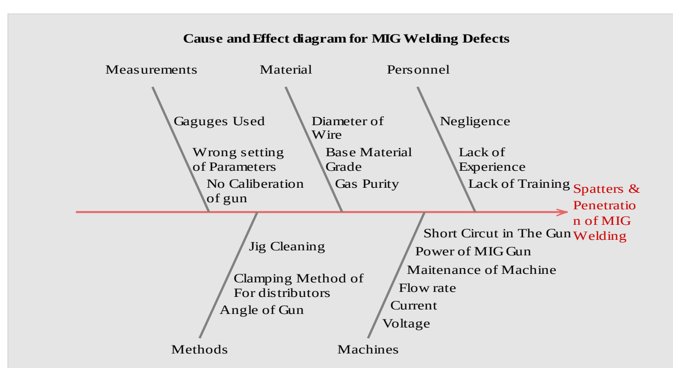


Figure 3. Pareto Analysis

Figure 4. Cause and Effect Diagram

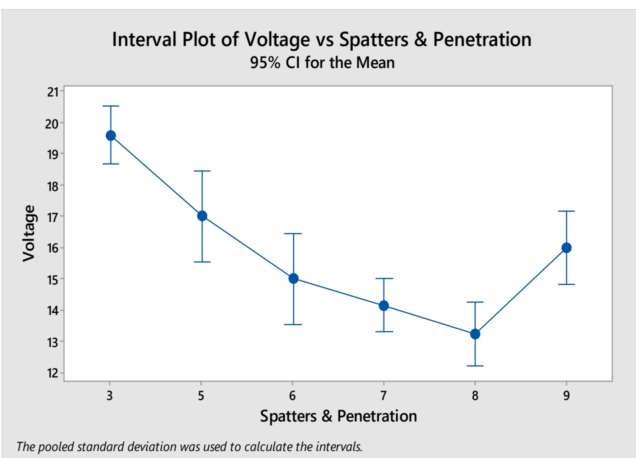
3.2.1 Sigma Level Calculation

Total Defects= 9020, Total Inspected= 27000, Opportunity per unit= 1, Total No of Defect Opportunity= 27000
DPU (Defects/unit) = Total Defects/ Total Produced = 9020/27000 =0.334 (1)
DPO (Defects per opportunity) = Total Defects/ Total Produced*No of opportunities of defect (2)
=0.334
Yield= 1-DPO = 1-0.334 = 0.67 (3)
DPMO= DPO*1000000 = 340000 (4)
Sigma Level = 2

3.3 Analyze Phase

One way Annova is used to check whether two groups are different or not, which group is best. Analysis of variance was used to indicate the whether different settings of voltage, current, flow rate and angle of MIG welding have significant effect on the Spatters creation or not.

Data was collected by using different voltages and keeping all three factors constant. Null hypothesis was all means are equal while alternative hypothesis was at least one mean is different. Significance level was $\alpha = 0.05$. Equal variances were assumed for the analysis. There were 6 Subgroups levels of Voltage and there values were 3, 5, 6, 7, 8, and 9. P-value< 0.05 which shows factor is significant. Also the mean value of spatters created is different at different levels of voltage making it significant (Interval Plot).



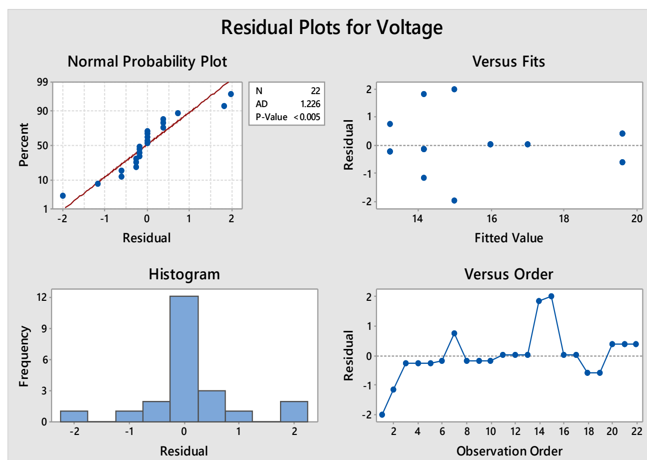
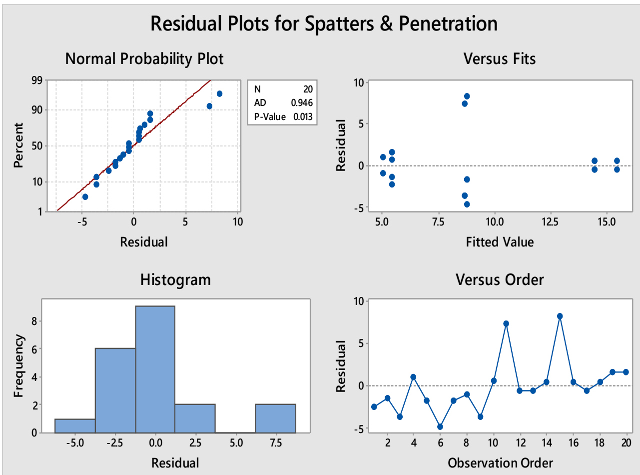


Figure 5. Analysis of variance (Interval Plot)

Figure 6. Analysis of Variance (Residual Plot)

Analysis of variance for flow rate of argon gas was performed. In analysis for flow rate of gas was varied keeping all other factors constant. There was large difference between the mean values of spatters created (Box and Interval Plot). Also P-value < 0.05 shows that our null hypothesis is rejected. This factor was also significant. Null hypothesis assumed that all means are equal while alternative hypothesis was assumed that at least one mean is different. Significance level was $\alpha = 0.05$. Equal variances were assumed for the analysis. Factor Information includes total levels were 6 and their value were random 15, 16, 17, 18, 19, 20. Analysis of Variance shows p-value 0.014 which is <0.05 making the factor significant.



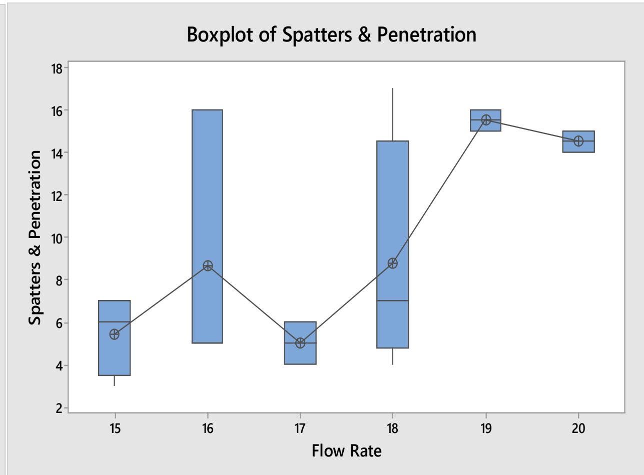
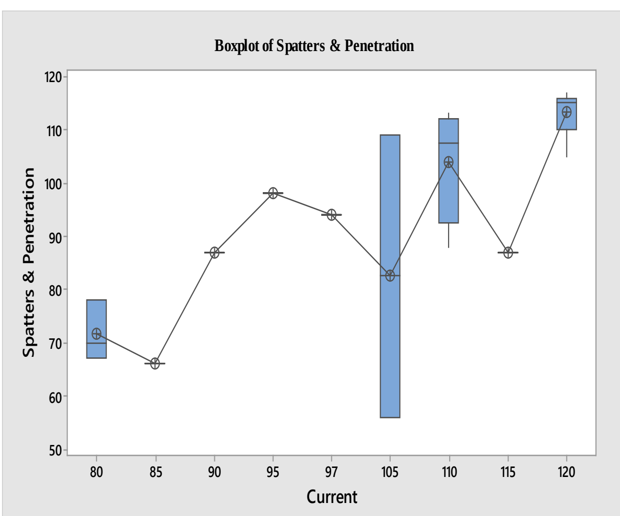


Figure 7. Analysis of Variance (Box Plot)

Figure 8. Analysis of Variance (Residual Plot)

One way Annova current vs spatters was conducted at different setting of current keeping all other three factors constant. Box plot & Interval plot showed a large difference in mean value of Spatters created. Also the P-Value=0.027 is for current after analysis of data in Mini-tab. P-value <0.05 shows that there is significant effect of current on spatters creation which is needed to be optimized in order to reduce defects.

Null hypothesis was that all means are equal while alternative hypothesis was at least one mean is different Significance level was α = 0.05. Equal variances were assumed for the analysis. Total random levels for current Were 9 and their values were 80, 85, 90, 95, 97, 105, 110, 115, 120. After Analysis of variance p-value was 0.027.



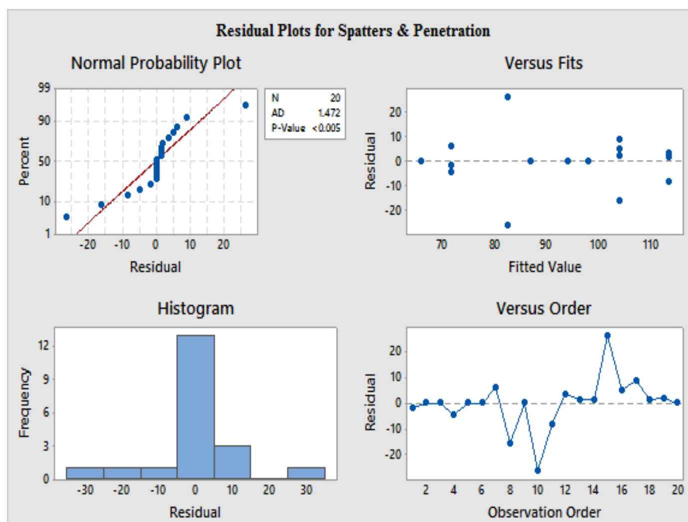


Figure 9. Analysis of Variance (Box-Plot)

Figure 10. Analysis of variance (Residual Plot)

Analysis of variance angle of MIG welding gun was performed in Mini-tab. Angle of gun was varied and data was collected keeping all other three factors at constant value. P-Value<0.05 at different levels of gun angle depicts that's this factor is significant. Null hypothesis assumed that all means are equal while alternative hypothesis was that at least one mean is different. Significance level was α = 0.05. Equal variances were assumed for the analysis. Total level of variable was 3 and their values were 45, 60, and 90. Analysis of Variance showed in Minitab was 0.041 which is less than 0.05 making factor significant.

3.4 Improve Phase

All the significant factors were optimized through 2k Factorial design and fitted linear model for optimization of process parameters. After designing the experimental runs and measuring the output variable by using fillet weld gauge. The output was measured in no of spatters on a distributor which are above the acceptable thickness 1 cm. Further to find out optimal settings of parameters Fitted linear modle was used.

StdOrder	RunOrder	CenterPt	Blocks	Current	Voltage	Flow Rate	Angle	No of Spatters
1	1	1	1	80	13	22	45	8
18	2	0	1	140	19	23.5	52.5	7
5	3	1	1	80	13	25	45	9
12	4	1	1	200	25	22	60	10
19	5	0	1	140	19	23.5	52.5	11
17	6	0	1	140	19	23.5	52.5	12
14	7	1	1	200	13	25	60	13
16	8	1	1	200	25	25	60	14
13	9	1	1	80	13	25	60	16
2	10	1	1	200	13	22	45	3
4	11	1	1	200	25	22	45	4
8	12	1	1	200	25	25	45	2
10	13	1	1	200	13	22	60	7
9	14	1	1	80	13	22	60	7
15	15	1	1	80	25	25	60	8
3	16	1	1	80	25	22	45	9
6	17	1	1	200	13	25	45	8
7	18	1	1	80	25	25	45	9
11	19	1	1	80	25	22	60	9

Figure 11. DOE 2^k Factorial Design

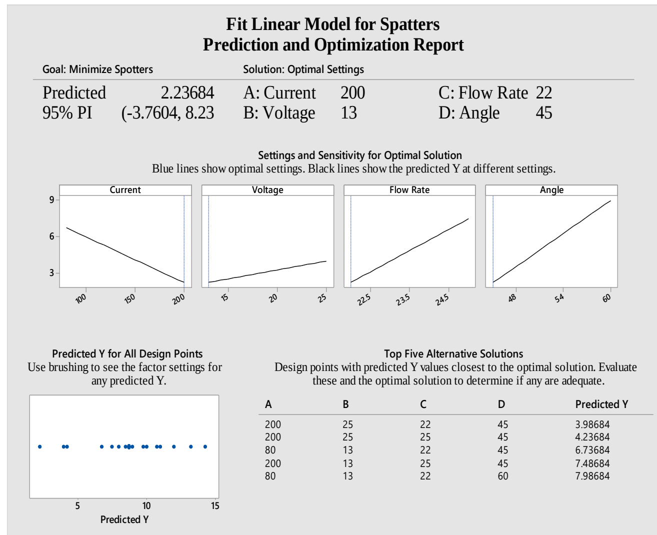


Figure 12. Prediction and Optimization Report

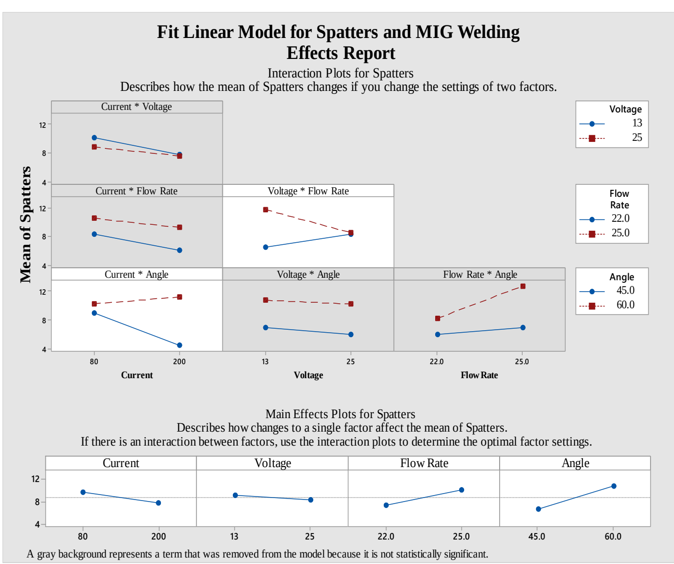


Figure 13. Effects Report

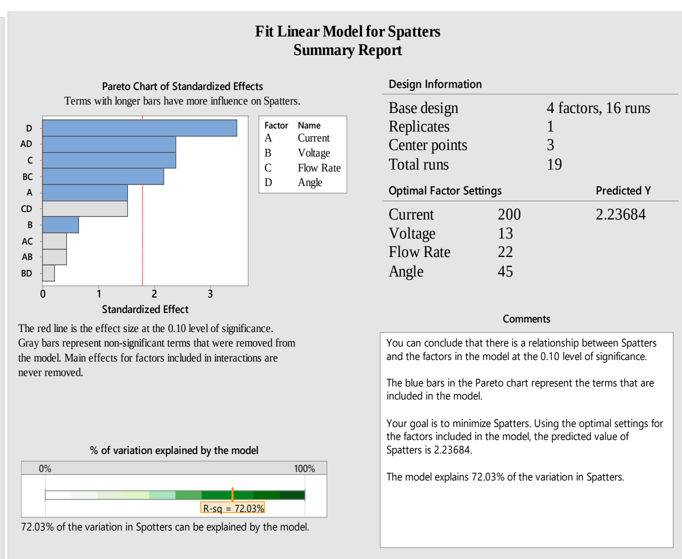


Figure 14. Optimization Summary Report

3.5 Control Phase

SPC is very strong set of tools with numerous kinds of control charts each with unique application. A C chart was drawn to assess whether our process defect rate is within the defined defect rate specifications or not. The results of monitoring the process shows that process is capable as compared of its previous un-controlled behavior. After applying the improved parameters and all the process controls a data was collected for 10 days and c-hart of defects was drawn.

Failure Mode and Effect Analysis is used when new controls are being defined in existing process and identifying potential failure modes. Failure mode and effect analysis includes every process in MIG Welding of distributors, their potential failure mode, causes, severity, occurance, detection criteria and recommedned controls for the sustainability of improved process.

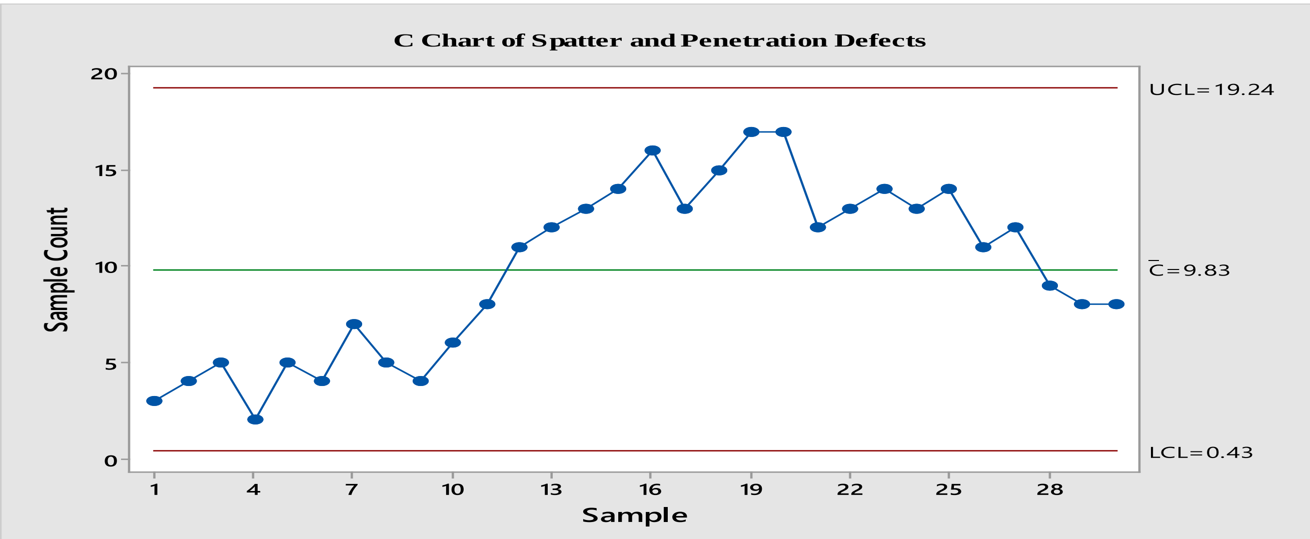


Figure 15. C-Chart

Requirements	Potential Failure Mode	Potential Effect(s) of Failure	Severity	Potential Cause(s)/ Mechanism (s) of Failure	Occurrence	Current Process Control for prevention	Current process control for Detention	Detention	RPN	Recommended Action(s)
Material as per Specification	Wrong Material	Final Product out of Specs	8	Parts mixing because of excessive inventory	4	Separate Bins placed	MIG welding Jig	2	64	Storage of only required amount of CKD in bins
Process Standard Parameters	Un-standardized process Parameters	Spatters & Penetration	9	Process is not being monitored	4	Flow meters and gauges	Spatters on Distributors	6	216	
Spot position as per standard	Spot position not as per standard	Weak weld Joint	8	Negligence of worker	4	MOS for welding	Visual Inspection	3	96	Training of operator / Increase skill level
Welding at standard position / alignment	Welding not at proper position / alignment	Final Assembly not possible	8	Distributor not aligned at 90 Degree	2	Tri-Square	Welding Jig	3	48	Periodic calibration of jig

				Brackets not seated properly in jig	2	Cleaning of jig	Use of locating pins	3	48	
Distributor not melted after welding	Distributor melted	Leakage	8	Over processing / welding for more than required	3	None	Visual Inspection	3	72	Training of operator / Increase skill level
Spatters not Enter into slots and holes of distributor	Spatters Enter into slots and holes of distributor	Blockage / Clogging of Condenser	8	Welding not performed at standard parameters / Wrong angle	3	None	Visual Inspection	2	48	Optimal Process Parameters Setting
		Difficulty in M-Tubes insertion	5						30	
No Big spatters on the surface	Big spatters on the surface	Appearance not good	4	Welding not performed at standard parameters	4	None	Visual Inspection	2	32	Same control as for above process
				Nozzle size not as per standard		None	Visual Inspection	2	32	Use Nozzle of required length

Table 3. FMEA

4. CONCLUSION

Six Sigma DMAIC Methodology is very robust to minimize the variation in existing processes. Six sigma is structured approach to identify the problem, measure the problem, analyze the current situation, improve the current process and define controls to long term benefits. This paper helps improving the MIG welding problems in automobile HVAC manufacturing organization. After the completion of this research the tangible and in-tangible benefits are listed as:-

Improved Quality rate, productivity and reduced lead times. 25% defects were reduced as compared to pre-project defect rate. A net saving of US $0.8 million annually to the organization. Improved six sigma Level from 2 sigma to 4 sigma level of MIG welding process.

5. REFERENCE:

1. Amit Dhamija, Neeraj Saini, Om Ji Shukla And Anil Kumar Misra "sigma level improvements in mig welding using dmaic approach" sop transactions on statistics and analysis volume 1, number 1, march 2014.

2. Darshak A. Desai Jiju Antony M.B. Patel, (2012),"an assessment of the critical success factors for six sigma implementation in indian industries", international journal of productivity and performance management, vol. 61 iss 4 pp. 426 – 444

3. H. Sekhar R. Mahanti, (2006),"confluence of six sigma, simulation and environmental quality", management of environmental quality: an international journal, vol. 17 iss 2 pp. 170 – 183

4. Jayakumar Narasimhan and Erick C. Jones (2004) "Reduction of variation in a Welding Process using Operational Six Sigma Methodology" www.uta.edu/rfid/PDFs/2.1.../14.%20POTIERC2004_JONES

5. Mahesh S. Shinde, Dr. K. H. Inamdar "Improving TIG Welding Quality using DMAIC" Volume 3 Issue 6, June 2014 **www.ijsr.net**

6. Mr. Mahesh S. Shinde, Dr. K. H. Inamdar "Reduction In TIG Welding Defects For Productivity Improvement Using Six Sigma" www.ijtra.com Volume 2, Issue 3 (May-June 2014), PP. 100-105
7. Ricardo Pires De Souza Hélio Roberto Hékis Lucas Ambrósio Bezerra Oliveira Jamerson Viegas Queiroz Fernanda Cristina Barbosa Pereira Queiroz Ricardo Alexsandro De Medeiros Valentim, (2013), "implementation of a six sigma project in a 3m division of brazil", international journal of quality & reliability management, vol. 30 iss 2 pp. 129 – 141

8. Shashank Soni, Ravindra Mohan, Lokesh Bajpai and S K Katare "reduction of welding defects using six sigma techniques" Vol. 2, No. 3, July 2013
9. Thakar SinghP, Dinesh Kumar, Pradeshi Ram "An Implementation Of Six-Sigma In Steel Tube Welding." A Case Study Vol. 2 Issue 9, September 2015

10. The Six Sigma Handbook Revised and Expanded A Complete Guide For Green Belts, Black Belts, And Managers At All Levels Thomas Pyzdek.

11. Yousaf, F. and Ikramullah Butt (2013) work on "Reduction in Repair rate of Welding Processes by Determination & Controlling of Critical KPIVs" Received 2013-07-23 - Accepted 2013-11-19 http://dx.doi.org/10.4995/ijpme.2014.1609

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Film Making and Studio at Karachi

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Abstract

"Film as dream or film as music" No art passes our conscience in the way film does, and goes directly to our feelings, deep down into the dark rooms of our souls." said by the legendary filmmaker Ingmar Bergman. This citation substantiates the belief that film and television are the most powerful form of all communication techniques and leaves a profound impact on the psyche of an individual and in turn affects the society. As the world has turned into a global village, cinema and film-making plays an important role not only in promoting cultural values and bonding different countries. This film studio will deliver the entire production solutions that will translate the concepts into an effective onscreen rendering, scripting, and editing, audio & video special effects. Bold topics through films will purify the society from superstitions, evils and fake stories. Film studio will provide an environment interior or exterior which will be designed specifically for the production of motion pictures.

1. INTRODUCTION

A film studio is a major entertainment place or motion picture company, which has a privately owned facilities that are used for making films and TV serials. The facilities are handled by that company. The studio is rented to different producers and directors for film shooting and recording purposes. With the growing diversification of studio into such fields as video games, television, parks, home video and publishing, this has become Multi-National Corporation. Studio premises generally feature multiple sound stages along with an outside back lot, as well as offices for studio executives and production companies. There is normally a studio "commissary", which is the traditional term in the film industry for what other industries call a company cafeteria.

Some years before film studios use to have only indoor and outdoor shooting facilities. The advancement of technology brought major changes in the field of film making. Animation techniques such as green screen technology and development of sound system have given the touch of reality. In film studio. all the facilities required including office spaces, residence facilities for actors and other technicians. In film studio one can shoot a movie in a very fast pace as one can construct different indoor and outdoor scenes quickly by using the workshop facilities available in the studio.

Among the social needs of man, communication with others is the biggest need that one has got to fulfill. Today when the world has been turned into a global village, living without awareness of the changing cultures, fashion and countries taking place around us, one cannot survive well. The means of media satisfy this social need of man. Pakistan entered into Television Broadcasting age with a small pilot TV Station established at Lahore from where transmission was first beamed in Black & White with effect from 1964.

2. AIMS AND OBJECTIVES

Technical improvement of Pakistani movies and serials is evident from the change in screen presentation. The public has greatly appreciated this cosmetic transformation not only in movies and serials but also in News & Current Affairs.
The main aims and objectives of this Research on Film making and Studio will be to study all the necessary facilities from pre-production stage up till the release of the films so that the film makers will not go through any kind of hurdles during the film making process.

- To design the facility that can accommodate the pre-production, production, post production and release of the movie and that can also financially function on its own.
- To provide platform for the new talents arising in the film and television sector.
- To facilitate film makers and directors during the film making.
- To provide the facility of producing CDs and DVDs of the movies.
- To introduce the animation technology.

3. PROJECT JUSTIFICATION

Media industry is one of the big industries in Pakistan. Lots of money and talents can be seen in present context of Pakistan film and drama industry. All these money and talents are suffering in the process of making movies. Especially moviemakers like producers and directors are suffering during film making due to lack of facilities and equipment necessary.

The “Film Studio” as proposed will bring all the facilities necessary from pre-production to release of movie for film makers under single roof. This will facilitate each and every film maker. Other scope of this kind of film studio can be seen internationally. Recently movies from Hollywood like (expendables, Gravity, Avatar) were shot inside the studios. This kind of movies and documentaries were shot before too but Pakistan could not gain economically from this due to lack of such facilities. Thus this kind of facility under one roof will not only benefit existing film makers but also benefit young talents as they don’t have to wonder around in the film making process.

4. INFLUENCE OF MOVIES ON THE SOCIETY

The influence of films on our society is bidirectional. Society reflects in movies and in turn movies influence society. There is a thread reflection in both. The Pakistani society, across every state used to be a very conservative one. 80 years back if one would time travel and show our previous generation the present state of our society, none of them would accept it or believe it, or even look down upon people who live them.
Let’s turn focus towards good movies with positive content. The movies have definitely influenced even the lowest strata of people in the society, who have no access to good books or have the opportunity of interacting with really broad minded people. Good movies have made the society think positively, it has stood for women empowerment, it has helped to break notions of dowry, it has helped people to digest women remarriage, it has helped to break mindless superstitious beliefs, it has brought out a good understanding of the urban and rural, It has helped people to understand about relationships, movies have helped the society to be out from the cluster of caste. Not only that, good movies have promoted the culture faces. It has helped to convey about the history and mythologies to next generation. Good movies have also promoted patriotism.
Movies are a powerful weapon. This Media can sway the way a society thinks. Provided it goes into the hands of good directors with good, positive and broad thinking. If the movies don't have a striking impact, it should not pull down the society back to its stone ages.

5. LITERATURE REVIEW

The first ever film studio in Pakistan, Pancholi Film Studio on Upper Mall Road Lahore was inaugurated in 1948. In 1952, Pancholi studio was allotted to a famous ghazal and folk singer Malika Pukhraj and became Malika Studio. Then it

was rent to some other parties and its name was also changed as Jawidan Studio, later it was sold by Malika Pukhraj and it became Upper Mall Scheme with lot of houses.
Babel berg studio near Berlin was the first large-scale studio and the forerunner to Hollywood, which produces global blockbusters every year.

Early nitrate film was notoriously flammable, and sets were and are still very flammable, which is why film studios built in the early-to-mid 20th century have water towers to facilitate firefighting.

In 1893, Thomas Edison built the first movie studio in the United States when he constructed the Black Maria, a tarpaper-covered structure near his laboratories in West Orange, New Jersey, and asked circus, vaudeville, and dramatic actors to perform for the camera.

The pioneering Than Houser film studio was founded in New Rochelle, New York in 1909 by American theatrical impresario Edwin Than Houser. The company produced and released 1,086 films between 1910 and 1917, successfully distributing them around the world.

In the early 1900s, many companies started moving to Los Angeles, California. Although electric lights were by then widely available, none were yet powerful enough to adequately expose film; the best source of illumination for motion picture production was natural sunlight.

5.1 THE MAJORS BEFORE THE GOLDEN AGE

In 1909, Thomas Edison led to the creation of the Motion Picture Patents Company, widely known as the Trust. Comprising the nine largest U.S. film companies, it was "designed to eliminate not only independent film producers but also the country's 10,000 independent distribution exchanges and exhibitors." Though its many members did not consolidate their filmmaking operations, the New York–based Trust was arguably the first major North American movie conglomerate. In 1916, a powerful Hollywood studio was established when Adolph Zukor merged his Famous Players Film Company movie production house with the Jesse L. Lasky Company to form Famous Players–Lasky.

5.2 THE MAJORS DURING THE GOLDEN AGE

Between late 1928, there were eight Hollywood studios commonly regarded as the "majors". Of these eight, the so-called Big Five were integrated conglomerates, combining ownership of a production studio, distribution division, and substantial theater chain, and contracting with performers and filmmaking personnel. The remaining majors were sometimes referred to as the "Little Three" or “major minor” studios Two - Universal and Columbia were organized similarly to the Big Five, except for the fact that they never owned more than small theater circuits. The third of them, United Artists, owned a few theaters and had access to production facilities owned by its principals, loaning money to independent producers and releasing their films. During the 1930s, the eight majors averaged a total of 358 feature film releases a year.

5.3 THE MAJORS AFTER THE GOLDEN AGE

5.3.1 1950s–1960s

The end of the Golden Age signaled by the majors' loss of a federal antitrust case that led to the divestiture of the Big Five's theater chains, it somewhat leveled the playing field between the Big Five and the Little Three. In November 1951, Decca Records purchased 28% of Universal; and the studio became the first of the classic Hollywood majors to be taken over by an outside corporation, as Decca acquired majority ownership. The 1950s saw two substantial shifts in the hierarchy of the majors: RKO, perennially the weakest of the Big Five, declined rapidly under the mismanagement of Howard Hughes, who had purchased a controlling interest in the studio in 1948. In 1956, when Big Five studios released one of the biggest blockbusters of the decade which was named as, Around the World in 80 Days. By the middle of the next decade, it had reached 16% and was the second-most profitable studio in Hollywood. Despite RKO's collapse, the majors still averaged a total yearly release slate of 253 feature films during the decade.

5.3.2 1970s–1980s

The early 1970s were difficult years for *all* the major film studios. Movie attendance, which had been declining steadily since the Golden Age, hit an all-time low in 1971. In 1973, MGM studio was drastically downsized. By the mid-1970s, the industry had rebounded and a significant philosophical shift was in progress. As the majors focused increasingly on the development of the next hoped-for blockbuster and began routinely opening each new movie in many hundreds of theaters.

5.3.3 1990s-Present

With the exception of MGM/UA, the old-established studios did bounce back. The purchase of Fox presaged a new round of corporate acquisitions. Between 1989 and 1994, Paramount, Warners, Columbia, and Universal studios all changed ownership in a series of conglomerate purchases and mergers that brought them new financial and marketing muscle.

6. FILM STUDIOS TODAY

With the growing diversification of studios into fields such as film making, TV serials, television and publishing, they have become multi-national corporations. As the studios increased in size they began to rely on production companies, to handle many of the creative and physical production details of their feature films. Century City in Los Angeles was once part of the 20th Century Fox back lot, which was among the largest and most famous of the studio lots. In most cases portions of the back lots were retained and are available for rental by various film and television productions. Some studios also offer tours of their back lots, while Universal Pictures allows visitors to its adjacent Universal Studios Hollywood theme park to take a tram tour of the back lot where films such as Psycho and Back to the Future were once shot.

7. INDEPENDENT FILMS AND STUDIOS

In the 1980s and 90s, as the cost of professional 16mm film equipment decreased, along with the emergence of non-film innovations such as S-VHS and Mini-DV cameras, many young filmmakers began to make films outside the "studio system". Filmmakers made films that pushed boundaries in ways the studios were then reluctant to do. In response to these films, many distributed by "mini-studios" like Miramax, the "majors" created their own in-house mini-studios meant to focus on edgier "independent" content. Focus Features was created by Universal Pictures and Fox Searchlight was created by 20th Century Fox for this purpose.

8. CAUSES OF FAILURE OF FILM INDUSTRY IN PAKISTAN

Pakistan film industry was established in the city of Lahore and is often referred as “Lollywood”. The Pakistan film industry was taking its last breaths as it was unable to attract and audience for long period of time.

The Pakistan film industry was at peak in the 60s with a lot of hit movies and audiences. In the early 70’s VCRs were introduced in Pakistan and pirated Indian movies started appearing in the markets with the availability of Indian movies in the markets viewers had the options to watch either Pakistani or Indian movie because before the introduction of VCRs audience had no choice but to watch Pakistani movies and industry flourished.

9. GOLDEN PERIOD OF PAKISTANI FILM INDUSTRY

The golden period of Pakistani film industry started in 60’s. Many actors proved themselves through remarkable acting. Not only actors but directors, singers and writers also did outstanding work which is memorable.

After a long phase of success, the film industry gradually declined in 90’s as many old and favorite actors leave the industry and new were too young to take their places. Directors like Syed Noor and Javed Sheikh tried to push the industry up but failed as majority of movies of that time were flopped. A number of movies released which were far away from our Cultural and Moral values. The basic reason of the downfall of Pakistani film industry is not the lack of talent but the major reason was the farness from our culture and technology, also the industry was ill-treated by the government in previous years. The bad story line and lack of good film making equipment forced a number of artists to leave the film industry, some of them also moved to neighbor country to show their acting skills. This was really a serious issue and need consideration by the seniors in the industry.

10. THE REVIVAL OF PAKISTANI FILM INDUSTRY

The basic needs for the revival of film industry are as follows;

- Investment to increase the number of movies per annum and also to upgrade the standard of movies. It could be risky but a very bold step for the rejuvenation of industry.
- Payment of good amount to the artists, so that they avoid serving other countries and show their skills in front of their own cameras.
- Construction of modern technology film studios, which will provide a single place, where a full movie can me completely recorded.
- Good storyline which should raise social and economic issues of our country.
- Movies must show our cultural and moral aspects, so that people could move toward cinemas with their families without hesitation.
- Good equipment must have to be introduced to improve standard of movies.
- There must be a good promotion of the movies so that people wait eagerly for new movies.

Now days, many young people are entering and investing in Lollywood with new and interesting movies, People can hope for the success of these new pieces of arts by the young talent as the future of Lollywood depends on their work.

11. PAKISTAN ENTERTAINMENT INDUSTRY TODAY

Pakistan Entertainment Industry is on its peak now providing nation with exciting reality and live shows, dramas and movies and there are many movies waiting to be released every year. Surely an absolute great start of this year and this industry is expanding day by day allowing new talent to pour in. This Industry is on a booming stage. Talking about film and drama industry worth in billions now moreover the whole entertainment industry is so much powerful now that it had allowed foreigners to jump in and foreign content is also being telecast.

12. RISE OF PRIVATE CHANNELS

In 2002 during the Musharraf regime private channels were given licenses to broadcast the transmission from Pakistan. Therefore, it was during that period when the monopoly of the state owned TV channel was challenged. In the initial period the uplink licenses were not issued therefore transmission of private channels were uplinked from outside Pakistan, most of the private channels in this period were operating from UAE, UK and Thailand. Later the permission of uplink was granted and the channels started their transmission in Pakistan. Private investors most of them who were already associated with the print or any other form of media found this business of TV channels very lucrative and obtained licenses. Since then the media industry in Pakistan is on a high. There are many news, entertainment, music and sports channels which are operated and controlled from Pakistan. The rise of private channels has also created waves in the advertising industry, film and drama industry of Pakistan has grown immensely.

13. IMPACT OF DIGITAL TECHNOLOGY ON FILM STUDIOS

The industry that has been expansively affected by technological variations is film. Both mechanical and digital innovations have influenced everything from equipment to distribution, altering how films are made and the manner in which people consume them.

New technologies are readily invented, tested, and perfected. It has become easy that technology has taken film in very different directions. Rodriguez is famous for getting his shooting done rather quickly. Technology's greatest impact is perhaps felt in new cameras that allow cinematographers to shoot in a higher definition, letting viewers take in more of the amazing work in set design. Technology also drives entire segments of film now, enabling movies that were not possible before.

13.1Technology and Innovation

Virtual back lots allow actors to appear in far flung destinations, the digital backgrounds, have helped bolster domestic economies. Now directors can incorporate scenes from their wildest imaginations without breaking the bank or rewriting their scripts.
One of the biggest innovations in the film and TV industry has been in the realm of sustainable practices. Film studios have begun swapping out energy-consumptive filming practices for more environmental-friendly options.

13.2Digital Technology

Digital technology has changed the way films are shot, mainly with the use of special effects. The illusions used in the film, television, and entertainment industries to simulate the imagined events in a story. One of the technologies is CGI ‘Computer Generated Imagery. CGI is the application of computer graphics to special effects. CGI is used for visual effects. For example, King Kong was a popular film because of the publicized special effects and how the film revolved around it. Adding visual effects to film was often a precise art, where the effect had to blend seamlessly with what is being shot. The software also allows editors to work on entire sections of a film, easily piecing scenes together after the post production effects are added in.

Shooting in digital is much easier because a person can do more in less time. Multiple cameras can run on the same shot, so can get the angle without having to waste time on retakes.

13.3 Film Production Equipment

Technology continues to advance and change the world of film making and all the equipment that goes with it.

13.3.1 Cameras

A new trend is using Go Pro HD cameras, which provide a wide angle lens and are good for first person views. The dolly and Steadicam are also inventions that signify benchmark camera techniques. The dolly, to put it simply, is the placing of the camera on wheels that move along tracks. The subsequent smooth movement means that camera man can follow people walking and talking or get sweeping opening shots, especially when you combine it with a crane. The Steadicam was the solution to many problems of a cameraman– getting the smoothness of a dolly system, but with the freedom of hand-held shooting.

13.3.2 Sound

Achieving a high quality sound for film production that is state of the art can make or break a movie’s overall quality. All the pros know that sound has a profound effect on the senses and should complement video, being equally as important.

13.3.3 Lighting

Lighting is a characteristic that one may not see as being vital to the film production process, but it is in fact an extremely important element. Professional lighting equipment accentuates shadows, brightens dark spaces and highlights the subject being filmed. Using reflectors, soft boxes and China Ball lanterns are subtle ways that can make light diffuse in different ways that can make a scene more dramatic.

13.3.4 Software

Video editing software, a tool every professional uses for film making. Software like Adobe Premiere Pro, Final Cut Pro, Sony Movie Studio Platinum and Avid Media Composer are some of the best available. Used to edit and make seamless clips of video, these popular software platforms have helped produce some of the best blockbusters.

13.3.5 Green Screen

Early digital compositing started in the 1940s with the ‘traveling matte’ – a process that was used to superimpose backdrops with actors performing against a blank, colored wall. These screen colors have changed throughout the decades, but the process and effect have remained the same. It is filmed against the (green) colored screen, then re-filmed with a filter on the lens that removes all the colored (green) areas of the film. It allows for actors to be ‘anywhere in the world’ and also create optical illusions, all the while saving on production costs.

13.3.6 3D Printing

3D printing is set to revolutionize film-making from a production design perspective. Concept artists often design with computer-generated imagery (CGI) and computer-aided design (CAD) software, which lends itself perfectly to printing in 3D. Because the technology can also achieve such sophisticated levels of detail, print size and finish, props departments on big productions are embracing the flexibility and efficiency the process affords. Recently released films also used Prop shops' facilities, where entire spaceships and sets can be printed and assembled. **Digital transformation is no longer an option – it's the imperative.**

14. THE TECHNOLOGICAL EVOLUTION OF FILMMAKING

The development of motion picture complexity has been driven by a continuing technological evolution, ignited and manipulated by human initiative and inventiveness, which has afforded filmmakers the opportunity to practice a more complex craft to tell more complex stories.

15. TECH BREAKTHROUGHS IN FILM

Many writers started writing "animated films" but could not make because the technology needed to tell the stories hadn't been invented yet. Following are some examples of Tech Breakthroughs in some films:

15.1Avatar Fusion Camera System

The Fusion Camera System along with Vince Pace, who also developed new underwater lighting for Cameron's undersea sci-fi adventure flick "The Abyss." Older 3D tech also used two cameras placed side-by-side, but those cameras were so big that their lenses ended up being far apart, not close to each other like human pupils, as with Cameron's small hi-def. cameras. This tech has since been used in such films as "Tron: Legacy," "Hugo" and "Life of Pi." See Fig:5

15.2"Gravity" light box

Before "Gravity," no one had attempted to make an entire film that takes place in zero gravity. One big challenge of pulling off the authentic look of zero gravity in Earth's orbit was simulating the sun's light that bounces off the dayside of Earth. The film's effects team created an LED light box that emitted and could instantly change the appropriate light on the actors inside. The box was 20 feet tall and 10 feet wide, and the interior walls were constructed of 196 panels, each containing 4,096 tiny LED lights. "Gravity" went on to get a Best Picture Oscar nomination and win seven Academy Awards.

Autodesk Maya is popular 3D computer graphics software that's been used for films like "Avatar" and "Finding Nemo" and TV too, including "Game of Thrones." Over the years, different artists have made various additions and improvements to the software. The program enabled the "LotR" effects team to create battles among tens of thousands of orcs, humans and elves with autonomous agent animation. Without technology, it would be nearly impossible for Hollywood to produce the volume of films that it does. See Fig: 6

15.3Jurassic Park Dinosaur Input Device

At the time "Jurassic Park" was made, there were plenty of talented animators who knew how to use traditional tools. To address this issue, the Dinosaur Input Device (DID) was created for the film. Stop-motion animators posed a mechanical model dinosaur for each frame of animation. The system, renamed Direct Input Device, was later used for "Starship Troopers" and "Three Wishes." See Fig: 7

15.4The Matrix Reloaded

As films like "Tron: Legacy" demonstrate, creating a believable CG version of a recognizable actor "Looker" delivered the first computer-generated human character in a feature film, "The Matrix Reloaded" made some strides in this area with John Gaeta's invention of Universal Capture. Blending the use of lens-based cameras and synthetic 3D CG, this facial animation system captured an actor's expressions from various angles and stored them in a library used to create multiple characters. See Fig: 8

16. TECHNOLOGY INNOVATIONS

(Fig: 1 a) Aircraft Shooting inside a Green room (Fig: 1 b) Aircraft After Effects through Technology

(Fig: 3 a) A scene from The movie inside a color studio (Fig: 3 b) A scene from The movie inside a color studio after effects

AVATAR movie's technology innovation Fig: 5

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GRAVITY THE LIGHT BOX (Fig: 6)

Upside Down master (Fig: 6 a)

Ender's Game (Fig 6 b)

Jurassic Park (Fig: 7)

The Matrix Reloaded (Fig:8)

17. CONCLUSION

Following are the design considerations, which should be involved in the selection of site, as well as in the construction of Film and TV studios, and these will provide a pleasing environment in the making of the movies and TV Serials.

- The film studio should be located far from congested areas; at the same time, it should be approachable from different routes of the road.
- It should have a good relationship between spaces, which can provide easy work flow.
- The structural requirements must be fulfilled.
- The functional and spatial requirements must be completed for indoor and outdoor shooting purpose.
- It should have own transformer for electric supply.
- It must have ample of parking for different categories.
- Each block in the film studio premises must be centrally air conditioned.
- Proper high class lighting should be provided.
- For work room the minimum area of 86 sq. ft. should be allowed and free circulation space should be of minimum 16 sq. ft. per employee and width of the corridor should be such that two persons can pass each other easily.
- Computers and screens should not be placed directly opposite to the window in work room because due to this a shadow of window is casted on the screen which will disturb the work.

REFRENCES:

1. Sharanya Sunderamoorthy, Watched most of the Tamil movies and some Malayalam movies
Written Sep 9, 2015
2. Johnson, R. W.; Hindman, T. C. (January 8, 1861). To the People of Arkansas (Speech). Washington: W. H. Moore. Retrieved March 27, 2016.
3. Written by JB91 edupdf.org 9 OCTOBER 2016 AT 19:05
4. These 10 ambitious movies pushed their filmmakers to invent new technology
#EDGE OF TOMORROW #STAR TREK
EMILY ROME 08.25.15

ENTREPRENEURSHIP: ECONOMIC WASTEWATER TREATMENT

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Abstract: Being an entrepreneur, bringing a little change in the conventional approach of wastewater treatment is the current research's aim. Usually, the wastewater is treated through sand and gravel media but moving on to the further economic and feasible option, plastic media has been selected. The media being light-weight and easily replaceable has been utilized in the form of disposed plastic bottles. Another economic factor of the project is that the system designed here works through the solar energy. The construction and operation of system along with the collection of plastic bottles to be used as filtrate, creates opportunities for the nearby unemployed people. Several physical as well as chemical parameters such as pH, total suspended solids, total dissolved solids, chloride concentration, turbidity, and B.O.D_5 of treated and untreated wastewater are observed and studied. Furthermore, the filtered water is utilized for plantation of the trees near to the site, hence saving the valuable resource of water for human life.

1. INTRODUCTION

There are many forces like technological obstacles, changing economies and small and large demographical changes which have resulted in opportunities and fears for organizations, and for societies which are transformed in this world. For coping up with these changing forces, public and private organizations and institutions as well as public are more getting more oriented towards entrepreneurship. Entrepreneurship may be defined a multifaceted phenomenon, being analysed as a resource or a process. The Schumpeterian view states entrepreneurial process as one of the significant influences in the economic development of a region (Toma et al, 2014).

The aim of this study is to provide a handful information about the application of principles of entrepreneurship concerning the wastewater treatment and to see the aftermath of this experiment in shape of observations and undoubtedly economic return calculation.

We have experimented ultimately for computation of the economic return from the constructed project. The principles of entrepreneurship have been used as the foundation of the project but it is highlighted most at two points; mainly at the using of recycled plastic bottles and using of solar energy for operation of motors.

At the global level, one method of protecting the water resources is treating the wastewater. It addresses two challenges i.e. protection of environment and the health of public. Water currently present on earth is valued to be 1,400 trillion cubic meters. Whereas, freshwater is only 3% of this quantity. This concludes that freshwater is a valuable resource, specifically when not distributed evenly. So, for getting useful access of water, proper sanitation service and reservation of water resources, the correct way is wastewater treatment (Vasugi M, 2015).

A nearby site was evaluated in terms of odour nuisance creating the causes for several health issues due to mismanagement of wastewater so we proposed to kill these problems and treat the wastewater by using simultaneously the principles of wastewater treatment alongside principles of entrepreneurship in order to make process efficient, economical and sustainably liable.

Current research works utilizes the recycled plastic bottles as filterate to make the process efficient and sustainable. In addition to it. The process leads to entrepreneurship approach in the treatment of wastewater; as enough work has been done worldwide but not in Pakistan concerning this media. The treated water will be used for the plantation purpose thereby making the first university scale project in Sindh province to achieve this milestone. All the transference of wastewater will done by using pumps which will draw their powers from solar energy. Solar plates are installed nearby the site to grab the solar energy from sun and convert it into electricity so that pumps could be operated.

Entrepreneurship is a purposeful activity to initiate, maintain and develop a profit oriented business (Cole, 1968). Entrepreneurship is the resource, process and state of being through and in which individuals utilize positive opportunities in the market by creating and growing new business firms (Gries and Naudé, 2011). So the basic aim of this paper are to know the concepts of wastewater treatment and to highlight the basic role of entrepreneurship in wastewater treatment. Hence, this paper provides both the theoretical as well as real time model so that the true pros and cons of this relationship may be obtained.

The physical setup of this filtration plant consists of gathering tank, where the wastewater is collected. In the sedimentation tank, next to the collection tank, primary treatment takes place. Treatment of water in biological terms takes place in the filtration unit then. After it the water is stored from where it is utilized for plantation purpose using pipelines. The entire waste water treatment unit is designed to work under solar energy. The project conserves of the most important resource; enhancing the concept of entrepreneurship; reducing environmental load; treating wastewater; proper disposal of wastewater along with reduction of carbon footprint through plantation.

Previously when people used to live in small communities, the waste disposal problem wasn't of much consideration but as the population has increased the waste generation and its management issue has increased considerably. Sewage mostly consists of organic and inorganic materials, pathogens, microbes and toxic chemicals which have the tendency to create major problems if not treated properly (Lenntech, 2009).

Sometimes the organic matter which is dissolved in wastewater may escape the primary (sedimentation) treatment, it can be removed filtration treatment system. Sometimes secondary and additional settling tanks are also installed for further removal of suspended solids. In this system, organic matter is consumed by microbes as their food and they convert them into essentials like CO_2, H_2O and energy for their own growth. A plant consisting secondary treatment can be efficient up to 85% removal of suspended solids and BOD (Fosu, 2009).

Another research explained about the efficiency of plastic media by designing the two-combined anaerobic-aerobic filters which were packed together with clay and plastic media both for the treatment of highly concentrated effluent. The author designed one was equipped with clay and other was equipped with plastic material and project was done in two phases. The results he got while in phase I was 84% removal in COD whereas in Phase II removal varied from 90 to 93% (Rebah, 2009)

In 2003, for wastewater treatment and reuse, a floating plastic media filter system was designed which was coupled with plastic media and sand filters. Several experiments were done which included removal of suspended solids in surface water, which resulted from secondary effluent of sewage treatment plant. 96.26% and 95.48% were the respective efficiencies of average turbidity and suspended solids removal (Chiemchaisri, 2003).

As we have seen above, water security involves a combination of physical, chemical, biological, social and economic factors, all acting at different scales and changing over time (Bogardi et al., 2012; Garcia et al., 2013; Moore et al., 2014). The complexity of these challenges in a rapidly changing world means that new, locally-adapted and innovative solutions are often required.

Water innovation can apply not only to new sustainable technologies but also to new partnerships extending across public administration, research and industry: new business models and new forms of water governance that are not only innovative in themselves but can also stimulate and support technological innovations (Martins et al., 2013; Moore et al., 2014; European Water Platform, 2014). Furthermore, innovation need not be an entirely new technology or concept; novel combinations and innovative ideas for improvements on current technologies and systems, all have a part to play (EIP Water, 2014).

The Strategic Implementation Plan for EIP Water identifies five thematic priority areas: (1) water re-use and recycling; (2) water and wastewater treatment, including recovery of resources; (3) the water-energy nexus; (4) flood and drought risk management and (5) ecosystem services. Cross-cutting priority areas include: water governance; decision support systems and monitoring and financing (European Commission, 2012a).

Wastewater contains important resources, such as phosphorus and nitrogen, which could, if recovered, be re-used. Integrated and innovative wastewater treatment plants of the future will be able to recover these resources as part of the treatment process, increasing resource efficiency as well as generating clean water (Guest et al., 2009).

The author employs a methodological framework based on SWOT analysis to chalk out main factors and concerns in order for public policy organisations to encourage local entrepreneurs to invest in sustainable development. He conducted a survey in which he examined the strength cum weaknesses cum opportunities cum threats which were faced by Greek Development Agencies (DAs) which he considered is important for encouraging local entrepreneurs to exploit new opportunities using local natural resources. His results signified that institutional, structural, social and economic factors can play a critical role in whether entrepreneurs invest in new business ventures associated with natural resources. He has used the concept of green entrepreneurship for the first time in the environmental field related to public policy (E.I. Nikolaou et al, 2011).

There is oneness in the concepts of everyone that today world is facing serious environmental degradation and that the development and application of environmental technologies is essential to solving our environmental problems. Because of ever-increasing demand day by day so manufacturer of goods and products should also be increased in order to lineate the demand vs supply graph and it has created many opportunities for small and medium-sized enterprises (SMEs). The author explains that how SMEs can play a more satisfying part in improving the environmental industry. It mainly focusses on the entrepreneurial opportunities to be used for SMES in the environmental industry and also suggests that SMEs should be helped through policies and incentives. Author in the beginning tells about the definition and usage of SMEs and its relationship with the Environmental industry. Then he moved ahead to size and growth of the environmental goods and services industry and the main drivers of the industry growth. After that another section referred to the theoretical rationale for the environmental goods and services market and why entrepreneurial opportunities exist in the market. Finally, it discussed the entrepreneurial opportunities for SMES and presented several policies and incentives that government and other agencies could use to stimulate SME participation in the environmental industry (McEwen, 2016).

Wastewater sector is equipped with the reusing as a result of many expert who are calling continuously for great resource recovery, which is supported by alternative solutions like source separation. Source separation is proved to be advantageous for improving treatment capacity, food security, and efficiency. This research is related to source reduction according to Technology Innovation Systems (TIS) in order to identify obstacles and policy recommendations. Source-separation is proven to be at development phase, studies have proved that source reduction is said to be the idea of entrepreneurs and has been proved to work well within on-site niche and particular in black water (McConville et al, 2017).

The research depicts the achievements of entrepreneurs in the municipal solid waste industry in industrialized central and northern Europe. These entrepreneurs had deep feeling for environmental degradation and tried, however, by every mean to overcome it. They started with sorting and recycling waste materials which made huge profits and saved environment as well. It also achieved the social values (Jones & Spadafora ,2014).

2. METHODOLOGY

2.1 Quantifying Wastewater

To determine the total quantity of the wastewater which goes into the septic tank, two methods were used to verify total quantity of wastewater being generated. The safety factor was also considered while calculating the daily generation of wastewater.

2.1.1 Approximate method:

There are in total two overhead tanks on the right side of main Administration Block, MUET. Adding the factor of safety, we got total water usage of 4000 litres per day, 70% of which was considered as the wastewater as per the conventional approach. 2500 litres as daily input of wastewater into septic tank was specified and the system was designed accordingly.

2.1.2 Measurement method:

We used another method to verify the measured flow which we termed as physical or real time approach. We placed a plastic tank and diverted the wastewater which was earlier going into the septic tank we diverted that wastewater to the plastic tank. We monitored the quantity for over a month. The flow we got was around 2500 litres per day.

2.2 Entrepreneurship

As mentioned earlier that the entrepreneurship approach has been used as the foundation of the project but it is highlighted most at two points; mainly at the using of recycled plastic bottles and using of solar energy for running of motors.

2.2.1 Solar Energy

This system solely rely on the solar system. Multiple plates are installed to run the system. For that DC motors with pumps have been installed over two locations which run on solar power. Total number of 8 plates of 120 watt, 12 volt each have been installed to run two DC motors. Motors and plates are connected with the wire having gauge 176. We had purchased used panels at half price because they were cheap and useful.
Two motors of 0.75 HP have been installed at two following locations:

1. Near sewage tank for pumping waste water into sedimentation tank.
2. Near Storage Reservoir for pumping the treated water to Greenland.

2.2.2 Plantation

Plastic pipe of PVC material are installed for watering the trees. Each of the tree is watered by giving a hole/opening in the pipeline from which water flows out. Following the principle of drip irrigation, we have installed some similar system of watering with some adjustments for saving the cost.
There is the main pipe which is connected to the pump (pump is drawing water from the storage reservoir), then it the pipe is branched in three sub-pipes/sub-mainlines and goes through the plants watering them. There is valve installed at the beginning of each branch in order to control the flow of water to the particular direction.

2.2.3 Plastic Media:

Important parameters considered for selection of the media for treatment were the space available on site; economic aspects; the climatic conditions of the area; wastewater quality (current and required).

The reason for using plastic bottles was to make the process economical; intrusion of entrepreneurship approach in wastewater treatment process and making it further green to use that water for plantation; ultimately saving the fresh-water resource.

We had collected all the bottles from the Mehran University main campus and from the Hyderabad City by going to the streets and collecting the recycled plastic bottles. On the other hand, we had contacted with local garbage dealers to hand over us sufficient quantity of plastic bottles. It enables us to reduce the environmental and plastic load from the environment and also it is used for useful purpose.

3. RESULTS

After completion of the design and construction phase, the main problems faced were regulation of the system. But we would not be running after the results related to water and wastewater parameters but we have proposed to refer this study with the costings and returns of the entrepreneurship we have used. We have calculated the initial cost and then its returns within some period which we call as payback period and after payback period the project would run for free.

Table 1. Cost Analysis

ITEM	COST OF EACH (RS)	COST (RS)
Solar plates (8)	6600	52,800
Plastic Bottle	1000	1000
Pipelines (6 lines)	1000	6000
Plantation	-	6000
TOTAL		**65800**

RETURN:
Considering the period of 5 years, the Electricity Consumption cost will be:

Table 2. Operational Cost

ITEM	SPECS	OPERATING HOURS (DAY)	LOAD FACTOR (4)	MONTHLY CONSUMPTION (KWh) (5)=(0.75*730*(4))	UNIT RATE (RS/KWh) (6)	TOTAL MONTHLY (RS) (5)*(6)
MOTOR 1	0.75 HP	6	0.25	186.875	20	3737.5
MOTOR 2	0.75 HP	4	0.16	87.6	20	1752
TOTAL						**5489.5**

Yearly Benefit: 5489.5 * 12 = Rs. 65,874
Total benefit: 65,874 * 5 =Rs. 3, 29,370

Apart from taking about the economic terms, this project/study research is also efficient in terms of wastewater filtering parameters. As the treated wastewater was decided to be used for plantation purpose despite that results we got were exceptional making our project economically feasible and technically acceptable. There was 85%, 97%, 93.1%, 75.27%, 79%, and 58% reduction in Turbidity, TSS, TDS, BOD, COD & Nitrates respectively.

4. CONCLUSION

It is concluded that the project is paying back the amount spent on it in almost a year. The total amount spent on the measures taken for entrepreneurship were around Rs: 65,800 whereas benefits we are getting from it in a year are around Rs. 65,874. And if we consider 5 years as a life of project then benefit we will get is Rs. 3, 29,370. So the payback period is only 1 year.

5. RECOMMENDATIONS

Mentioning about the treatment perspective; if advanced methods and further treatment is done, one can get exceptional results. About the entrepreneurship approach of the system; it might be installed in less developed areas where the scarcity of water is prevailing and wastewater is not treated so the people of that area will be benefited in much better way.

6. ACKNOWLEDGEMENT

Initial praise for ALMIGHTY ALLAH; to make this happen. The faculty members from different departments of Mehran University, Jamshoro and **ENGR. ZULFIQAR ALI MEMON** (Executive Engineer, HESCO WAPDA) are appreciated for their guidance throughout the research work.

7. REFERENCES

1. Arndt, H.W., 1987.Economic Development, The History of an Ideea", University of Chicago Press, Chicago, p.230.
2. Bogardi, J.J., Dudgeon, D., Lawford, R., Flinkerbusch, E., Meyn,A., Pahl-Wostl, C., Vielhauer, K. & Vorosmarty, C. (2012) Water security for a planet under pressure; interconnected challenges of a changing world call for sustainable solutions. Current Opinion in Environmental Sustainability 4 (1), pp. 35–43.
3. Chaffee, K. R. (2005). U.S. Patent Application No. 11/660,535.
4. Chiemchaisri, C., Panchawaranon, C., Rutchatanunti, S., Kludpiban, A., Ngo, H. H., & Vigneswaran, S. (2003). Development of floating plastic media filtration system for water treatment and wastewater reuse. Journal of Environmental Science and Health, Part A, 38(10), 2359-2368.

5. Cole, H., 1968. The Entrepreneur: Introductory Remarks, American Review of Economics, LVIII-2, 1968, p.64-71.
6. EIP Water (2014) EIP Water Barriers and Bottlenecks. pp. 1–19.
7. European Water Platform. Water Innovation Europe 2014 “Water in Europe: Green tape or Blue Gold?” (2014)
8. Fosu, A. (2009). Assessing the Efficiency of the KNUST Sewage Treatment Plant.
9. Garcia, J., Salas, J.J., Martin, I. & Vymazal, J. (2013) Research and innovation on ecotechnologies applied to improve wastewater treatment efficiency. Ecological Engineering 50, pp. 1–4.
10. Gries, T., Naudé, W., 2011. Entrepreneurship and human development: A capability approach, Journal of Public Economics, 3(1), pp. 216-224.
11. Guest, J. S., Skerlos, S. J., Barnard, J. L., Beck, M. B., Daigger, G. T., Hilger, H., ... & Mihelcic, J. R. (2009). A new planning and design paradigm to achieve sustainable resource recovery from wastewater 1.
12. Herron, R. B. Robinson Jr., 1993, A Structural Model of the Effects of Entrepreneurial/Characteristics on Venture Performance, Journal of Business Venturing, VIII (3), p.281-294.
13. http://www.emag.suez-environnement.com/en/treatment-wastewater-global-public-health-environmental-protection-challenge-11126
14. http://www.lenntech.com/chemistry/filtration.htm
15. http://www.waterworld.com/waste-water.html
16. Jones, G. G., & Spadafora, A. (2014). Waste, Recycling and Entrepreneurship in Central and Northern Europe, 1870-1940.
17. McConville, J. R., Kvarnström, E., Jönsson, H., Kärrman, E., & Johansson, M. (2017). Source separation: Challenges & opportunities for transition in the swedish wastewater sector. Resources, Conservation and Recycling.
18. McEwen, T. (2016). Entrepreneurial Opportunities for Small and MediumSized Enterprises in the Environmental Goods and Services Industry. International Journal of Academic Research in Business and Social Sciences, 6(10), 218-251.
19. Moore, M.-L., von der Porten, S., Plummer, R., Brandes, O. & Baird, J. (2014) Water policy reform and innovation: A systematic review. Environmental Science & Policy 38, pp. 263–271.
20. Nikolaou, E. I., Ierapetritis, D., & Tsagarakis, K. P. (2011). An evaluation of the prospects of green entrepreneurship development using a SWOT analysis. International Journal of Sustainable Development & World Ecology,18(1), 1-16.
21. Rebah, F. B., Kantardjieff, A., Yezza, A., & Jones, J. P. (2010). Performance of two combined anaerobic–aerobic biofilters packed with clay or plastic media for the treatment of highly concentrated effluent. Desalination, 253(1), 141-146.
22. Schumpeter, J., 1911. The theory of economic development”, Cambridge, MA: Harvard University Press. (Revised editions in 1961)
23. Shane, S. A., Venkataraman, S., 2000.The promise of entrepreneurship as a field of research, Academy of the Management Review, 25 (1), pp.217-226.
24. Toma, S. G., Grigore, A. M., & Marinescu, P. (2014). Economic development and entrepreneurship. Procedia Economics and Finance, 8, 436-443.
25. Vasugi M., “Advances in water treatment methods and conversion of wastewater to irrigation using solar pumps”, 2015 Vol. 5 (1) January-March, pp.48-55.

HUMAN HEALTH RISK ASSESSMENT FROM SO_2 AND NOISE AT FIVE BUSIEST ROUTES IN HYDERABAD CITY

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Abstract: The objective of this study is to assess the human health risk from SO2 and noise at five busiest routes in Hyderabad city. Air pollutants emitting from vehicles is most common cause of polluting outdoor air that can cause premature death because of respiratory diseases, eye irritation and heart illness etc. SO2 monitor and digital sound level meter is used to predict ground level concentration of SO2 and noise level for health risk assessment. Concentration of SO2 and noise level have been compared with Agency for Toxic Substance Registry (ATSDR), World Health Organization (WHO) and National Environmental Quality Standards (NEQS) guidelines. Results shows that SO2 concertation and noise level at five locations in Hyderabad city is above the NEQS, WHO and ATSDR standards for ambient air.

1. INTRODUCTION

The quick increase in road transport system, due to urbanization, increase in population has made regions much more concerned about noise pollution as well as air pollution. Transport sectors are mainly considered as one of main source of urban air pollution and other related problem. Pakistan like developing countries have heterogeneous composition of traffic. Heterogeneous traffic flow is one which have different vehicles spacing, speeds, sizes and operating characteristics (Kalaiselvi & Ramachandraiah, 2016). Emissions from these vehicles such as CO, SO_2, NOx, O_3, and Suspended Particulate Matter (SPM) are common urban air pollutants (Hassan, Malik, Waseem, & Abbas, 2013). These pollutants are usually emitted from engines due to combustion of fuels and high level noise is produced from unnecessarily horns and engines. As traffic flow increase, noise level increase correspondingly. High speed of vehicles is also responsible for the noise pollution generation. The engine propulsion, engine inlet exhaust and transmission include brakes, horns, gears, chassis body structure, door slamming and load on vehicles (Marathe, 2012). Emissions of SO_2 and Noise pollution is caused by due frequently traffic jam, poorly maintained vehicles and human behavior (Taylor, 2016). Hyderabad, Karachi, and Lahore are densely populated city which contribute a large amount of ambient air pollution.

Hyderabad is 5th most populated city in Pakistan, obviously it faces dense transported system that cause serious damage to city environment and human health due to air and noise pollution. Hyderabad city has some points where roads remain busy with very dense traffic. Vehicles with different type of engines are emitting large amount of SO_2, NOx, CO, CO_2 and other by products and unwanted use of horns causing noise pollution which causes hearing loss and other disturbance at different time. Health impacts from different air pollutants depends on type of pollutant and concentration in air and length of exposure (Ahmed, Zubair, Begum, & Khan, 2014). Short term exposure of SO_2 can cause skin burning, irritation of throat and nose, and difficulties in breathing (ATSDR, 1998). High intensity of noise harms our ability of listening, irritate us and cause mental disturbance (Bruce, Perez-Padilla, & Albalak, 2000).

There is need to assess the human health risk of people living and working surrounding five busiest routes of Hyderabad city. This crucial due to increase in road transport, emissions and noise are also increase. In Pakistan such kind of study are not conducted only ambient air quality is monitored at different city of Pakistan such as Lahore

(Ashraf, Mushtaq, Sultana, & Iqbal, 2013), Karachi (Ahmed et al., 2014) and Rawalpindi and Islamabad (Hassan et al., 2013). Health risk assessment usually include numerous keys steps as follow

1. Determination of vehicles emission concentration and noise level.
2. Evaluation of air and noise pollution in surrounding environment
3. Computation of carcinogenic and no carcinogenic health risk
4. Determination of health risks (Mokhtar, Hassim, & Taib, 2014).

1.1 Objectives

To determine concentration of SO_2 and noise at different five busiest routes of Hyderabad city

To assess human health risk from noise at five busiest routes in Hyderabad

2.METHODOLOGY

The study area is Hyderabad city in Sindh, which is 3rd largest city of Pakistan. Located at 25.367 °N latitude and 68.367 °E longitude with an elevation of 13 meters (43 ft.) and it is located on the east bank of the Indus River (Kassar, 2013). In this study five sampling location were selected as show in figure No:1

Fig-1 Sampling Location

2.1 Data Collection

2.1.1 SO_2 Emission Data:

SO_2 emission is collected at different five busiest routes of Hyderabad city during morning, afternoon and evening using SO_2 monitor and we take average of these three-time data for daily concentration. Monitors are used with different replaceable field sensors to detect different noxious gasses in ambient air. Monitors measure concentration of gas continuously and relate against user-configurable alarm values. Simply operate with three buttons with text menu and password protection. Monitors provides the most sensing and alarm capabilities of any single gas monitor at one time.

2.1.2 Noise Data:

Digital sound level meter is used to collect noise data at different five busiest routes of Hyderabad city during morning and evening. Digital sound level meter has been made to meet measurement requirement of health, safety engineer, and sound quality control in various environment which include traffic, factory office, audio system and family.

This equipment has following functions:

- lt is designed according to th6 lEC651 TYPE2 & ANSI S1.4 TYPE2
- Modern and portable design
- Accuracy up to ±1.5 dB
- Measurement range: 30 dBA-1 30 dBA
- MAX Hold
- Auto backlight display
- Auto power OFF

2.2 Human Health Risk Assessment

Human health risk methodology is taken from various publication such as (Mokhtar et al., 2014) and (Doe, 2012) risk assessment of human health includes four steps as shown in figure 2 which is taken from US EPA website.

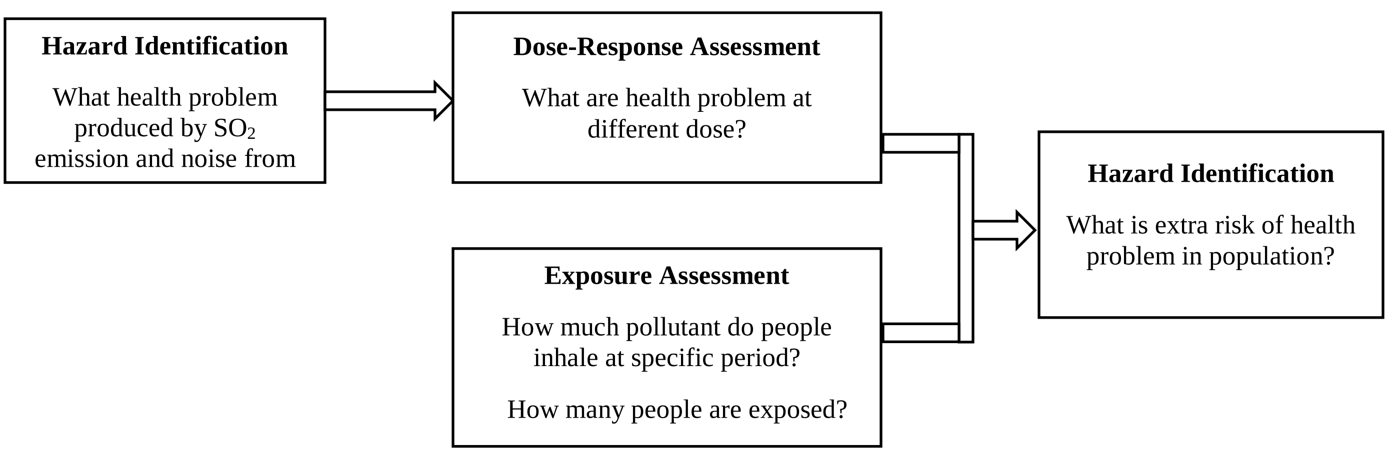


Fig-2 Human health risk assessment

2.3 Hazard Identification

The key pollutants from vehicles that may affect the human health are SO_2, CO, NOx, CO_2 and noise. In this study SO_2 and noise were selected for health risk assessment. Due to lack of device and data availability CO, NOx and CO_2 were not taken into account.

2.4 Dose-Response Assessment

Dose response is quantitative process to notice link between hazard to dose exposure in question and existence health effects. Every day mortality and morbidity due to every day concentration of air pollutants has been reported by an association (Levy, Hammitt, Yanagisawa, & Spengler, 1999). US EPA has developed cancer slop factors (CSFs) for carcinogenic effects, though for non-carcinogenic health effects inhalation reference concentration (RfC) and reference dose (RfD) are used to define link. RfC is taken from ATSDR, WHO guidelines and NEQS.

2.5 Exposure Assessment

The present study is simplified by analyzing exposure of people living and working surrounding the study area. All age people were considered. Differentiation by sex were not made (Meneses, Schuhmacher, & Domingo, 2004). Human exposure to SO_2 and noise were predicted by using SO_2 monitor and digital sound level meter. These devices were used to find noise level during the morning and evening and average daily concentration of SO_2 to assess short term human health risk. The pollutants concentration and noise level measured by SO_2 monitor and digital sound level meter are used as input to assess human health effects due to SO_2 emissions and noise from vehicles (Mokhtar et al., 2014).

2.6 Risk Characterization

Risk characterization for non-cancer causing health risk due to inhalation, by quantifying the hazards using hazard quotients (HQ) that is define as follows (US-EPA, 2005; Doe, 2012).

$$HQ = EC/RfC \tag{1}$$

Where

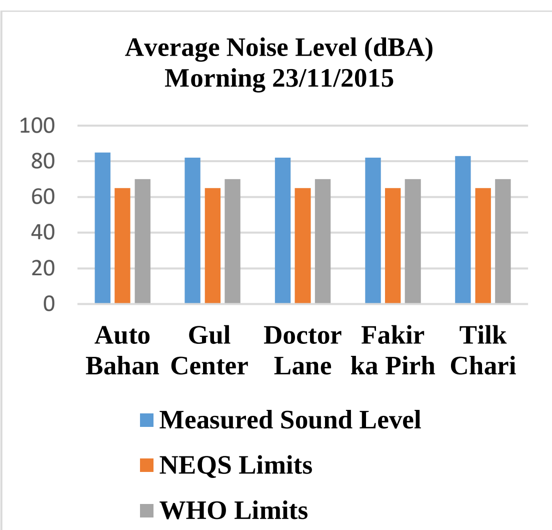
EC = exposure air concentration (µg/m3)

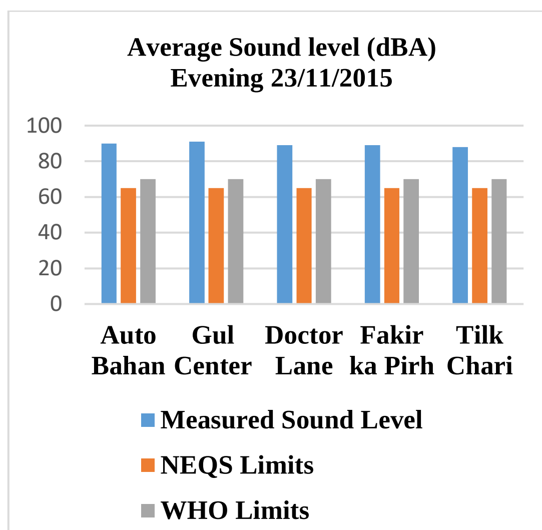
RfC = reference concentration (µg/m3)

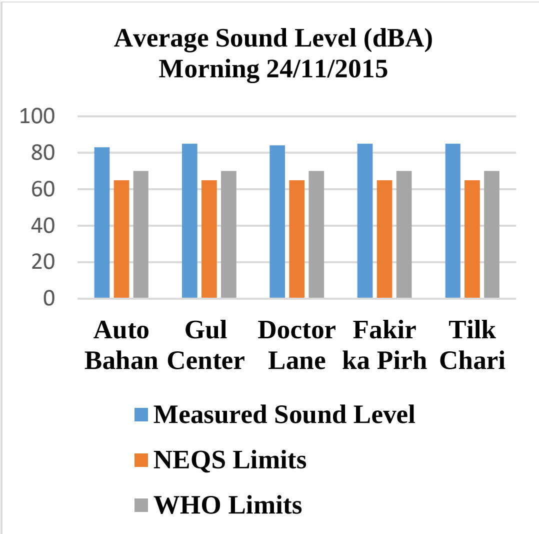
When HQ is less than one (HQ<1) shows that pollutants concentration below reference concentration (RfC) value, where no action is required to reduce pollutants level because pollutants are within limit and within that limit there is no potential risk. It would be pointed that HQ>1 does not crucial possibility of adverse health effects. It is more appropriate to use warning potential risk of adverse health effects can be occurred.

3. RESULTS AND DISCUSSION

3.1 Average noise level during morning and evening






Average Sound Level (dBA)
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Doctor Lane
Fakir ka Pirh
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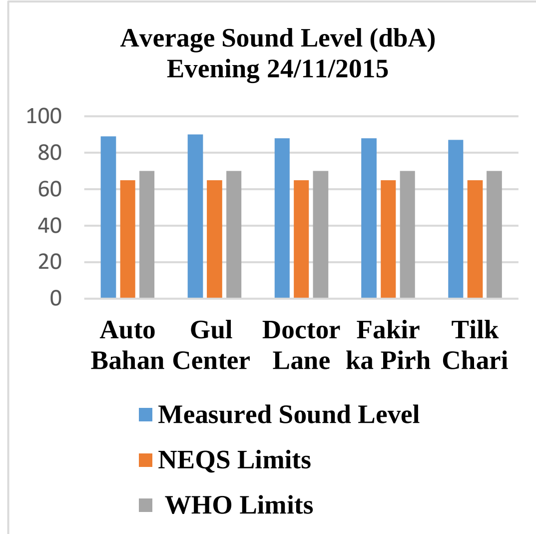
Measured Sound Level
NEQS Limits
WHO Limits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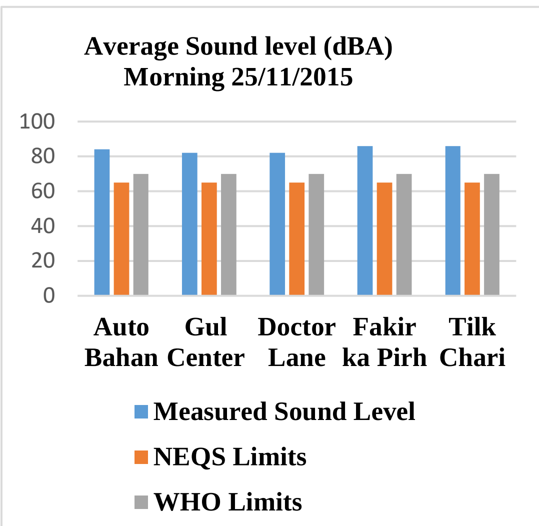
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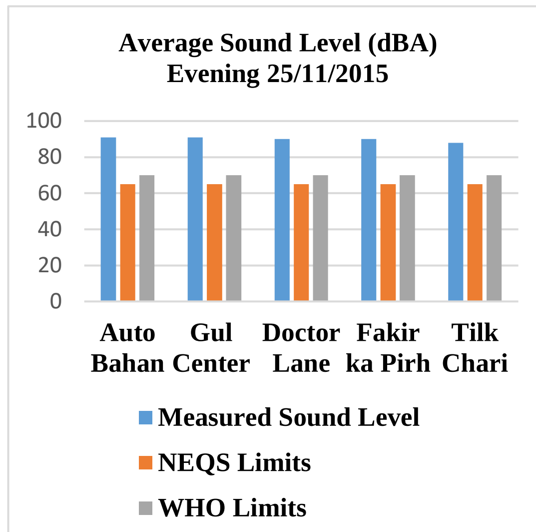
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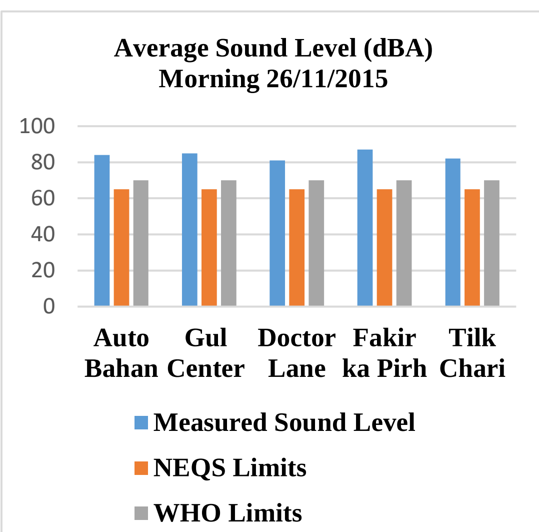
Measured Sound Level
NEQS Limits
WHO Limits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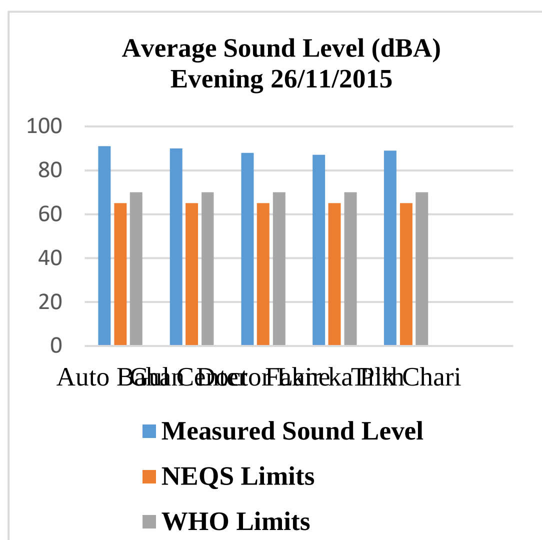
Measured Sound Level
NEQS Limits
WHO Limits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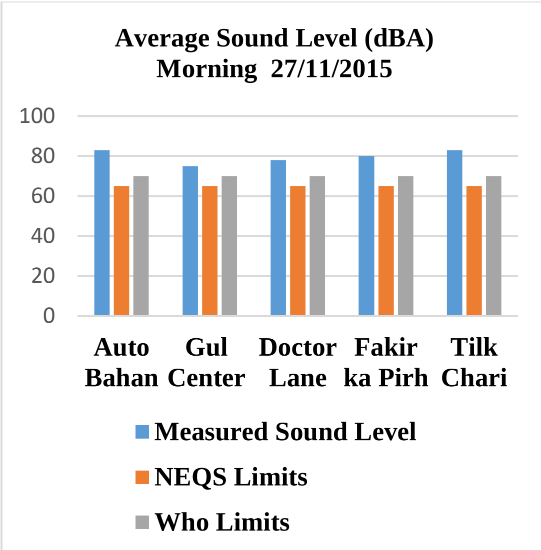
Average Sound Level (dBA)
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Measured Sound Level
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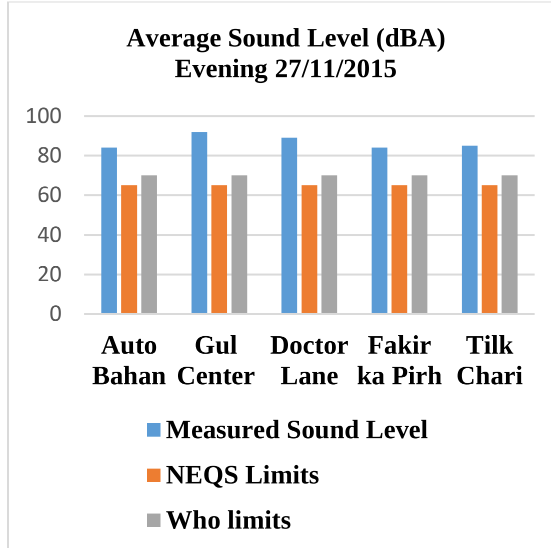
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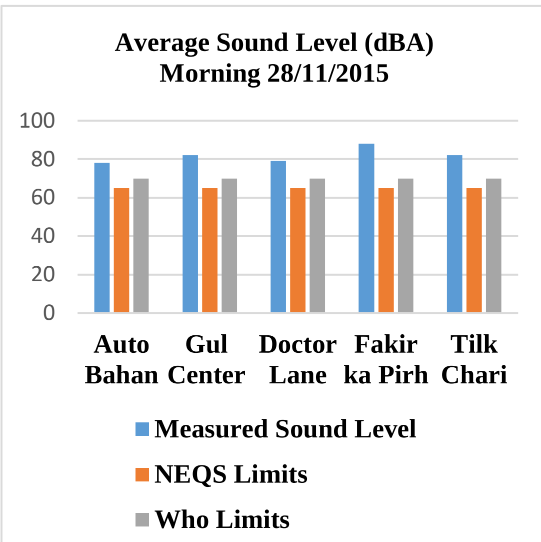
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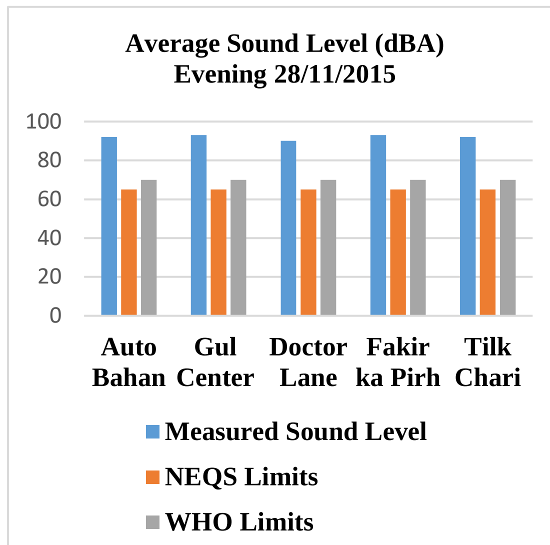
Fakir ka Pirh
Tilk Chari
Measured Sound Level
NEQS Limits
Who Limits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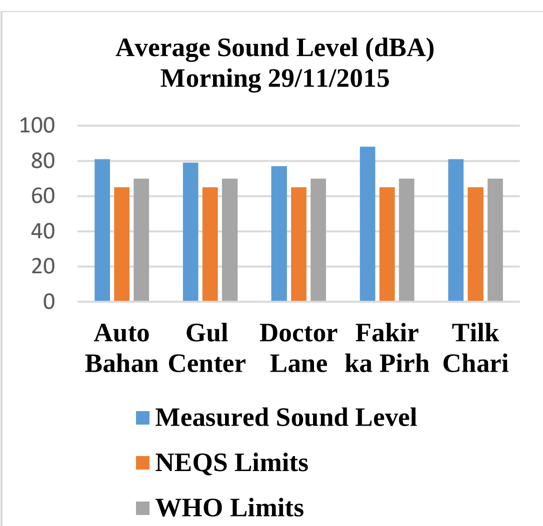
Tilk Chari
Measured Sound Level
NEQS Limits
WHO Limits


Average Sound Level (dBA)
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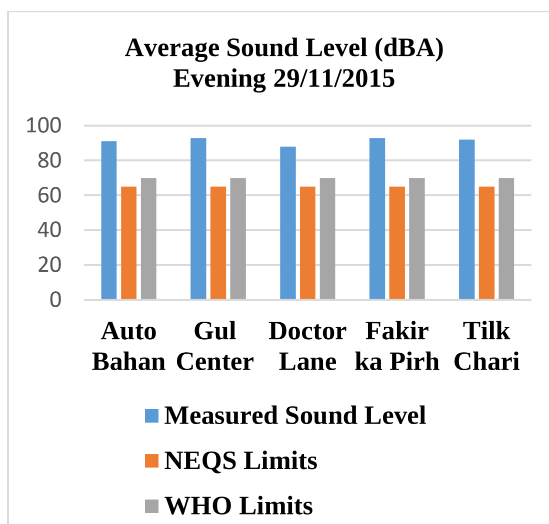
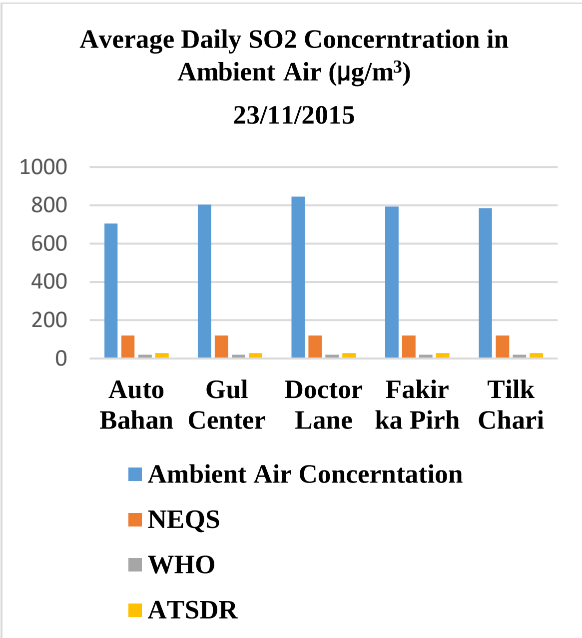
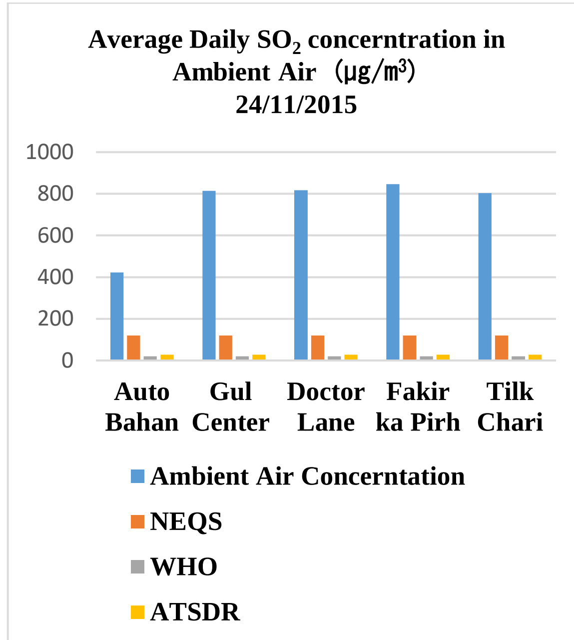
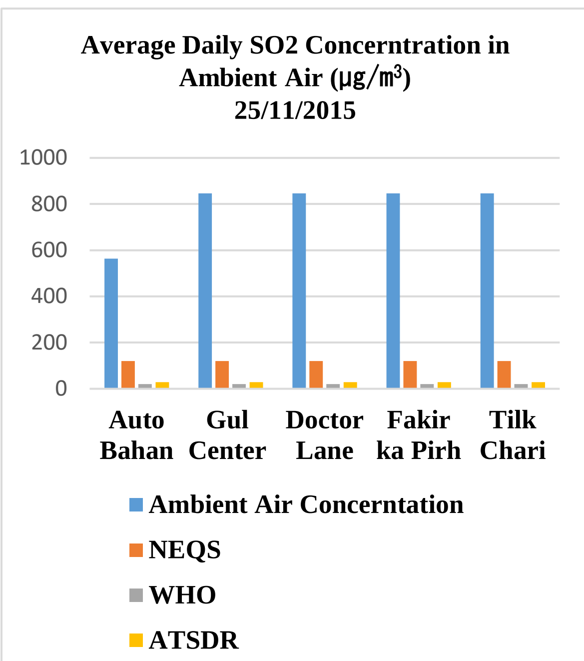
Gul Center
Doctor Lane
Fakir ka Pirh
Tilk Chari
Measured Sound Level
NEQS Limits
WHO Limits

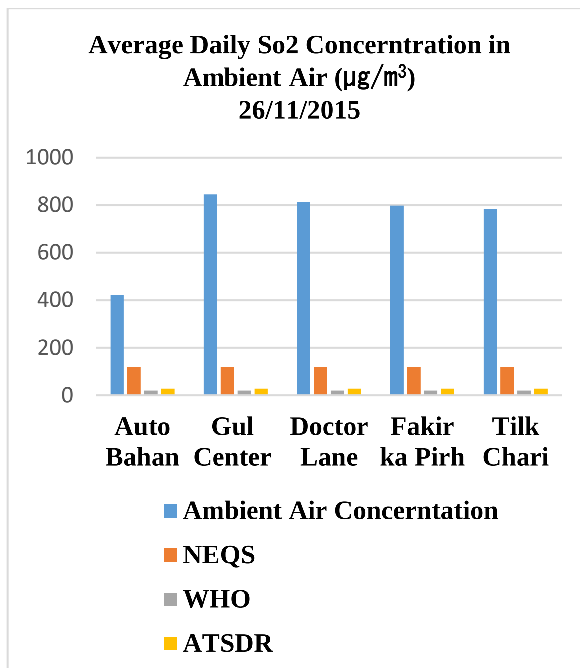

Average Sound Level (dBA)
Evening 29/11/2015
100
80
60
40
20
0
Auto Bahan
Gul Center
Doctor Lane
Fakir ka Pirh
Tilk Chari
Measured Sound Level
NEQS Limits
WHO Limits

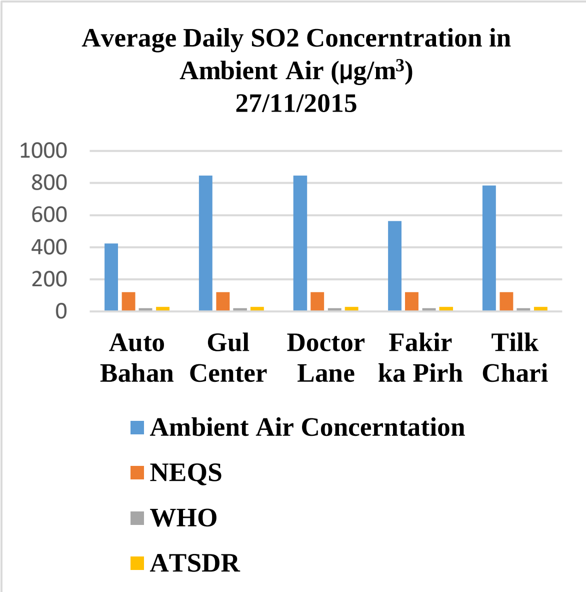
3.2 Daily average SO_2 concentration

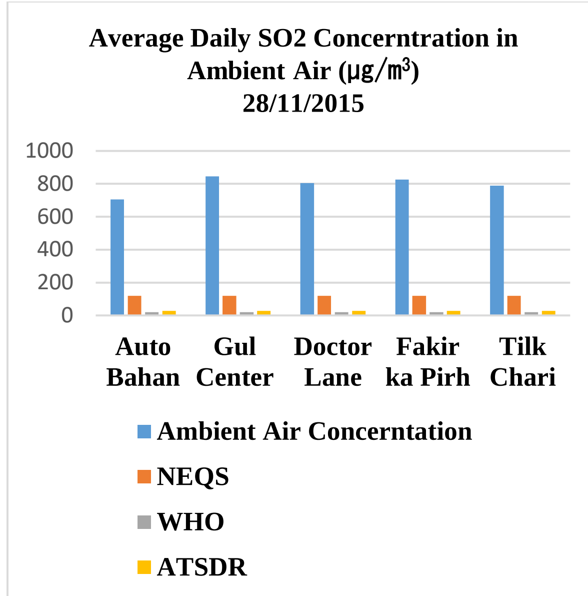


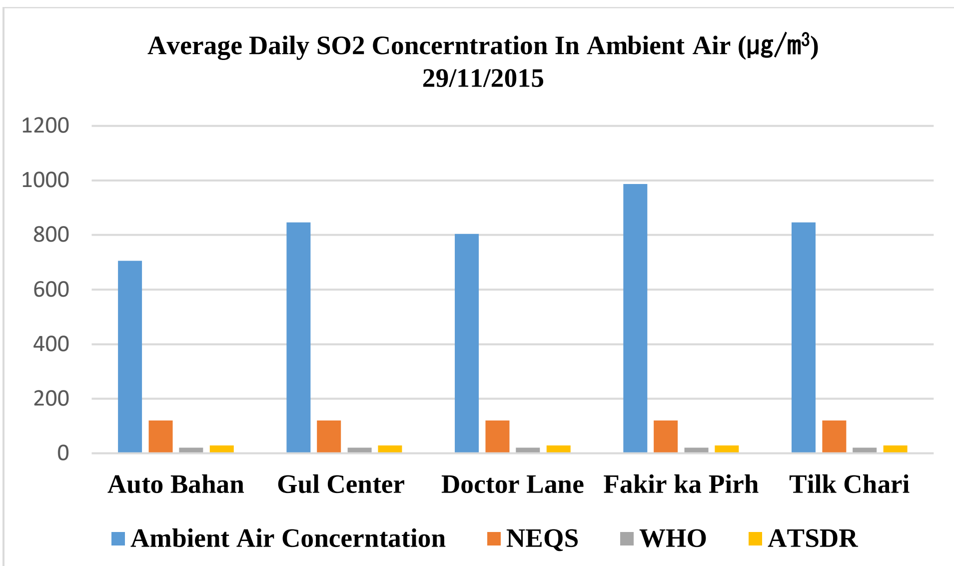












From weekly studied we assessed risk of human health from daily exposure of SO_2 and noise emitting from vehicles at five busiest routes of Hyderabad city from 23rd Nov 2015 to 29th Nov 2015. The result found regarding SO_2 were exceeding WHO guideline and NEQS for ambient air. For human health risk assessment, we compare the results of SO_2 with Agency for Toxic Substance Diseases Registry (ATSDR) which suggest reference concentration of SO_2 is 28.2 µg/m^3 (ATSDR, 1998) and daily exposure concentration of SO_2 in whole week is much higher than reference concentration it means hazard quotient (HQ) are greater than 1 which means SO_2 emitting from vehicles at different five busiest routes of Hyderabad city has potential impact health of people living and working surrounding the Studied area. Similarly reference concentration of noise is taken from WHO guideline and NEQS Standards. These standards suggest that reference concentration in commercial area of noise are 65dBA and 70dBA respectively and exposure concentration of noise in whole week are greater than both reference concentration it means noise produce from vehicles engines and unusual horns can impact health of people living and working surrounding the study area. Especially shopkeeper and traffic police men are more vulnerable because they are continuously working there. the finding suggests that there is need to have detail evaluation on short term and long term health effects from air pollutants and noise producing from vehicles in Hyderabad city. In this study we have only assess short term health risk from SO_2 and noise but we did not assess long term health risk due to lack of availability devices for long term.

References

Ahmed, D., Zubair, A., Begum, A., & Khan, M. U. (2014). Investigation and Evaluation of Ambient Air Quality in Various Parts of Karachi Metropolitan City , Pakistan, *21*(1), 234–243. http://doi.org/10.5829/idosi.mejsr.2014.21.01.21152

Ashraf, N., Mushtaq, M., Sultana, B., & Iqbal, M. (2013). Preliminary monitoring of tropospheric air quality of Lahore City in Pakistan, *3*(2), 19–28.

ATSDR. (1998). Public Health Statement - Sulfur Dioxide. *Public Health*, 7. Retrieved from www.atsdr.cdc.gov/

Bruce, N., Perez-Padilla, R., & Albalak, R. (2000). Indoor air pollution in developing countries: a major environmental and public health challenge. *Bull.World Health Organ*, *78*(9), 1078–1092. http://doi.org/10.1590/S0042-96862000000900004

Doe. (2012). Guidance Document On Health Impact Assessment (HIA) In Environmental Impact Assessment (EIA), (2), 12.

Hassan, M., Malik, A. H., Waseem, A., & Abbas, M. (2013). Air pollution Monitoring in Urban Areas due to Heavy Transportation and Industries: a Case Study of Rawalpindi and Islamabad. *Journal of the Chemical Society of Pakistan*, *35*(6), 1623–1629.

Kalaiselvi, R., & Ramachandraiah, A. (2016). Honking noise corrections for traffic noise prediction models in heterogeneous traffic conditions like India. *Applied Acoustics*, *111*, 25–38. http://doi.org/10.1016/j.apacoust.2016.04.003

Levy, J. I., Hammitt, J. K., Yanagisawa, Y., & Spengler, J. D. (1999). Development of a New Damage Function Model for Power Plants: Methodology and Applications. *Environmental Science & Technology*, *33*(24), 4364–4372. http://doi.org/10.1021/es990634+

Marathe, P. D. (2012). Traffic noise pollution. *Ijed*, *9*(1), 63–68.

Meneses, M., Schuhmacher, M., & Domingo, J. L. (2004). Health risk assessment of emissions of dioxins and furans from a municipal waste incinerator: Comparison with other emission sources. *Environment International*, *30*(4), 481–489.

Mokhtar, M. M., Hassim, M. H., & Taib, R. M. (2014). Health risk assessment of emissions from a coal-fired power plant using AERMOD modelling. *Process Safety and Environmental Protection*, *92*(5), 476–485.

Taylor, E. T. (2016). GASEOUS AIR QUALITY INDICATORS ALONG TRAFFIC ROUTES IN GREATER FREETOWN , SIERRA LEONE, (December). http://doi.org/10.18488/journal.10/201

Kassar, Ghulam Abbas. "Demography of Sindh." 6 february 2013: 4.

An analysis of human errors leading to accidents taking into account existing theories and systems

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Abstract: The accidents due to human errors while operating equipment are an issue that many researchers are trying to address for last many decades which has become an increasingly important topic for researchers. Wiegmann (2005) described six main human error perspectives i.e. cognitive, ergonomic, behavioral, aeromedical, psychosocial and organizational which provide the foundation for further investigation and analysis of human error in accidents.

Wiegmann & Shappell (2005) provided Human Factor Analysis and Classification System (HFACS) model for human error identification and for investigation of an accident which can be tailored to other fields. Unsafe acts of workers may be either due to errors or violations. The examples of errors may be over control of equipment, over reliance on automatic features of equipment, neglect to watch or interruption etc. Baker & McCafferty (2005) gave main causal factors underlying human errors i.e. task omission, situation assessment & awareness etc. This study has also used data from US Department of Labor (2016). Finally, a case study of Three Mile Island (TMI) supports the earlier conclusions of human error perspectives that the main element in accidents was presence of human error accompanied by design equipment failure.

1. INTRODUCTION

An error is doing or lack of doing an act which act or lack of action that breaks some prescribed standards of the organization which can be described as non-conformity to accuracy of work. Human errors are responsible for numerous accidents in many industries such as in Three Mile Island (TMI), Bhopal and Chernobyl etc.

Currently, many developments in formation of rules and regulations to minimize the human errors have resulted in availability of numerous systems and persons employed to prevent human errors in equipment. To analyze the human errors at work, we first have to identify broad perspectives encompassing human nature. Wiegmann (2005) described six main human error perspectives cognitive, ergonomic, behavioral, aeromedical, psychosocial and organizational which provide the foundation for further investigation and analysis of human error in accidents.

Wiegmann & Shappell (2005) provided Human Factor Analysis and Classification System (HFACS) model for human error identification and for investigation of an accident which can be tailored to other fields. Baker &

McCafferty (2005) gave main causal factors underlying human errors i.e. task omission, situation assessment &awareness etc. This study has also used data from US Department of Labor (2016). The main top 10 frequently cited standards by Federal OSHA in fiscal year 2015 include fall protection, construction and hazard communication standard, general industry etc. Finally, a case study of Three Mile Island (TMI) supports the earlier conclusions of human error perspectives that the main element in accidents was presence of human error accompanied by design equipment failure.

1.1 OBJECTIVES

The overall objectives of the study are:

i. To analyze the wide perspectives around human nature which can lay the foundation for further analysis of human errors causing accidents.
ii. To study the accident and investigation models such as HFACS for analyses of human errors.
iii. To review the data / statistics of US Department of Labor and OSHA for accidents due to human errors.
iv. To review the Three Mile Island (TMI) accident in support of analyses.

2. LITERATURE REVIEW

Wiegmann &Shappell (2005) observed that the outcomes of analyses help the organizations to enhance methods and techniques for preventing accidents in addition to providing direction for future investigations. And, Johnson (1999) observed that frequency of human errors is also enhanced by organization failure and inadequate managerial and regulatory controls. Pillay (2015) found that technological progress have outperformed the way the industries accomplish safety.

Human error cannot be viewed in isolation but a systems approach is needed for ensuring safety. Such as Munro (2008) concluded that approach to understanding human error has shifted to system centered focus which considers the multifaceted interrelation among large number of factors including human nature, design of equipment and organizational environment. And, Cintron (2015) found that organizations and their leadership should coordinate to make an environment of frankness and reporting which will ensure the application of investigative methods.

Researchers now also support composite analysis covering possibly all aspects of organization and human nature. Saari (1995) identified five types of analysis i.e. analysis for place and types of accidents, for monitoring developments which may be positive or negative, for prioritization of preventive measures, for implementation of corrective action and for discovery of new areas of risk.

Nadhim (2016) stressed the need for adopting new research methods as future research would be more interdisciplinary which would require simultaneously the knowledge of information technology, behavioral methods, system approach and ergonomics in order to create a combined approach to handle risks. As McIntosh (2000) pointed out that the accidents are combination of human error, equipment failure and management approach.

The researcher therefore finds a gap in addressing of risks as the work on combined holistic approach is lacking and is comparatively a new area in human factor in accidents and would therefore try to fill this gap.

3. METHODOLOGY

This research will be descriptive research which will also use secondary data of reported human errors. According to Kothari (2004) the main aim of descriptive research is the explanation of state of affairs as it exists at present. And, Kirsh & Suilvan (1992) observed that merging many methods allows the researcher to look into the diversity that accompanies any human behavior and allows him to resist making isolated monolithic theory. Thus, the researcher aims to study the human error with the following methodology:

- Study the various perspectives of human nature which act as foundation for any further analysis of human errors leading to accidents,
- Study a well-recognized system such as HFACS which will help in analyzing and investigating accidents from the perspective of human error, thus, building upon the perspectives mentioned in the above methodology,
- Analyze the available data or literature on human errors and accidents to build on the analysis in the above mentioned first two methodologies. Such analysis will include:
    - Study of reported causal factors with human errors,
    - OSHA statistics on main causes of accidents due to human errors,
    - Frequently reported OSHA standards violations,
    - Other data relating to human errors and accidents.
- Support the conclusions and analysis in above methods with a case study of a major accident.

4. ANALYSIS

The presence of existing studies and increasing number of rules and frameworks imply that great number of industries and individuals are anxious about this field of study. In this study analysis is divided into following areas to arrive at suitable conclusion:

4.1 Human perspectives and human errors

To analyze the human errors at work, we first have to identify broad perspectives encompassing human nature. In this analysis, the role of these perspectives will be studied before pointing to further analysis. Wiegmann (2005) described six main human error perspectives as shown in Figure 1.

i. **The Cognitive Perspective:** This perspective assumes the human mind as a modern computer which can analyze the information received through senses i.e. eyes, smell etc. and can then conduct mental examination of the information to arrive at conclusion or solution. This perspective however does not consider task related factors such as equipment design or environmental conditions such as fatigue etc.

ii. **The Ergonomic Perspective:** It is also called systems perspective. It assumes that human errors are due to interaction of many factors such as link between humans and their equipment and machines. This, connection is so important that it is taken into account in every step of design process.

iii. **The Behavioral Perspective:** This perspective may take into account human ability and motivation of the individual which may in turn depend on reward and punishment models resulting in satisfaction or dissatisfaction. The factors which may influence it are job environment, peer groups, ability, training and job itself.

iv. **The Aeromedical Perspective:** This model assumes that errors are indicators of underlying mental or physiological conditions such as sickness or tiredness.

v. **The Psychosocial Perspective:** This perspective assumes the relations between operator and other persons working around him such as supervisor, colleagues, staff etc. affect the quality of performance given by him. This interaction is also affected by personalities and attitudes.

vi. **The Organizational Perspective:** This perspective assumes that happening of accident is the natural end of line of events which occur in a fixed and rational order.

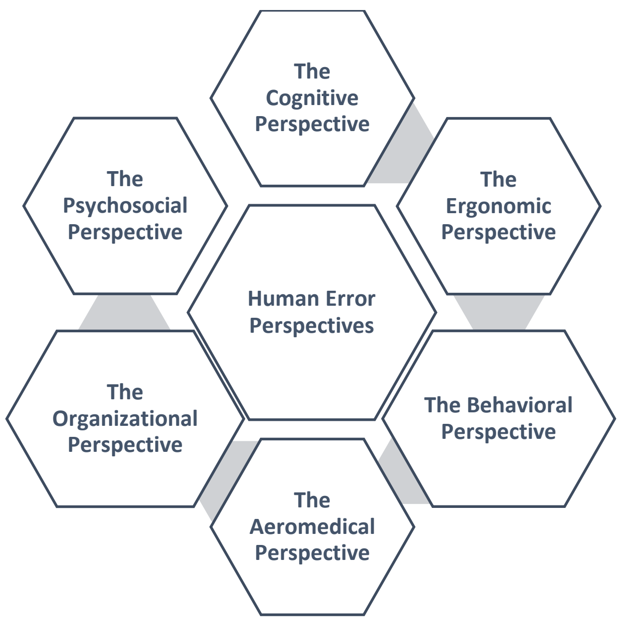

Figure 1. Human error perspectives as given by Wiegmann (2005)

4.2 Human Factor Analysis and Classification System (HFACS)

HFACS investigates the human reason of an accident and gives a means to help in the analysis procedure. It was created by Dr Scott Shappel & Dr Doug Wiegmenn, Civil Aviation Medical Institute and University of Illinois at Urbana-Champaign, USA. Cintron (2015) observed that HFACS is used as a tool in various fields such as military, maritime, mining & railroad industries etc. and described it as a useful tool for human error identification and for investigation of an accident which can be tailored to other fields. He analyzed that this was due to easier use of HFACS, its adaptability to various fields and achievement of uniform analysis as shown in Figure 2.

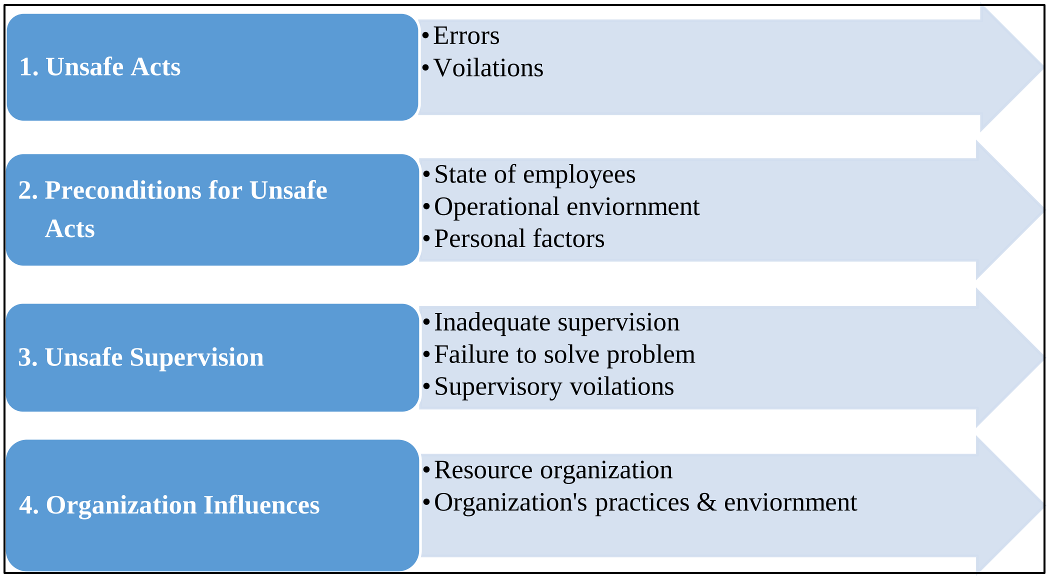

Figure 2.Human Factor Analysis and Classification System (HFACS) in an organization

The unsafe acts in the forms of errors and violations may lead to accidents. The errors may result due to wrong or inability to take decisions, misjudging the scenario, failure to comply with rules and regulations or manuals, and, use of improper techniques etc. Violation of rules may also result in accidents. The violations may be routine or exceptional. Routine violations may be failing to comply with manuals or unauthorized approach etc. while exceptional violations may be unauthorized acts or improper working techniques etc. Preconditions for Unsafe Acts include poor condition of operators, personnel factors, environmental factors, unsafe supervision, organizational influences etc.

4.3 Human errors& causal factors

Baker & McCafferty (2005) observed that main causal factors underlining human errors may be task omission, lack of situation assessment or awareness etc. as shown in Table 1:

Table 1: Causal factors leading to accidents in ship design

Sr. #	Causal Factors	Count
1.	Task omission	16
2.	Situation assessment & awareness	15
3.	Knowledge, skills and abilities	13
4.	Mechanical / material failure	06
5.	Procedures	05

4.4 Main reasons for injury at work – The fatal four

US Department of Labor (2016)in Occupational Safety and Health Administration (OSHA), found out Falls as main cause of labor injury with 39.9% of total deaths in construction followed by Electrocution (8.2%), Struck by Object (8.1%), and, caught in between (4.3% i.e. compressed by equipment or object and / or crushed in collapsing structure etc.). OSHA termed these as ‘fatal four’.

4.5 Frequent OSHA standards violations

The following were the top 10 most frequently cited standards by Federal OSHA in fiscal year 2015 (October 1, 2014, through September 30, 2015):

1. Fall protection, construction.
2. Hazard communication standard, general industry.
3. Scaffolding, general requirements, construction.
4. Respiratory protection, general industry.
5. Control of hazardous energy (lockout/tagout), general industry.
6. Powered industrial trucks, general industry.
7. Ladders, construction.
8. Electrical, wiring methods, components and equipment, general industry.
9. Machinery and Machine Guarding, general requirements.
10. Electrical systems design, general requirements, general industry.

4.6 Incident rates of non-fatal workplace injury

The US Department of Labor (2016) showed following incident rates of non-fatal workplace injuries and illnesses.

Table 2: US Department of Labor (2016): incident rates of non-fatal workplace injuries and illnesses

(Thousands)

Sr. #	Industry	Total Recordable Cases	Cases with days away from work, job transfer, or restriction		
			Total	Cases with days away from work	Cases with job transfer or restriction
1.	State and Local Government	3.3	1.7	1.0	0.7
2.	Private Industry	3.0	1.6	0.9	0.7
3.	Goods producing	3.7	2.1	1.1	1.0
4.	Construction	3.5	2.0	1.3	0.6
5.	Manufacturing	3.8	2.2	1.0	1.2
6.	Service providing	2.9	1.5	0.9	0.6
7.	Educational & Health Services	4.0	1.9	1.1	0.8

The Bureau of Labor Statistics (2016) compiled categories affected by incorrect rate data which provides the information about the fatal injury rate in various industries as shown below:

Table 3: The Bureau of Labor Statistics (2016): categories affected by incorrect rate data showing fatal injury rate in various industries

Category	Grouping	Total Hours Worked (corrected)	Fatal injury rate (corrected)
First-line supervisors/managers of construction	Occupation	1,493	17.4

trades and extraction workers			
Carpenters	Occupation	2,393	4.8
Construction laborers	Occupation	3,078	13.3
Operating engineers and other construction equipment operators	Occupation	700	8.0
Electricians	Occupation	1,563	10.0
Painters, construction and maintenance	Occupation	999	9.2
Pipe layers, plumbers, pipefitters, and steamfitters	Occupation	1,143	5.6
Roofers	Occupation	356	46.1
Structural iron and steel workers	Occupation	106	28.3
Other extraction workers	Occupation	232	18.1
First line supervisors of food preparation and serving workers	Occupation	1,907	2.0
Sales and related workers	Occupation	28,388	1.7
Wood manufacturing	Industry	785	10.7
Merchant wholesalers, durable goods	Industry	3,522	6.0
Asian, non-Hispanic	Race/Ethnicity	15,382	1.8

4.7 Case Study- THREE MILE ISLAND (TMI)

In March, 1979, a plug was created in resin bed used to purify process water in the nuclear plant. The operator, trying to remove plug, erroneously hooked air-line into the water line. But, water rushed into the air line as water had created higher pressure than the air, and water went into the pneumatic valves used for controlling entry of cooling water to the core of nuclear reactor. Resultantly, core became pressurized and overheated. 90% of reactor core was damaged and small quantity of radioactive gas was released into the atmosphere.

As pointed out by McIntosh (2000), this was the case of human error and minor malfunction. The human error was in the form of misjudgment due to this minor malfunction in the equipment which was supported by other malfunctions. Thus, the main element was absence of knowledge of reactor during this crisis accompanied by design equipment failure.

1. Discussion

Therefore, falls, slips and trips were the top most reasons for occupational injuries. The human factor therefore cannot be viewed in isolation and any organization can be viewed as a set of individual parts working together based on the assumption that there are fundamental elements of all organizations that must work together smoothly for achievement of safety and productivity. Thus, this consists of an efficient structure of which human factor is an integral part. This also requires safe human-machine interaction and considerations for avoiding unsafe acts of operators that may lead to errors and accidents.

A gap in analysis, development and use of preventive system exists which this study has tried to fill. What is really missing in HFACS is an emphasis on error-producing factors related to equipment design. After the accident, it is always easy to identify where supervisors or management should have paid more attention. It may be more meaningful to compare it with other similar tools. The current accidents can be categorized now allowing for analysis of trends rather than after years of delay.

2. Conclusion

In closing, the researcher has emphasized three main points that have emerged from this study. The first relates to the main human error perspectives for studying of human errors leading to accidents. Six dominant perspectives have been identified by Wiegmann (2005) described six main human error perspectives i.e. The Cognitive Perspective, the Ergonomic Perspective, the Psychosocial Perspective, the Organizational Perspective, the Aeromedical Perspective and the Behavioral Perspective. These perspectives provide the basic understanding of why human errors occur. Although, these may not be conclusive cause of any accident but their understanding surely will create a foundation for a well-established analysis of safety measures and in equipment design process. Hence, their understanding is the cornerstone of any analysis for role of human factor in accidents.

Next, the HFAC is used as a tool and has unique feature of adoptability and can be used in various fields for human error identification. Its analysis consists of studying unsafe acts, pre-conditions for unsafe acts, unsafe supervision and organizational supervision. The unsafe acts may lead to accidents and may be in the forms of errors and violations.

The second point as identified by Baker & McCafferty (2005) is of pointing out the main causal factors underlining human errors, which may be task omission, lack of situation assessment or awareness etc. US Department of Labor (2016) found out falls as the main cause of injury, followed by electrocutions and struck by object. OSHA pointed out main standard violation which includes fall protection, hazard communication standard, respiratory protection etc.

Finally, available statistics was also used to identify the fatal injury rate in various industries. The Bureau of Labor Statistics (2016) found roofers, structural iron and steel workers and extraction workers have the highest fatal rate injuries followed by Construction laborers, electricians and wood manufacturing. It identified merchants, supervisors, sales and related workers as the professions with lowest fatal rate injuries.

REFERENCES

1. Baker C.C &McCafferty D.B. (2005) '*Accident database review of human element concerns: What do the results mean for classification?*', ABS Technical Papers 2005, Presented at the Human Factors in Ship Design, Safety and Operation held in London, February 23-24, 2005 http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.639.2187&rep=rep1&type=pdf [Accessed 30 November, 2016]

2. Bureau of Labor Statistics (2016) *'US Department of Labor', https://www.bls.gov/bls/errata/cfoi-errata-2016.htm*, [Accessed 14th December, 2016]
3. Cintron R (2015) 'Human Factors Analysis and CLASSIFCATION System Interrater Reliability for Biopharmaceutical Manufacturing Investigations', *Walden University Scholar Works*, http://scholarworks.waldenu.edu/cgi/viewcontent.cgi?article=1193&context=dissertations, [Accessed 4th December, 2016]

4. Johnson C (1999)*'Visualizing the Relationship between Human Error and Organizational Failure'*, Department of Computing Science,University of Glasgow, Glasgow<http://www.dcs.gla.ac.uk/~johnson/papers/fault_trees/organisational_error.html, [Accessed 16 November, 2016]

5. Kirsh G & Suilvan P.A (1992) Methods and Methodology in Composition Research, SIU Press, https://books.google.com.pk/books?hl=en&lr=&id=cW_vrdU1FFQC&oi=fnd&pg=PP7&dq=methodology+for+research&ots=CaCNt3TRwJ&sig=qcIqHg8WiqPbBR7dV36UTWV6woo#v=onepage&q=methodology%20for%20research&f=false

6. Kothari C.R. (2004) Research Methodology, Methods and Techniques, New Age International, pp. 2, https://books.google.com.pk/books?hl=en&lr=&id=hZ9wSHysQDYC&oi=fnd&pg=PA2&dq=methodology+for+research&ots=1r-9sDiZI0&sig=DtoNgeUICdxJcT6a-JiT_2lqKcE#v=onepage&q=methodology%20for%20research&f=false [Accessed 15th December 2016]

7. McIntosh B.C (2000) Major Industrial Accidents: The Reasons and the Reactions, *'University of Tennessee, Honors Thesis Projects, 8-2000* http://trace.tennessee.edu/cgi/viewcontent.cgi?article=1410&context=utk_chanhonoproj, [Accessed 10th December, 2016]

8. Munro E (2008) 'A review of safety management literature', *Social Care institute of excellence,* London School of Economics http://www.scie.org.uk/publications/guides/guide24/files/literaturereview.pdf?res=true [Accessed 02 December, 2016]

9. Nadhim E.A et al. (2016) 'Falls from height in the construction industry: A Critical Review of the Scientific Literature', International Journal of Environmental Research and Public Health, MDPI, www.mdpi.com/1660-4601/13/7/638/pdf [Accessed 8th December, 2016]

10. Pillay M (2015) *'Procedia Manufacturing'*, 6th International Conference on Applied Human Factors and Ergonomics (AHFE 2015) and the Affiliated Conferences, AHFE 2015, Science Direct <http://www.sciencedirect.com/science/article/pii/S2351978915002255, [Accessed 22 November, 2016]

11. Saari J (1995) 'Chapter 56 – Accident Prevention', *Encyclopedia of Occupational Health and Safety, From the international labor office'*, http://www.ilocis.org/documents/chpt56e.htm [Accessed 6th December, 2006]

12. US Department of Labor (2016) in Occupational Safety and Health Administration (OSHA) https://www.osha.gov/oshstats/commonstats.html [Accessed 15th December, 2016]

13. US Department of Labor (2016)*'Bureau of Labor Statistics'*https://www.bls.gov/news.release/pdf/osh.pdf [Accessed 16th December]

14. Wiegmann D A &Shappell S.A (2005) *'A Human Error Approach to Aviation Accident Analysis & Classification System'*, MPG Books Ltd, Bodmin, Cornwall, Ashgate, https://dvikan.no/ntnu-studentserver/reports/A%20Human%20Error%20Approach%20to%20Aviation%20Accident%20Analysis.pdf, [Accessed 14 November, 2016]

OPTIMIZATION OF DISTRIBUTION SYSTEM BY USING CLUSTERING TECHNIQUE

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Abstract: Optimising distribution network is becoming a great challenge for supply chain managers. Setting the best possible framework and selecting the right transporters brings quick cost advantages to firms in competition. This research is a case study which is focused on providing solution to the supply chain curb for Dabur to maximize its profit gains and customer satisfaction. Dabur, a fast moving consumer goods company is faced with a plight of supply chain in the province of Khyber Pakhtunkhawa, in terms of late deliveries which consequently has resulted in lost sales. The distribution centres in KPK region rely on deliveries from Lahore warehouse which works on the principle of full truck load. Complete cost and delivery time analysis of warehousing and clustering has been done to reach an optimal solution that suggests establishment of a 3PW at Nowshera along with 3 regional clusters.
Keywords: Optimization, distribution, late delivery, clusters.

1. INTRODUCTION

Higher demand for products with their timely delivery inflicts greater dynamism in the logistics area. By optimizing distribution networks one can save million rupees in logistic cost and it will simultaneously improve service levels. Clustering and network integration are ways of increasing the competitiveness at the national level as well as international level. Logistics cost has been reduced about 40- 50% in Europe determined by Groothedde et al.(2005). A. Bourlakis (2001) stated that clustering technique is a major component of distribution problem in reducing the complexity of final product delivery. Clustering Techniques are integrated by several authors, as a contribution to this direction our objective is to reduce the level of late deliveries by improving the on-time deliveries by applying a cluster technique in order to make transportation domain effective and scheduled.
Clustering has been examined in multifariousness fields some are: logistics, statistics, pattern recognition, data mining, sensor networks, ad-hoc networks, machine learning, partitioning of customers into clusters for delivery schedules. It might probably proliferate the margin of profit because of the planned, organized movement of vehicles. It will also help the routing problems a better solution for the vehicle to take a befitting route from the clusters. Sungyoung et al. (2008) found that clustering is an effective approach for organizing a network. Clusters analysis is the technique for easily finding identical groups even children can label out the objects of, people, buildings, animals, plants, vehicles etc.
In the context of utility, most of the areas where clusters technique is used are: 1) Biology: biologists have applied clustering technique to analyse genetic information. 2) Information retrieval: (www) has zillions of webpages and the outcomes of a question back as thousands of webpages. Clustering technique used to organise these search outcome back as small number of webpages. 3) Climate: clustering technique is used to search out the patterns in the atmospheric pressure of atmosphere in Polar Regions and ocean areas that effect on land climate. 4) Medicine & Psychology: Clustering technique has been used to identify the type of illness and condition, and this technique has been used to detect patterns of disease. 5) Business: Organizations accumulate plenty of data on customers (potential and current). Clustering technique is be used to divide the customers into various clusters for further evaluation and marketing activities.

It has been noticed that with only one mistake or delay, numerous customers will discontinue their shopping with that retailer and that will lead to a disastrous impact on customer satisfaction, brand image. Late deliveries of orders can have a negative impression on the customer’s future choices to shop with a retailer on the web, by telephone, or in the store, as per a study by Voxware (2012). Currently the company is facing problem related to late deliveries & discontinuity of products in KPK region. Due to that supply chain problem occurs because KPK region is mainly depend on the deliveries from Punjab region. Punjab is working on Full truck load concept i.e., until and unless company receives order equal to full truck load from KPK, the deliveries will not be processed which causes higher inventory problems in Punjab Distribution Center and that’s the reason why product unavailability occurs and that is the main reason the company’s sales are decreasing day by day the company is also facing the declining curve of customer in KPK region. The present study compared the current scenario of the company with the proposed clustering technique implemented in KPK region in order to reduce the late deliveries in Punjab region. Qualitative method were acquired in this paper where we broach an unadorned approach to cost efficient, distributed clustering to amortize the late deliveries, abolishing discontinuity of orders.

2. LITERATURE REVIEW

Xu Xian-haoel al; (2015). A survey conducted by the NBS in China, 3rd party distribution outlay amounted 69.20 billion dollars in 2013, expanding 32.7% more than 2012. In today's competitive business globe, various organization outscore their distribution center from 3rd party distribution centers. Organization's specific aim is to cut-down their operation expenses and focus on core competencies; in this manner, DC industries turns into a blasting business throughout the world. Ideally distribution centers can greatly improve the efficiency of logistics systems and corporates can reduce operational costs determined by Wang et al. (2012). Yang (2013) Examine that; after years of focusing on the reduction of production and operational costs, corporates are now focusing on distribution activities for reducing the cost as the last frontier. DC to be a sort of warehouse where organizations can store of their merchandise which is limited. As a result, DC's concentrate on item movement and throughput (receiving orders, arranging orders, and then sending of orders), and collect information and reporting (throughput and usage, transportation documentation, damage and loss claim) rather than storage they also concluded in their research that the customers are the essential entity of this supply chain. Fundamental aim of the supply chain is to satisfying customers that will reflect the process of generating benefit for organization itself. Chopra & Meindl (2001).

Zachariah et al; (2011) analysed the effects of 3rd party logistics that an extensive variety of organizations are currently swinging to 3PL service suppliers that are now becoming critical part of today's market.

Sharma and Lambert (1994) Observed in their research that cluster analysis is a method for gathering objects into groups so that objects in the same group must have one similarity. Nananukul (2013). Determined in his research customer clustering problem is used in order to satisfy the customer needs with limited production and logistics capacity that could affect the operating cost throughout the distribution planning. Wang et al; (2014). Concluded in their research that in order to reducing the complexity of large logistics network the essential step have been carried out is to make Clusters of customers that will optimize the large logistics network. Voxware (2010). Did survey on how customers cancel their orders resulting the factor of late-delivery in orders, The outcome demonstrates that with only one mistake or delay, numerous customers will discontinue their shopping with that retailer. Late deliveries of orders can have a negative impression on the customer's future choices to shop with a retailer. An essential part of successful distributor is to give the right product at proper time to the right customer.

3. MATERIAL AND METHODOLOGY

In this section, we will be presented the proposed methodology for the clusters formation. Our approach was referred to a group of methods which specify qualitative analysis, where large number of data are collected through methods such as e-mail questionnaires, telephone interviews, or from published statistics and that data is then analyzed using statistical techniques. This survey seeks to discover the reason behind late-deliveries; calculated late-deliveries month wise and has been analyzed to take an action for improving timely delivery of products in KPK region. Thirteen months data has been analyzed through excel spread sheet including 3 factors, timely-delivery, late delivery as well as discontinuity of products as per current scenario again those 3 factors are analyzed after implementing cluster technique.

Logistics and warehousing role starts when the finished good is ready to be dispatched, called as the final part of SCM which plans, decides, implements and controls the efficiency and effectiveness of the company. The company has distributors in Sindh, Punjab and in KPK region but it has only 2 Distribution centers one is in Sindh region and the other one is in Punjab region, now the problem is Sindh region's DC covers the delivery of the products in whole Sindh region, while Punjab region DC covers the delivery of the products of Punjab region as well as in the KPK region. The deliveries of the products in KPK region are made by 1 heavy truck which is loaded with the products and covers the delivery of present month in the very next month which causes higher inventory problem in Punjab DC and when the inventory is high the product unavailability occurs in Punjab DC as well the company faces the declining curve of customers in KPK region which particularly affects the sale of the company.

3.1 Demand per month:

Table 1.Average demand per month of KPK distributors

As shown in Table.No.1 DC is chosen in Peshawar, Nowshera, D-I Khan as well as in Abbottabad because these have higher orders than other cities of KPK so after loading the warehouse of KPK then organization will use mini pickups like shezore, for delivery of small number of orders. After selecting these areas now calculating the cost as well as time, then we will decide which one is more efficient than others.

3.2 Time Factors of products from July 2015-July 2016 in KPK region

1. On-time delivery:

Distributor Name	City	Avg. Demand of Cases Per Month
S.S Enterprises	**Peshawar** 655.1862	**1599.438**
Shakir Associates		
Canteen Store Department		
Marwat Enterprises		
Waqas & Traders	**Nowshera** 199.2731	
Irfan Traders	**DI khan** 173.6085	
Muzamil Enterprises	**Abbottabad** 149.9692308	
N.M.B Enterprises		
Arfeen Traders	**Timargara** 116.6077	
Universal Enterprise	**Mardan** 85.5331	
Cyan Ex Pharma		
Habbib Uni Traders	**Swat** 82.78562	
Adil Hussain Shah Traders	**Kohat** 76.9169	
Larosh Traders	**Mansehra** 59.55769	

This includes the order booking and delivery of orders from warehouse to the distributors on desired amount of time.

2. Late delivery:

This includes the total time taken from the desired amount of time to the receiving amount of time.

3. Discontinuity:

This includes when the distributors don’t take their orders neither on-time nor late, than they cancel their orders form the company and rush towards competitors, hence discontinuity of orders occurs.

In the following percentage figure the Green colour indicates the on-time delivery of the orders, the blue colour indicates the late delivery of orders, whereas the yellow colour indicates the cancelation of orders by distributors from the month July 2015 to July 2016.
As you can see in above figure the total percentage of late delivery in KPK region is more if we are delivering orders as per current scenario.

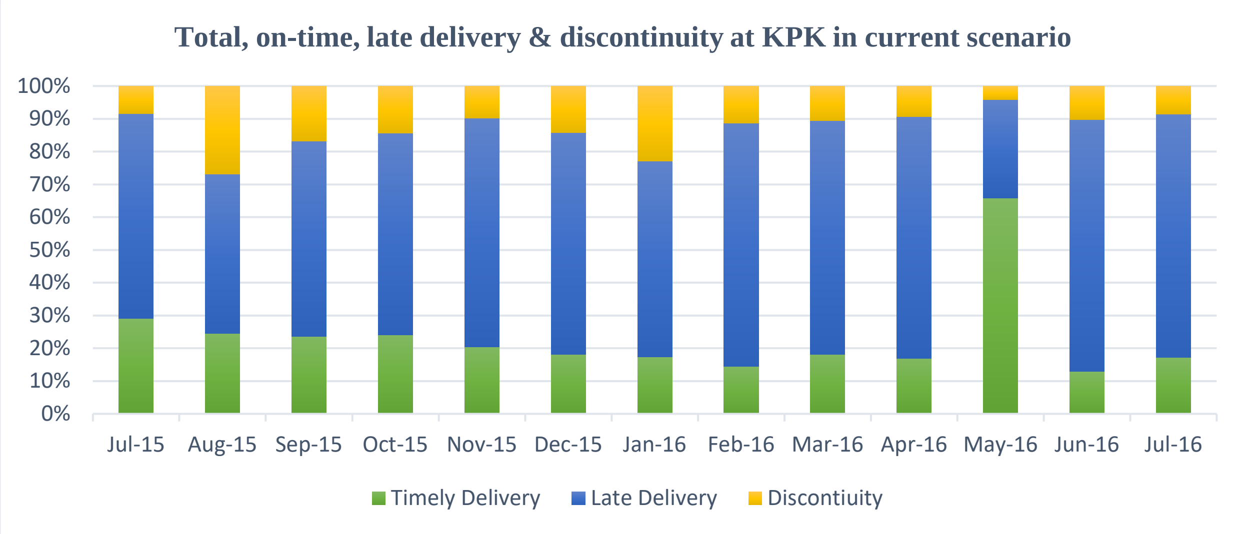

Figure 1. Total, on-time, late delivery & discontinuity at KPK in current scenario

3.3 Transportation:

Two types of transportation is used by company,

3.3.1 Primary Transportation cost:

This cost is for Trucks or container that carries Monthly orders to the KPK warehouse indicating the traveling cost traveling time of primary transportation. Transportation which is used for long distances that carry more weight than Secondary transportation. Trucks & Containers. Per km variable cost = 42/k

3.3.2 Secondary Transportation cost:

Transportation which is used for short distances that carry less weight than primary transportation. Mini pickups (eg. Shehroze, Suzuki) that carries 6.5 to 7-ton weight.
Per km variable cost = 32/k.

3.4 Clusters:

Customers order on 27 days of the month. i.e 5-31
By divide the customers into clusters. Those who are ordering on starting, middle and latter days of the month.

- Cluster No 1(5-13) move on to 13th date of the month
- Cluster No 2(14-22) move on to 22nd date of the month
- Cluster No 3(23-31) move on to 31st date of the month

With the help of excel spread sheet these 3 factors were analyzed of company's current scenario in KPK region and improved scenario after implementing clustering. Clustering technique will help to improve the timely-delivery of products which directly reduce the late deliveries, we have bound the company to delivery in three parts of the month and 3 clusters have been made in each month. 4 areas in KPK where distribution center has been suggested, top 4 cities where orders are high across the month, DI Khan, Peshawar, Nowshera and Abbottabad these 4 cities from KPK region and 1 city Lahore from Punjab, complete cost and delivery time analysis of Distribution centers and clustering has been done to reach an optimal solution that suggests establishment of a Distribution center at Nowshera along with 3 regional clusters.
This study is based on time-series data of Punjab warehouse and KPK distributors containing 13 months observations from the period july2015-july2016. The data is collected by categorizing time into on-time delivery, late delivery and discontinuity of products in KPK whereas Lahore inventories is affected by these 3 factors. As this study is carried to

find out which factors plays role of discontinuity of orders from the KPK distributors, the factors that have been taken in this study are On-time delivery of products, late deliveries of products, discontinuity of products, and total demand market in KPK. To check that whether the impact of these variables in sort out in optimization of distribution center are significant or not, top 4 cities of KPK where demand were high across the month during the time period of 13 months has been taken where we can establish a distribution center else delivering orders directly from Punjab warehouse. Excel spread sheets has been used to check the significance level of each factor of current scenario VS the significance level of each factor of proposed solution and with the help of Google maps we drawn networks of each clusters and then those networks are calculated by cost and time and select the city which would be cost efficient in term of cost; inventories and logistics across 5 cities: 4(Peshawar, Nowshera, D-I khan and Abbottabad) from KPK and 1(Lahore) from Punjab. Total expenditure and total traveling cost has been calculated of each city.
As shown in Table No. 1 Distribution center is chosen in Peshawar, Nowshera, D-I Khan as well as in Abbottabad because these cities have higher orders than other cities of KPK. Below calculations of time and cost of each selected cities of KPK as well as the total calculations time and cost from Lahore warehouse. For cities of KPK we calculated primary transportation as well as secondary transportation cost. At the end we propose the city which comes least in time as well as in cost by other cities.

4. Results and Discussion

Two alternative solutions are given to the organizations one is to implement cluster technique directly from the Punjab warehouse (Lahore) and the other one is to first establish a Third party Distribution center in KPK then implement cluster technique.

4.1 Traveling time calculation:

1. Total Time for Lahore:

Total time will be = Total travelling time [cluster1 + cluster2 + cluster3] (secondary transportation)
Total Traveling time: 97hr 15min

2. Total Time for Peshawar:

Total time will be = Total travel time (primary transportation) + Total travel time [cluster1 + cluster2 + cluster3] (secondary transportation)
Total Traveling time: 85hr 56min

3. Total Time for Nowshera:

Total time will be = Total travel time (primary transportation) + Total travel time [cluster1 + cluster2 + cluster3] (secondary transportation)
Total Traveling time: 85hr 43min

4. Total Time for DI-Khan:

Total time will be = Total travel time (primary transportation) + Total travel time [cluster1 + cluster2 + cluster3] (secondary transportation)
Total Traveling time: 88hr 45min

5. Total Time for Abbottabad:

Total time will be = Total travel time (primary) + Total travel time [cluster1 + cluster2 + cluster3] (secondary transportation)
Total Traveling time: 86hr 47min

4.2 Total expenditure calculation

1. Total expenditure for Lahore:

Total cost will be = Warehouse Pallet charges (65) + Total per trip cost [cluster1 + cluster2 + cluster3] (secondary transportation)
Total Cost: 1657.5 +167,872 = 169,529.5 Rs

2. Total expenditure for Peshawar:

Total cost will be = Warehouse Pallet charges (27) + Warehouse rent + Total Per trip cost (Primary transportation) + Total per trip cost [cluster1 + cluster2 + cluster3] (secondary transportation)
Total cost = 688.5 + 8000 + 21,504 + 125,280
Total cost = 155,472.5 Rs

3. Total expenditure for Nowshera:

Total cost will be = Warehouse Pallet charges (27) + Warehouse rent + Total Per trip cost (Primary transportation) + Total per trip cost [cluster1 + cluster2 + cluster3] (secondary transportation)
Total cost = 688.5 + 8000 + 19,992 + 125,280
Total cost = 153,960.5 Rs

4. Total expenditure for DI-Khan:

Total cost will be = Warehouse Pallet charges (27) + Warehouse rent + Total Per trip cost (Primary transportation) + Total per trip cost [cluster1 + cluster2 + cluster3] (secondary transportation)
Total cost = 688.5 + 8000 + 18,648 + 124,704
Total cost = 152,040.5 Rs

5. Total expenditure for Abbottabad:

Total cost will be = Warehouse Pallet charges (27) + Warehouse rent + Total Per trip cost (Primary transportation) + Total per trip cost [cluster1 + cluster2 + cluster3] (secondary transportation)
Total cost = 688.5 + 8000 +19,698 + 130,464
Total cost = 159,032.5 Rs

As an evident from the above calculation traveling time and total expenditure of 4 cities (Peshawar, Nowshera, DI-Khan and Abbottabad) from Khyber Pakhtunkhua and 1city (Lahore) from Punjab as per higher demand across the month; in the end Nowshera comes out to be the least from traveling time as well as from expenditure.
Below are the delivering routes from Nowshera distribution center from KPK.

4.3.1 Cluster 1

In cluster No.1 1st delivery is made from Lahore warehouse through primary type vehicle to the Nowshera distribution center then the products will be deliver to overall Cluster 1 in the starting of the month through secondary type vehicle.

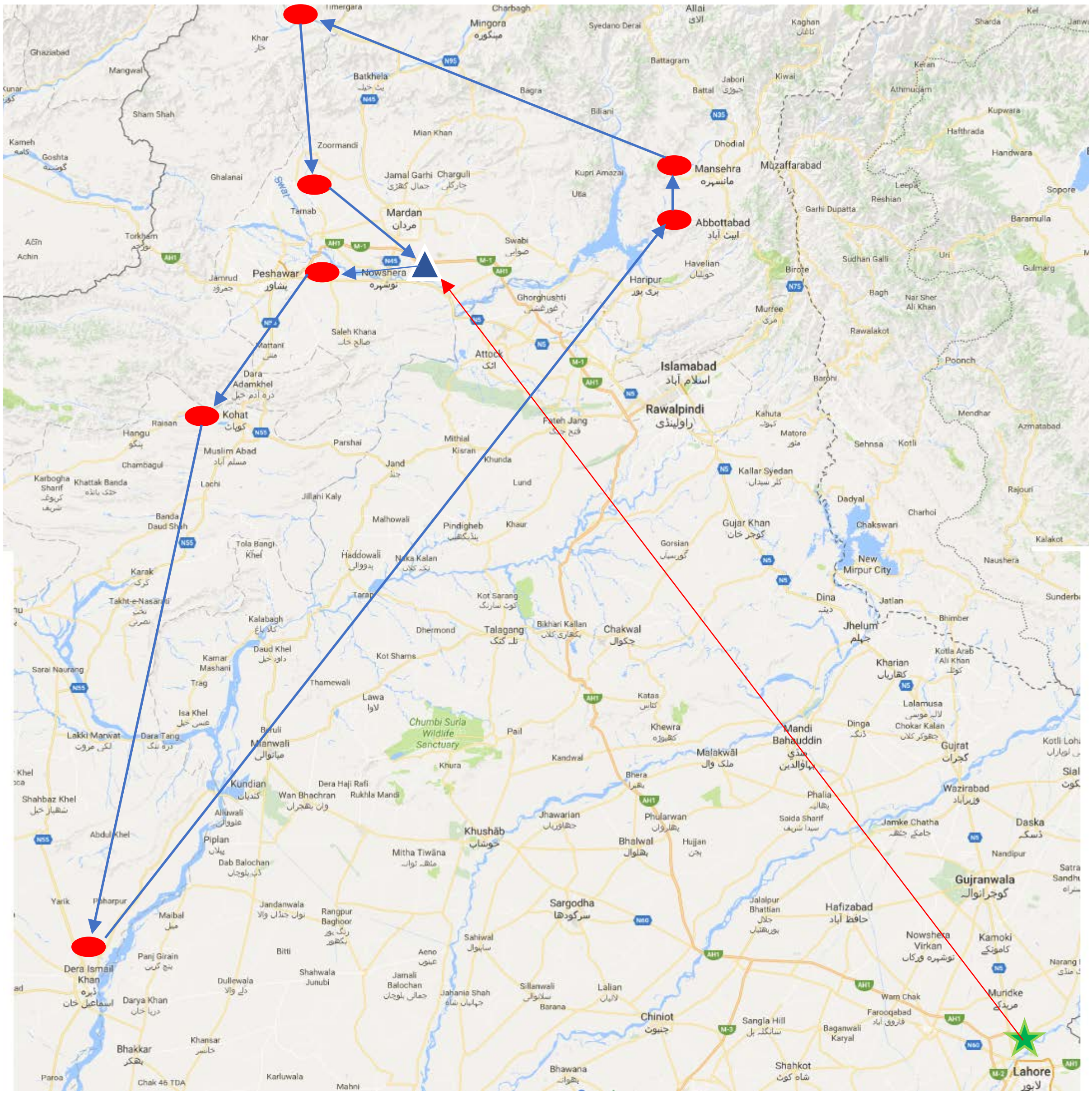

Figure 2. Cluster 1

4.3.2 Cluster 2

In cluster No.2 delivery is made from Nowshera distribution center through secondary distribution vehicles in the mid of the month.

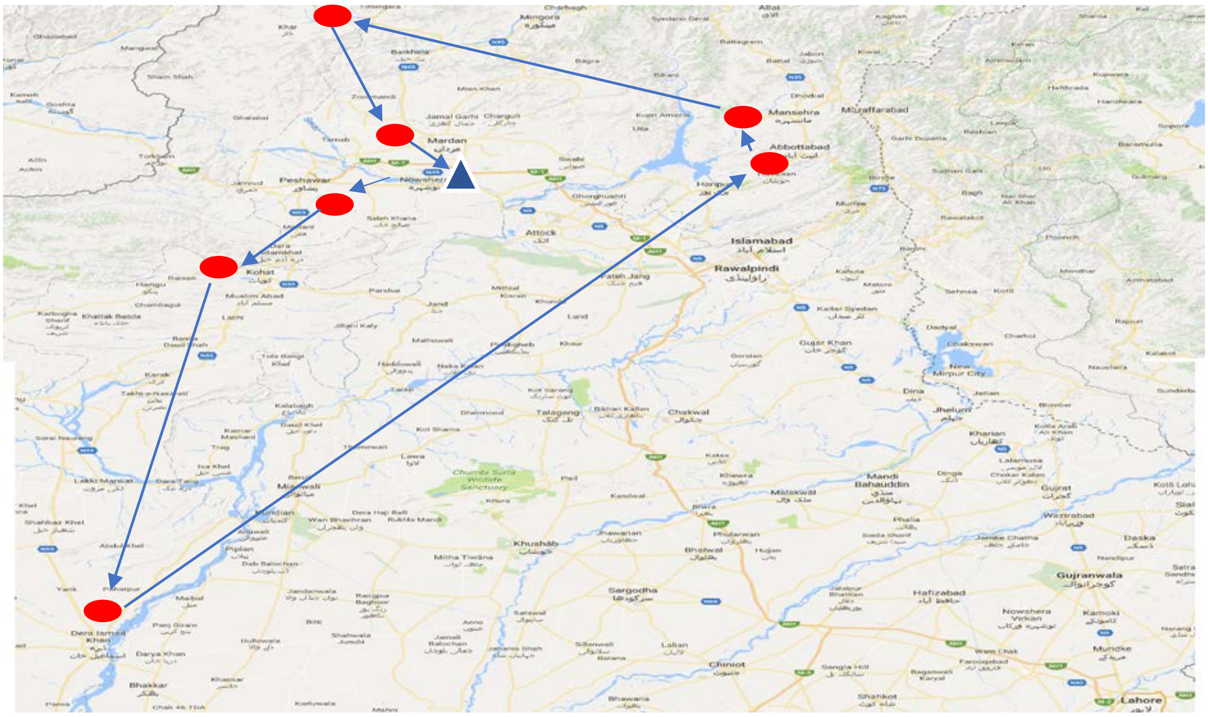

Figure 3. Cluster 2

4.3.3 Cluster 3

In cluster No.2 delivery is made from Nowshera distribution center through secondary distribution vehicles in the mid of the month.

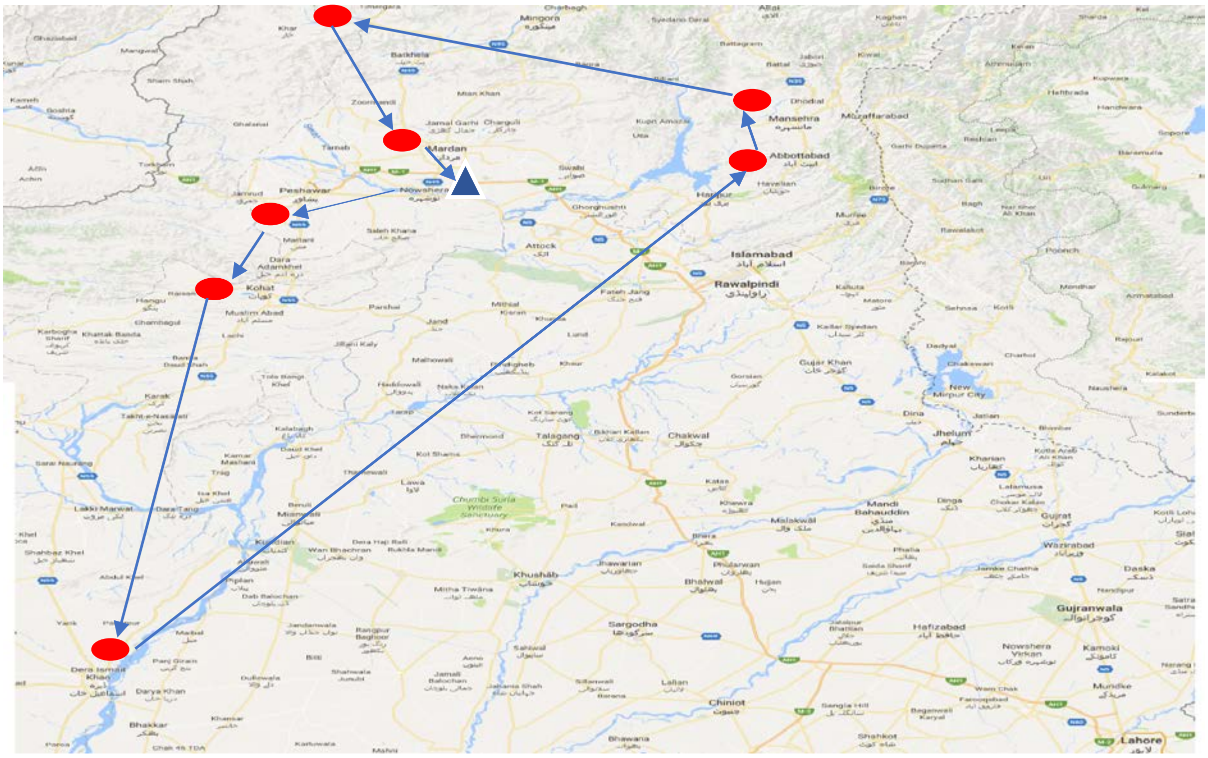

Figure 4. Cluster 3

Distributors Distribution Center Lahore Distribution enter

Primary Transportation Secondary Transportation

4.4 Graphical representation after proposed solution

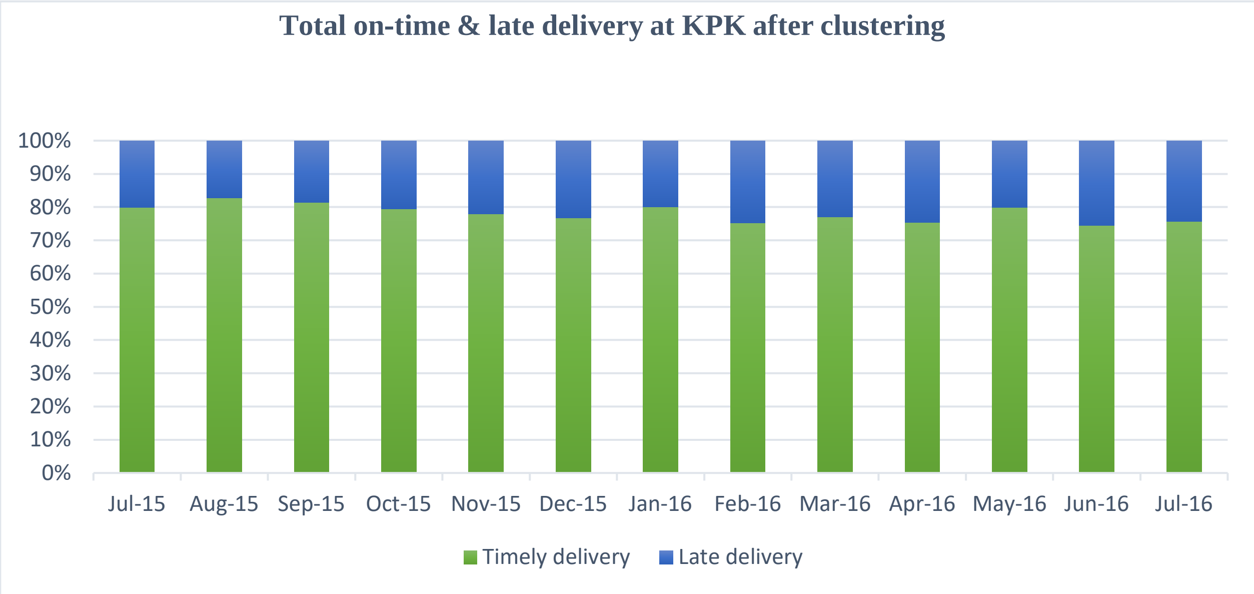

Figure 2. Graphical representation

4.5 Numerical Representation after proposed solution

Table 2. Numerical representation

Overall Improvement in delivering products	**Timely Delivery**			**Late Delivery**			**Timely Delivery**		
	%Old	%New	Improved	%Old	% New	Reduced	%Old	% New	Reduced
	27%	78%	51%	62%	22%	38%	11%	0%	11%

Numerical representation is given in table No. As shown in Table No.2 Total improvement in timely-delivery of every city in KPK determined in the old transportation was 27% now it has been improved by 57% whereas late-deliveries has been reduced 38% averagely in every city of KPK, and discontinuity which has been eliminated from every cities of KPK after implementing clustering transportation in KPK region.

5 CONCLUSION

Clustering technique is a major component of distribution problem in reducing the complexity of final product delivery. Clustering Techniques are integrated by several authors, as a contribution to this direction our objective is to reduce the transportation cost by applying a cluster technique in order to make transportation domain effective and scheduled. Though we didn’t use any sophisticated software and algorithms but by simple clustering of customers have been done in this research. The main theme of this research work was to improve the company’s Distribution & Logistics activities. Company were facing the problems of late deliveries & discontinuity of products and declining curve of customers in KPK region, where as the product unavailability & higher inventory problems were faced by Lahore warehouse. Complete cost and delivery time analysis of warehousing and clustering has been done to reach an optimal solution that suggests establishment of a 3PW at Nowshera along with 3 regional clusters. Planned and organized movements of vehicles can increase the profit margins of particular organization, which will aid the routing problem giving a better solution for the vehicle to move in an organized way. For the future work to add efficiency in routing solutions are by using different techniques of clusters to get results more accurately like Tabu-search algorithm, k-means algorithm, heuristic search and genetic algorithm. MATLAB simulation can also be used for optimization with the help of C-PLEX connector provide by IBM. Different mathematical model can be drawn for optimization. By optimizing distribution networks one can save million rupees in logistic cost and it will simultaneously improve service levels by proposing best possible route.

6 REFERENCES

Groothedde et al.(2005). Groothedde, B., Ruijgrok, C. and Tavasszy, L. (2005) “Towards collaborative, intermodal hub networks: A case study in the fast moving consumer goods market. Transportation Research” Part E, 41, 567-583.

A. Bourlakis (2001). Michael A. Bourlakis, Constantine A. Bourlakis (2001) “Deliberate and emergent logistics strategies in food retailing: a case study of the Greek multiple food retail sector” Supply Chain Management: An International Journal, 6 (4). pp. 189-200.

Sungyoung et al; (2008). Jin Wang, Yu Niu, Jinsung Cho, Sungyoung Lee, (2008) “Analysis of Energy Consumption in Direct Transmission and Multi-hop Transmission for Wireless Sensor Networks” Information Networking, 2008. ICOIN 2008. International Conference.

Voxvare 2010, retrieved from http://www.supplychainbrain.com/content/industry-verticals/retail/single-article-page/article/impact-of-late-or-inaccurate-deliveries-can-be-disastrous-study-shows/

Xu Xian-haoel al; (2015). Xu Xian-hao, Dong Wei-hong, and Peng Hongxia, (2015) “A Robust Optimization of Capacity Allocation Policies in the Third-Party Warehouse”, Mathematical Problems in Engineering, Volume 2015, Article ID 810798, 10 pages.

Wang et al, (2012). Y. Wang; X.-L. Ma; Y.-H. Wang; H.-J. Mao; and Y. Zhang; (2012) “Location optimization of multiple distribution centers under fuzzy environment,” Journal of Zhejiang University: Science A, vol. 13, no. 10, pp. 782–798.

Yang (2013). X u Yang “A review of distribution related problems in logistics and supply chain management”, vol.2, no.4, December 2013.

Chopra, S. and Meindl, P. (2001), “Supply Chain Management”, Prentice-Hall, Englewood Cliffs, NJ.

Zachariah (2011). Zachariah, Z.G.; Sanders, N.R; and Nix, N.W; (2011) “The emerging role of the third-party logistics provider (3PL) as an orchestrator”, Journal of Business Logistics, Vol. 32, No. 1, pp.40–54.

Arun Sharma; and Douglas M. Lambert; (1994) “Segmentation of Markets Based on Customer Service”, International Journal of Physical Distribution & Logistics Management, Vol. 24 No. 4, pp. 50-58.

Narameth Nananukul, (2013) “Clustering model and algorithm for production inventory and distribution problem” Applied Mathematical Modelling 37, 9846–9857.

Y Wang, X Ma, Y Lao, Y Wang (2014), “A fuzzy-based customer clustering approach with hierarchical structure for logistics network optimization”, Expert Systems with Applications 41 (2014) 521–534.

Successful Factors of Entrepreneurs of Small and Medium Sized Enterprises at Hyderabad

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Abstract

In order to evaluate the factors that affect the success of small and medium-sized enterprises in Hyderabad, it has been collecting survey data from businessmen in the Hyderabad region businessman selected through random sampling techniques of research. There are many factors to identify the demographic and environmental which hinder the commercial success of entrepreneurs in the small and medium enterprises at the Hyderabad. In the research methodology questionnaire was used to collect. The result of survey shows that the entrepreneur's achievement is depend on the infrastructure, environment, political issues, access of the market and capital are main barriers which are hindering the entrepreneurial success.

Education and experience are positively correlated in the selected entrepreneur of Hyderabad, whereas age is negatively correlated of success entrepreneurs of Hyderabad. In the survey result of entrepreneurs the model shows that the model relationship is a positive of statistically significant.

1. Introduction

In the past few decades, the growth of small and medium-sized enterprises in Pakistan has increased significantly, especially in Karachi and its vicinity. More and more investors are investing in Hyderabad to start new business. Economic surveys, the creation of the government and the private sector, should encourage greater participation of novice entrepreneurs. Development of small and medium-sized enterprises (SMEs) in Pakistan to improve the national economy.

According to the Federal Bureau of Statistics (FBS) recent population census, Pakistan has about 3.2 million economic enterprises. About 91% of these small and medium-sized enterprises (up to 98 employees) use about 78% of the non-farm workforce. SMEs contributed more than 31% of GDP, 24% of export earnings, and also shared 35% of manufacturing value added. Small and medium-sized enterprises are embedded in their business, planning and decision-making as a catalyst for IT economic growth and development, such as Hong Kong, Denmark and the United States.

Clearly, the modern high-tech industry has tremendous growth potential, but also proved that the traditional small and medium enterprises should adapt. In order to profit for the economy. If the new entrepreneur does not have enough room for prosperity, young entrepreneurs will not enter new business. Small business. An important part of a country's economic and social fabric, an international phenomenon. The enterprise is exactly the opposite of command and control. Small businesses in the global arena has been in a country's economic development has achieved a prominent position. Globalization has made small businesses the focal point of the business world. National economic growth, more and more small businesses to become the main force. SMEs in Pakistan Sindh analysis in this study is divided into:

2. Literature Review

It defines success in any part of the human life to achieve goals and objectives. While in business, and the success of this concept usually refers to the financial performance of the company, it has been interpreted in many different ways (Foley and Green, 1989). Some authors define the success of a concrete perspective of (the target), such as income or firm growth, and create personal wealth, profitability, turnover (Perren, 2000; Amrit et al 2000). Other studies (Watson et al 1998; Taormina and Lao, 2007) Successful business operations and continuing operations for at least three years. Some other studies explain the success of the intangible of intangible assets (for example, the goodwill of the institution) related to the critical success factors. Despite the fact that success has been studied extensively in the field of entrepreneurship, not a consensus on the successful understanding of the company and can be found in literature (Perez and Caninno, 2009).

This entrepreneurial and educational backgrounds critical skills to develop new business. Secondly, it appeared an increasing number of men and women and entrepreneurs in the economy of Pakistan, with less experience and education (Chowdhury, 2011). Other studies (Reynolds et al. 2000; Kristiansen et al. 2003; Sinha, 1996) found a significant relationship between entrepreneur age and business success.

3. Research Objectives:

- Identify key factors most commonly used to reflect the success of SME in Hyderabad
- To find out the available success factors uses by SMEs firms at Hyderabad.
- To analyzed most useful factors for the success of SMEs at Hyderabad.

4. Materials and Methods for Research

a. Sample

To achieve the objectives of the research study opportunity sample techniques was used from the whole population. 87 samples were selected from the areas of Hyderabad District. Questionnaires were distributed among the entrepreneur and at the time of distributing of questionnaire drop and collect procedure were selected for data collection with the questionnaire. Questionnaires were collected on the given tine the respondent. Selected enterprises were foods, publication and printing, steel and wooden furniture, beauty parlors, handloom unit and nursing homes. Majority of entrepreneurs were male (92%) and remaining were females.

b. Instruments

The study primarily was survey methods based. That instrument was developed for the information relating to research objectives. In the study structured questionnaire was distributed among the entrepreneurs. The resulting questionnaire comprised of demographic and environmental information of the respondents and a set of items to measure business success.

c. Measurement of Variables

Subjective perceptions of the entrepreneurs regarding their success have been used in our study rather than objective measurement. Five-point Likert scale fixed by strongly disagree And strongly agree were used to measure the perceived success. Demographic and Environmental factors are independent variables in the study.

5. Data Analysis

5.1 Demographic information of Respondents

This section shows the key demographic and feature data for entrepreneurs and sample firms. However, the figure below shows the main demographic data for the sample of respondents. Regarding the position, it shows that the overwhelming majority of the respondents are owner managers and managers, about two thirds (66%) of the respondents, and the remaining 24% of the respondents are without any managerial positions in the sample included in the sample , The owner to participate in the enterprise is considered one of the main reasons for success. The figures below also show that about 70% of the respondents have a two-year diploma, a secondary or lower qualification, which reflects the companies that do not require complex skills or education to manage and are considered successful companies.

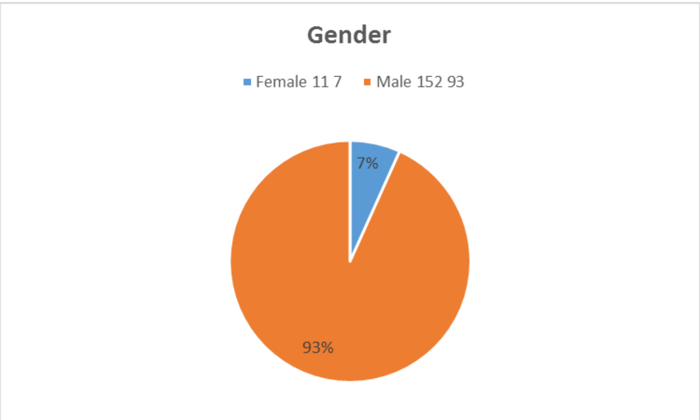

Figure-01 Gender

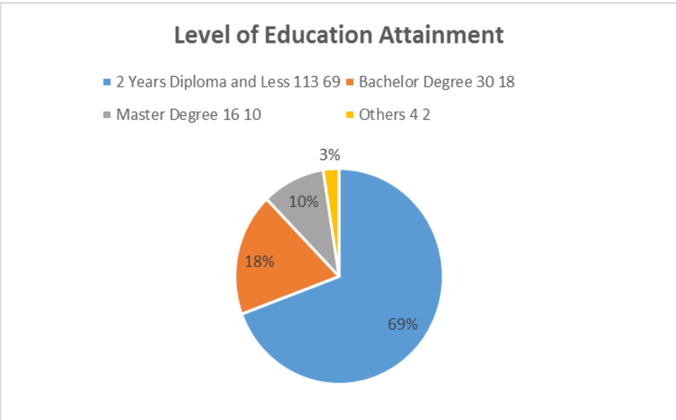

Figure-02 Level of Education

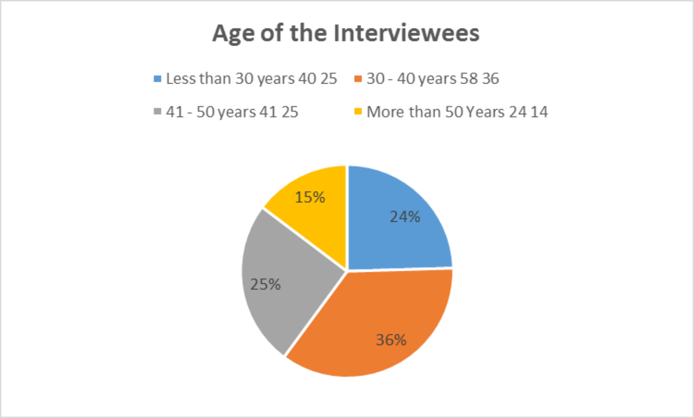

Figure-03 Age of the Respondent

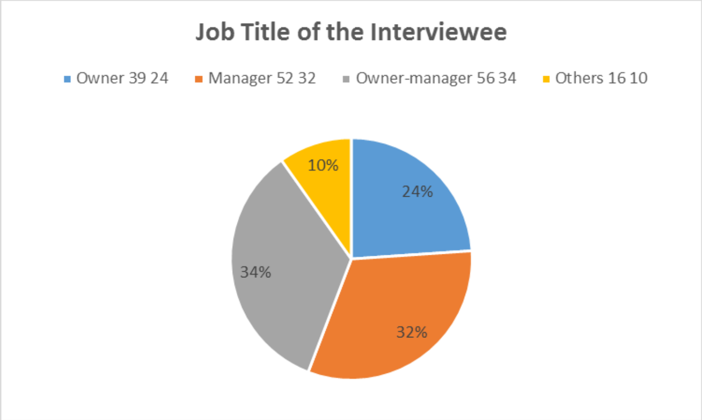

Figure-04 Job Title of Respondents

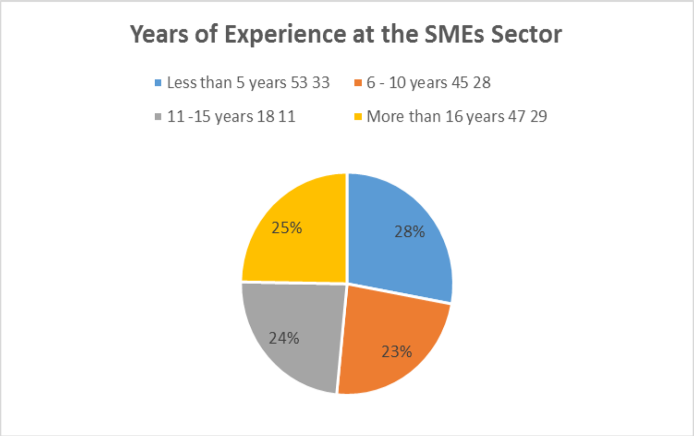

Figure-05 Experience of Respondent in SME

5.2 Firm Characteristics

The second part of this section describes the key features of the sample company, as shown in the following figure. However, it shows that about 90% of the sample companies are located in Hyderabad; this is because the branches of commercial banks and microfinance institutions are concentrated in these two main provinces, including half and almost half of the total population of Hyderabad Of economic activity. The graph below shows the distribution of firms in the main economic sectors, with 60% of the firms in the retail and service sectors, while the rest of the sample firms are getting loans from commercial banks.

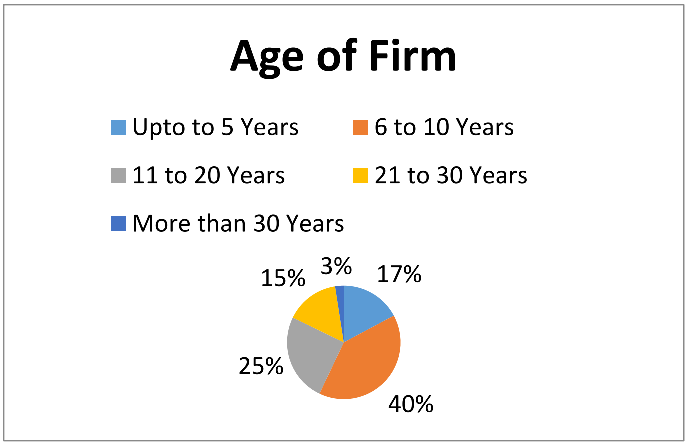

Figure-06 Age of Firm

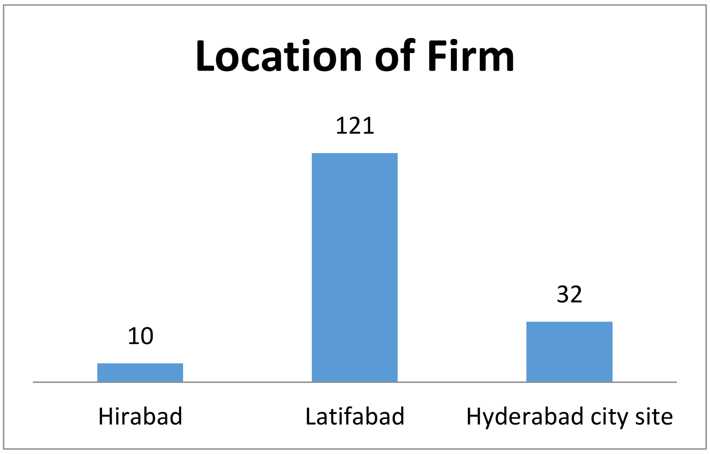

Figure-07 Location of Firm

Figure-08 Firm Sector

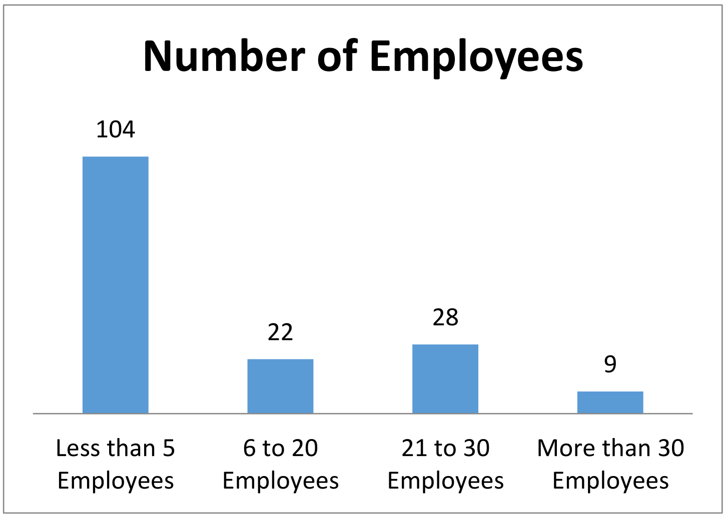

Figure-09 Number of Employees of Firm

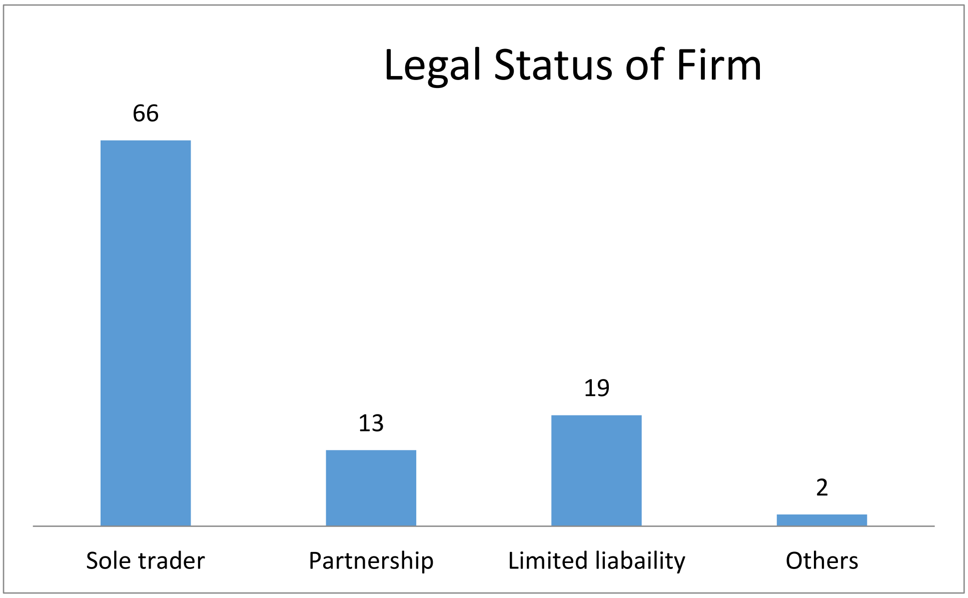

Figure- 10 Legal Status of Firm

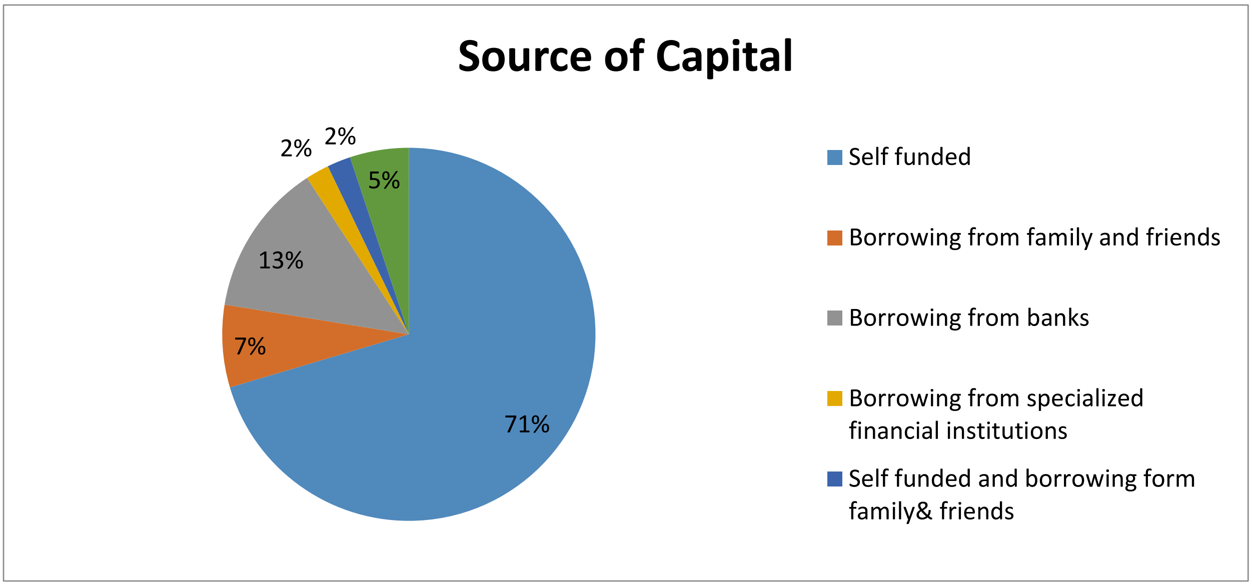

Figure 11- Source of Capital

SMEs Success Factors

This section examines the major success factors by reducing the number of variables to a number of factors that are indicative of all factors, each of which represents a small sum of variables that can be considered as a group of major components or determinants or success factors Medium - sized enterprises. However, the main factors that test their role in SME success are as follows: the structure of the firm; the technical procedures and technology used by the company; the structure of the company's human resources; the financial structure of the company; and the marketing and productivity factors of the firm. Lin (1998) and Sen and Taylor (2007) have used methods to examine these factors and rank them according to their importance as success factors for SMEs. The five factors listed above are listed in Table 1 in order of their importance, average and standard deviation. Respondents were of the view that the importance of these factors was ranked by their mean. The closer the average is to 5, the higher the importance of this factor. Therefore, rankings follow the following sequence: (1) technical procedures and techniques, (2) company structure, (3) financial structure, (4) marketing and productivity and (5) human resource structure. Their mean values ranged from 4.13 to 2.96.

Successful Factor Ranking

Value	No	Mean	St. D	Rank
Structure of the firm	9	3.91	0.83	2
Technical Procedures and Technology	5	4.13	1.03	1
Human resources at the firm	10	2.96	0.79	5
Financial structure of the firm	10	3.63	1.01	3
Marketing and Productivity	17	3.25	0.62	4

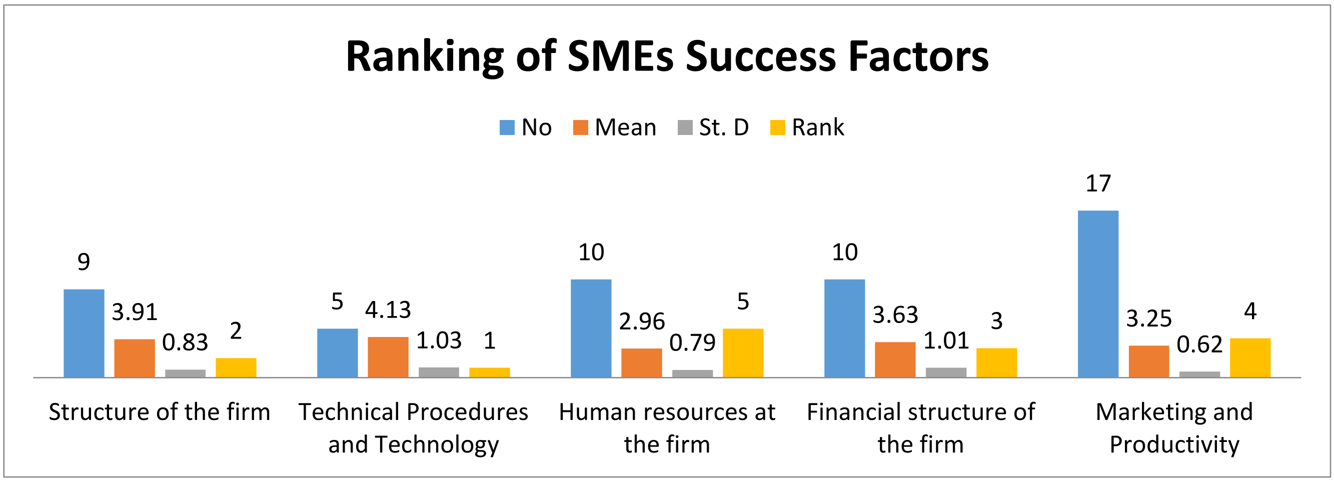

Figure -13 Ranking of SME Success Factors

Conclusion

SMEs have played a successful role in socio-economic development, innovation and job creation, not only in Hyderabad, but also around the world. This success comes from several factors. Finding these factors in Hyderabad is the main objective of this research paper. However, in order to achieve the research objectives, the researchers selected representative samples of successful SMEs from commercial banks or from specialized financial institutions, as these banks and financial institutions would not be able to fail companies.

The results of the study identified five major factors that could be major factors in the success of SME in Hyderabad. The order of importance of these factors is as follows:

Technical procedures and techniques, corporate structure, financial structure, marketing and productivity and human resource structure. These factors mainly reflect the main characteristics of small and medium enterprises. It also suggests that the strengthening of SMEs derives mainly from its characteristics, which will encourage new entrepreneurs, governments and financial institutions to support this sector expansion, as the aforementioned several favorable, such as work creation and innovation, may Help to reduce unemployment.

Finally, it is important to note that it is necessary to study this topic more in order to find additional factors that can be added to the success factor on the one hand. Or on the other hand to study the factors leading to failure. These factors may vary from country to country, and for several reasons, this survey is of particular importance to developing countries.

References:

- Al-Mahrouq. M, (2006). *The Relationship Between Firm Size and Growth in Manufacturing Sector in Jordan*. Dirassat, Administrative Sciences, Volume 33, No 1, 2006.
- Al-Mahrouq, M., (2007). *Unemployment in Jordan and the role of Micro, Small and Medium Enterprises in Reducing it*. Role of SMEs in Facing Unemployment, Workshop organized by Development and Employment Fund (DEF), 5-6/11/2007, Amman.
- Al-Tayeb. S, and Al-Mahrouq. M, (2004). *"Finance 'Additionality and Economic Effects of the Small*
- *Firms Loan Guarantee Scheme in Jordan"*, Dirassat, Administrative Sciences, Volume 31, No 2, 2004.
- Aquino. N.R, (1990). *Success Secrets*, Business and Economic Review, 36 (4), July – September, 20 -23.
- Carrier, C., (1994). Intrapreneurship in Large Firms and SMEs: A Compartive Study, *International Small Business Journal*, 12 (3).
- Chaganti, R. and Chaganti, R. (1983).AProfile of Profitable and Not-so-Profitable Small Businesses, *Journal of Small Business Management*, 21 (3): 43-51.
- Clemenz G., (1986). *Credit Markets with Asymmetric Information.* New York: Springer Virlage.
- Cowling M. and Sugden R., (1995). "Small Firm Lending Contract: Do Banks Differentiate Between Firms?", *Journal of Small Business Finance*, 14 (1), 87-98.
- Department of Statistics, (2007). *Industrial Survey*, Amman.
- ----, (2007). *Employment and Unemployment Survey*, Amman
- ----, (2007). *Jordan in Figures*, Amman.

- Dess, G and Davis, P. (1984). *Generic Strategies as Determinants of Strategic Group Membership and Organisational Performance*, Academy of Management Journal, 27 (2). Forbes and Mix Market Magazine, Vol. 3 (2007).
- Gaskill, L. VanAuken, H. andManning, R., (1993). AFactorAnalytic Study of the Perceived Causes of Small Business Failure, *Journal of Small Business Management,* 34 (4): 18 – 31.
- Ghosh, B. Teo Sock, K. and LowAik,M., (1993). Factors Contributing to the Success of Local SMEs:
- An Insight from Singapore, *Journal of Small Business and Entrepreneurship*, 10 (3): 33-46.
- Hobohm S., (2001). "Small and Medium-Sized Enterprises in Economic Development: The UNIDO Experience", *Journal of Economic Cooperation*, 22 (1), 1-42.
- Levy, B., (1993). Obstacles to Developing Indigenous Small and Medium Enterprises: An Empirical Assessment, *The World Bank Economic Review*, 7 (1): 65 – 83.
- Lin, C., (1998). Success Factors of Small and Medium-Sized Enterprises in Taiwan: An Analysis of Cases, *Journal of Small Business Management*, 36 (4). *Anadolu Üniversitesi Sosyal Bilimler Dergisi*
- **Sen, B. and Taylor, R., (2007).** *Determining the Information Needs of Small and Medium-Sized Enterprises: A Critical Success Factors Analysis*, Information Research, 12 (4).
- **Sekaran U., (2004).** *Research Methods for Business A Skill Building Approach Third Edition*. New York: John Wiley and Sons.
- **Simon, H., (1996).** *Hidden Champions, Boston*, Mass, Harvard Business School.
- **Storey D., (1994).** *Understanding the Small Business Sector*. London: Routledge.
- **Walker, E. and Brown, A., (2004).** What Success Factors are Important to Small Business Owners, *International Small Business Journal*, 22 (6).
- **Wijewardena, H, and De Zoysa, A., (2005).** *A Factor Analytic Study of the Determinants of Success in Manufacturing SMEs*, 35th EISB Conference-Sustaining the Entrepreneurial Spirit Over Time, Barcelona, Spain, 12-14 September, 2005.
- **Yusof, S. and Aspinwall, E., (1999).** *Critical Success Factors for Total Quality Management Implementation in Small and Medium Enterprises*, Total Quality Management, 10 (4-5).
- **Yusof, S. and Aspinwall, E., (2000).** *Critical Success Factors in Small and Medium Enterprises: Survey Results*, Total Quality Management, 11 (4-6).

APPROXIMATIONS FOR A 2-D LID DRIVEN CAVITY FLOW

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Abstract: This paper presents an explicit method to calculate a 2-D lid driven cavity flow with pressure distribution along the walls. The two dimensional incompressible Navier-Stokes equations along with the vorticity formulation in a rectangular domain are solved numerically using uniform and non-uniform grid sizes. The Reynolds number is taken between 100 and 1000. Their contours and semilogs are plotted to show whether which grid size converges to the solution faster and whether its error reduces while Reynolds number increases.

1. INTRODUCTION

In fluid mechanics, flow in an enclosure driven by moving boundaries is a fundamental problem. This type of flow can be found in certain engineering applications, or in academic research, where it can used to test various numerical methods and hydrodynamic stability problems. The case where a flow is induced by tangential movement of either one or both facing cavity boundaries is a classic example of such flow. In the literature, one-sided lid-driven cavity was studied extensively. For example, the work done by Ahlman, Pan and Acrivos, Croce, and Prasad and Koseff.

Kuhlmann extended the one-sided lid-driven cavity flow problem to two-sided lid driven cavity flow. These studies resulted into theoretical and experimental examinations when the two facing sides of the cavity move with constant velocities in opposite direction to each other for the two and three dimensional flows. Their results showed that the cavity aspect ratio and the Reynolds number are required for the existence of non-unique two-dimensional steady flows. The flows consists of separate co-rotating vortices adjacent to each of the moving walls at a low Reynolds number. When the Reynolds numbers are higher than the flow becomes unstable and transforms into a steady three dimensional flow. A numerical investigation of two-sided lid-driven cavity flows and a large number of non-unique steady flow types were performed by Albensoeder. Albensoeder and Kuhlmann investigated the flow driven by anti-parallel motion of two facing walls numerically, and showed the two-dimensional flow becomes unstable to different modes, depending on the cross-sectional aspect ratio. Blohm and Kuhlmann measured the steady and time-dependent bifurcations which occur at higher Reynolds number. A review of the available literature shows that for a systematic study of the respective instabilities and the nonlinear pattern formation, the basic two-dimensional flow solutions must be known. Therefore, it is the purpose of this present study to investigate the stability of the two-dimensional solution contours of such flows.

The governing equations for the resulting two-dimensional cavity flow are of a non-linear nature, and therefore, multiple solutions are possible. Previous numerical studies addressing the prediction of multiple stable solutions can be classified as belonging to one of two different approaches. The first approach treats the problem as an initial value problem and marches in time to attain a steady-state solution. The second approach solves the steady Navier–Stokes equations by means of a path following method or the so-called continuation method. In this paper, former technique is used since the time-dependent Navier–Stokes equations will give a stable steady-state solution if its solution exists. Accordingly, it is this approach which the current study adopts to obtain a solution manifold. Once the solution manifold has been determined, a time-dependent formulation is developed in order to investigate the permissible flow transitions within the solution manifold.

The current study is summarized as follows: two-dimensional flow in a two-sided lid-driven cavity with pressure distribution along the walls in a rectangular domain. The two lids are maintained at different boundaries and initial conditions. An explicit numerical scheme is applied in order to achieve a solution. Furthermore, different Reynolds numbers are used to analyze the errors and computational time. Section 2 of this paper presents the governing equations for the two-sided lid-driven cavity flow and introduces the numerical method which will be adopted for its solution. Meanwhile, section 3 presents the computed results and provides a detailed discussion. Section 4 discusses the results, and the final section of this paper presents some brief conclusions.

2. NUMERICAL METHODOLOGY

2.1 Governing Equations

The incompressible Navier-Stokes equations describe a wide range of problems in fluid mechanics. They are composed of an equation in mass conservation and two momentum conservation equations, one for each Cartesian velocity component. The dependent variables will be the pressure p and the velocity components u and v in the x and y directions respectively.

Consider a 2-D lid-driven cavity flow governed by the following non-dimensional incompressible Navier-Stokes equations in a rectangular domain $0 \leq x \leq X_L$ and $0 \leq y \leq Y_L$:

$$\frac{\partial u_i}{\partial x_i} = 0 \tag{1}$$

$$\frac{\partial u_i}{\partial t} + \frac{\partial}{\partial x_j}\left(u_j u_i\right) = -\frac{\partial p}{\partial x_i} + \frac{1}{Re}\frac{\partial u_i}{\partial x_j x_i} \quad for\ i = 1,2 \tag{2}$$

where $u_i = (u, v)$. After simplification, the above equations become:

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0 \tag{3}$$

$$\frac{\partial u}{\partial t} + \frac{\partial}{\partial x}(u^2 + p) + \frac{\partial}{\partial y}(uv) = \frac{1}{Re}\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial u^2}{\partial y^2}\right) \tag{4}$$

$$\frac{\partial v}{\partial t} + \frac{\partial}{\partial x}(uv) + \frac{\partial}{\partial y}(v^2 + p) = \frac{1}{Re}\left(\frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2}\right) \tag{5}$$

where $Re = \frac{X_L U_\infty}{\nu}$.

Unlike the compressible Navier-Stokes equations, the incompressible form does not have a time dependent term in the mass conservation equation. In the compressible form, the time dependent term provided a direct reference to density, allowing for a numerical scheme to solve for density directly. In the incompressible for, the momentum equations can be used to solve for *u* and *v*, but the continuity equation does not reference *p* because of the absence to this term. An artificial compressibility term must be added to the continuity equation to allow for the solution of *p*, shown below:

$$\frac{\partial p}{\partial t} + a^2\left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}\right) = 0$$

The term a denotes a pseudo speed of sound. As the numerical scheme progresses towards a steady state solution, the new time dependent term tends to zero magnitude. This implies that in the steady state the original continuity equation is recovered.

Now, for incompressible Navier-Stokes equations vorticity equation is as follows:

$$\frac{D\boldsymbol{\omega}}{Dt} = \boldsymbol{\omega}.\nabla u_i \tag{7}$$

where $\boldsymbol{\omega} = \nabla \times v$ is the vorticity, and $\frac{D\omega}{Dt} = \frac{\partial \omega}{\partial t} + u_i.\nabla\boldsymbol{\omega}$ is the material derivative of $\boldsymbol{\omega}$ with respect to time t. The vorticity equation describes the evolution of vorticity $\boldsymbol{\omega}$ of a particle of a fluid as it moves with its flow i.e. the local rotation of the fluid. Since 2-D flows are used in this paper, as in 2-D flows, $u_i = (u, v, 0)$ and so by definition $\boldsymbol{\omega} = (0,0,\omega) = \omega(x,y)\boldsymbol{z}$. It is then clear that the term $\boldsymbol{\omega}.\nabla u_i = \omega(x,y)\frac{\partial u_i}{\partial z} = 0$. So:

$$\frac{D\boldsymbol{\omega}}{Dt} = 0 \tag{8}$$

This means that vorticity is conserved as it moves with the flow. It is to be noted that if $\boldsymbol{\omega} = 0$ at time $t = 0$, then $\boldsymbol{\omega} = 0$ for all time.

2.2 Numerical Scheme

Explicit solution of the incompressible Navier-Stokes is relatively straightforward on non-linear terms. Numerous methodologies can be used, forward time- central space (FTCS), Dufort Frankel, MacCormack, Crank-Nicolson to name a few. If central differencing is used on the convective terms then artificial dissipation may be needed to ensure stability, and also the Reynolds number will be fairly large.

An explicit algorithm based on discretization of the momentum equations using a first order difference in time and a second order central scheme in space is used. The velocity components are solved first. So, the final equations of velocity components after discretization are:

$$u_{i,j}^{n+1} = u_{i,j}^{n} + \frac{1}{Re}\left[\frac{u_{i+1,j}^{n}-2u_{i,j}^{n}+u_{i-1,j}^{n}}{\Delta t(\Delta x)^2} + \frac{u_{i,j+1}^{n}-2u_{i,j}^{n}+u_{i,j-1}^{n}}{\Delta t(\Delta y)^2}\right] - \frac{p_{i+1,j}^{n}-p_{i-1,j}^{n}}{2\Delta x\Delta t} - \frac{\left(u_{i+1,j}^{n}\right)^2-\left(u_{i-1,j}^{n}\right)^2}{2\Delta x\Delta t} - \frac{u_{i,j+1}^{n}v_{i,j+1}^{n}-u_{i,j-1}^{n}v_{i,j-1}^{n}}{2\Delta y\Delta t} \tag{9}$$

$$v_{i,j}^{n+1} = v_{i,j}^{n} + \frac{1}{Re}\left[\frac{v_{i+1,j}^{n}-2v_{i,j}^{n}+v_{i-1,j}^{n}}{\Delta t(\Delta x)^2} + \frac{v_{i,j+1}^{n}-2v_{i,j}^{n}+v_{i,j-1}^{n}}{\Delta t(\Delta y)^2}\right] - \frac{p_{i,j+1}^{n}-p_{i,j-1}^{n}}{2\Delta y\Delta t} - \frac{\left(v_{i,j+1}^{n}\right)^2-\left(v_{i,j-1}^{n}\right)^2}{2\Delta y\Delta t} - \frac{u_{i+1,j}^{n}v_{i+1,j}^{n}-u_{i-1,j}^{n}v_{i-1,j}^{n}}{2\Delta x\Delta t} \tag{10}$$

Once the velocity components are computed for the time level *n+1*, the modified continuity expression can be solved for the pressure:

Now, the conservative vorticity equation is discretized, and its final form is:

$$\boldsymbol{\omega}_{i,j}^{n+1} = \frac{u_{i,j+1}^{n} - u_{i,j}^{n}}{\Delta y} - \frac{v_{i+1,j}^{n} - v_{i,j}^{n}}{\Delta x} \tag{11}$$

2.3 Numerical Scheme

Following are the initial and boundary conditions that are applied on $u_i = (u, v)$, call them SET-1:

$X_L = 1;\ Y_L = 1;\ U_\infty = 1$
$u(0, y) = 0\ and\ v(0, y) = 0$
$u(X_L, y) = 0\ and\ v(X_L, y) = 0$
$u(x, 0) = 0\ and\ v(x, 0) = 0$
$u(x, Y_L) = U_\infty\ and\ v(x, Y_L) = 0$

Now, SET-2 is for the flow in the weapons bay of the aircraft with the following non-dimensional geometry and boundary conditions:

$X_L = 4;\ Y_L = 1;\ U_\infty = 1$
$u(0, y) = 0\ and\ v(0, y) = 0$
$u(X_L, y) = 0\ and\ v(X_L, y) = 0$
$u(x, 0) = U_\infty\ and\ v(x, 0) = 0$
$u(x, Y_L) = 0\ and\ v(x, Y_L) = 0$

3. RESULTS

MATLAB was used to plot numerical results for the velocity and pressure fields, and to plot the horizontal and vertical velocity component contours, vorticity contours, and pressure contours. I have used Re (Reynolds number) =1000, 666 and 121 for uniform grid size and Re=1000 for non-uniform grid size.

After applying SET-1 on $u_i = (u, v)$ on a 81×81 uniform grid, the following results were achieved:

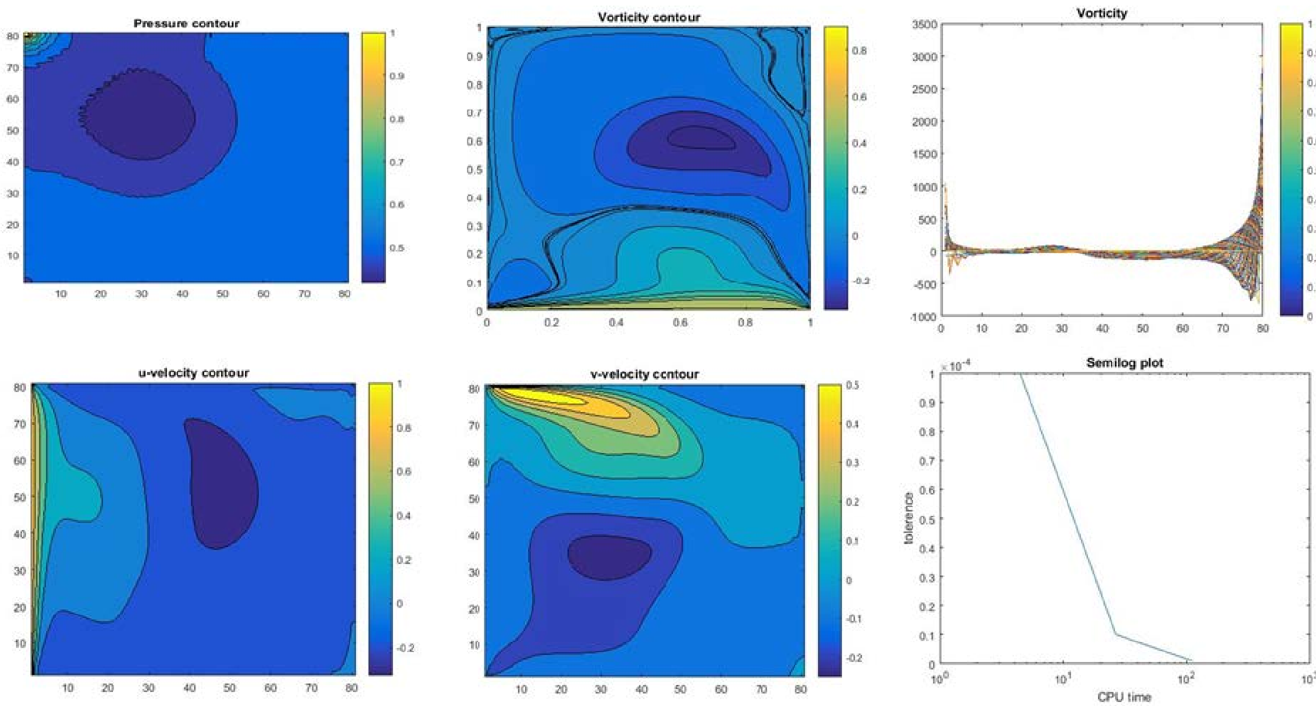

Figure 1. Contours for pressure, velocity and vorticity, and semilog plot for 81×81 grid size with Re=1000

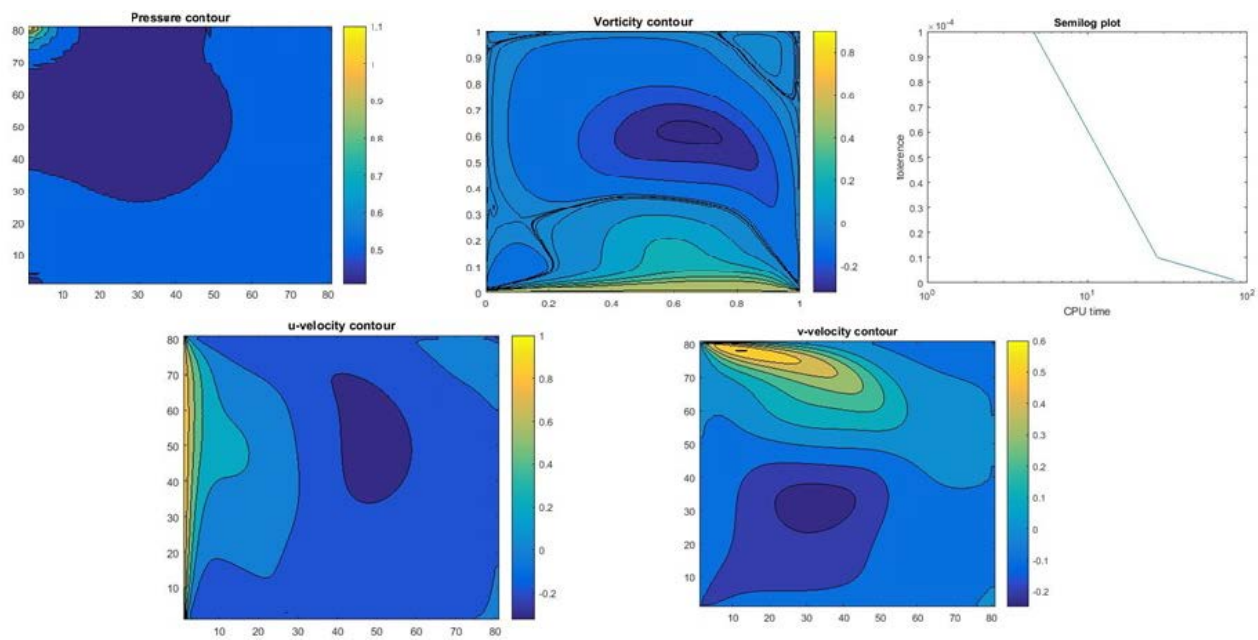

Figure 2. Contours for pressure, velocity and vorticity, and semilog plot for 81×81 grid size with Re=666

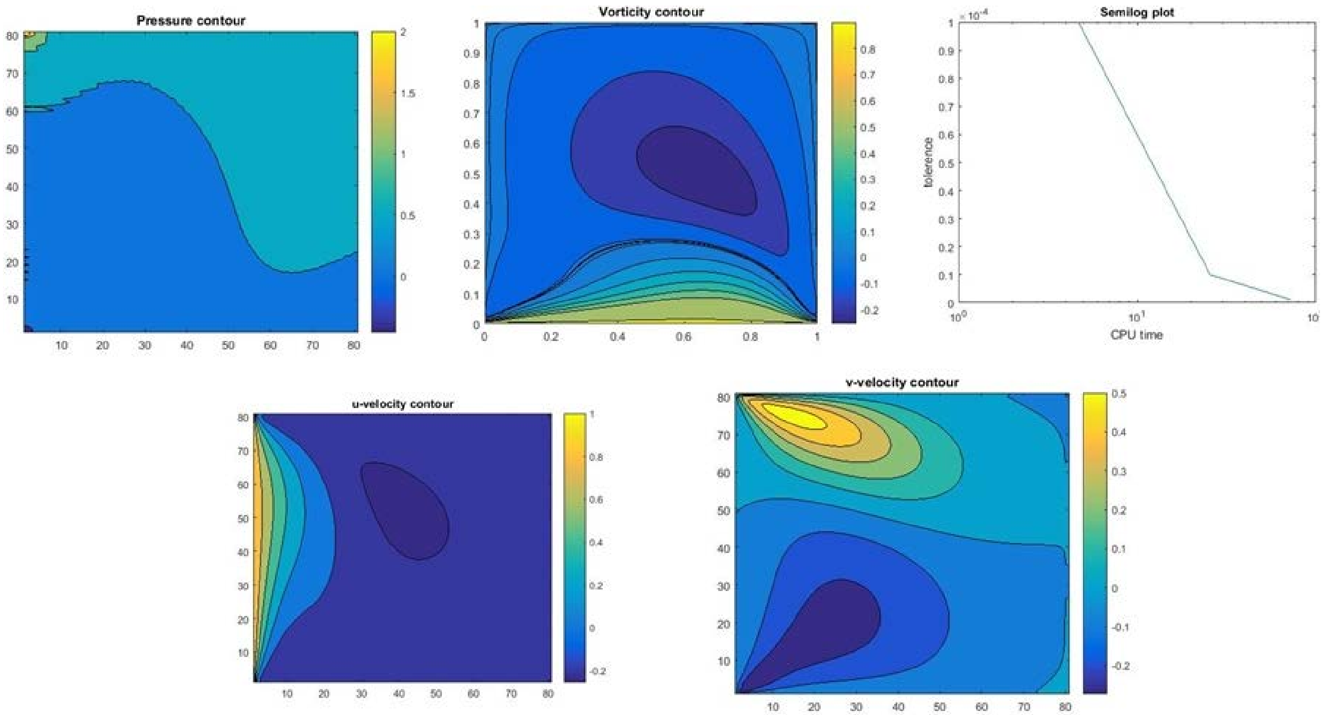

Figure 3. Contours for pressure, velocity and vorticity, and semilog plot for 81×81 grid size with Re=121

Now applying SET-2 on $u_i = (u, v)$ on a non-uniform grid, the following results were achieved:

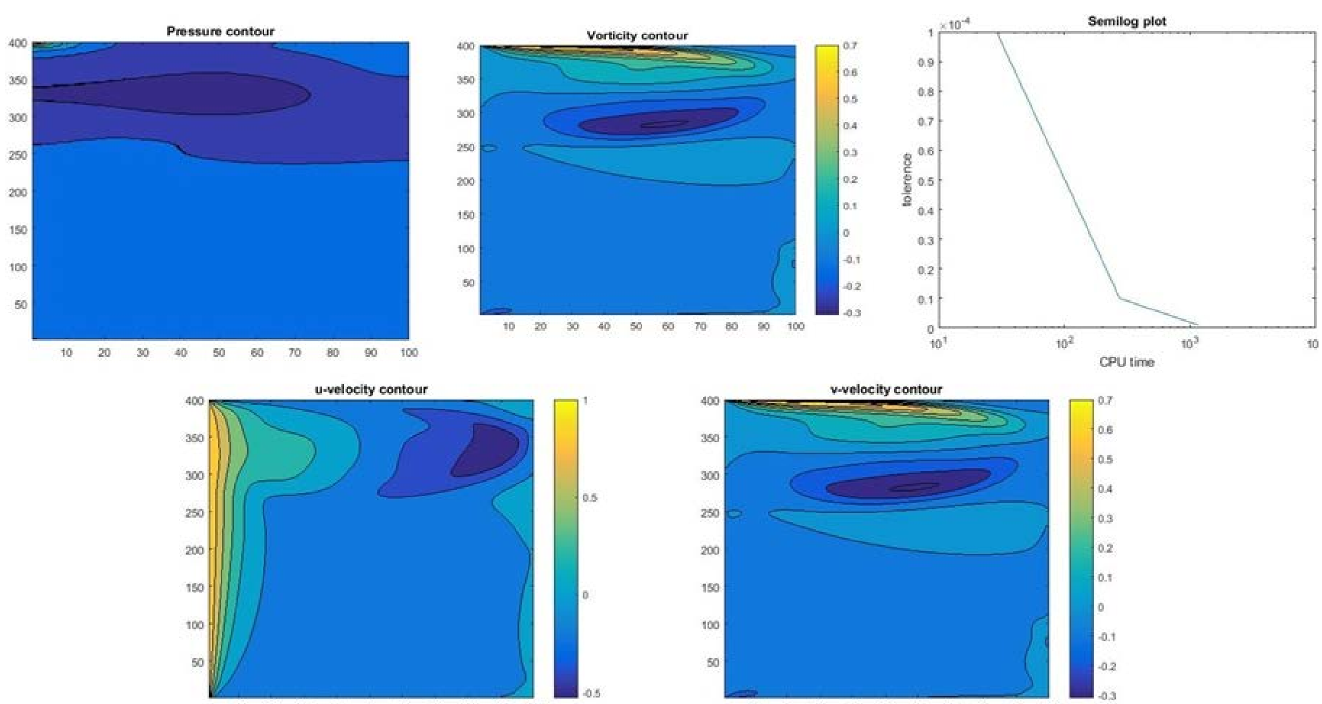

Figure 4. Contours for pressure, velocity and vorticity, and semilog plot for 400×100 grid size with Re=121

4. DISCUSSION

In this section, results from the previous section will be analyzed and discussed. It is divided into two subsection, first one discusses the results of SET-1 while next one discusses results of SET-2.

4.1 SET-1 with grid size of 81×81

First of all, the table below tells about CPU time (time required to solve a program) versus error:

Table 1. CPU time and error of 81×81 grid size

Grid size: 81×81	**CPU time**	**Error**
Re=121	25.624477 s	9.9568e-05
Re=666	27.467599 s	9.9180e-05
Re=1000	26.756918 s	9.8459e-05

The Table 1 shows that while Reynolds number increases error decreases the reason is that by taking Reynolds number higher the material is non-viscous (such as gases) and when it is lower than the material is viscous (such as honey). While time taken by the CPU to solve the program is variable.

Table 2. Maximum and minimum values of velocity, vorticity and pressure of 81×81 grid size

Re	u_{min}	u_{max}	v_{min}	v_{max}	ω_{min}	ω_{max}	p_{min}	p_{max}
121	-0.2549	1.0	-0.2735	0.5462	-557.9077	2.2318e+03	-0.4619	2.1702
666	-0.3251	1.0	-0.2484	0.6064	-751.4173	3.2023e+03	0.4093	1.1287
1000	-0.3272	1.0	-0.2499	0.5921	-816.0930	3.4200e+03	0.4173	1.0172

The above table discusses the values of primary vortices in a contour. $\boldsymbol{\omega}$ has the biggest vortice and its size increases as Reynold's number increase this is also shown in the figures of Section 3. Pressure decreases as the Reynolds number increases.

4.2 SET-2 with grid size of 400×100

The SET-2 uses a non-uniform grid of size 400×100 because of its initial and boundary conditions.

Table 3. CPU time and error of 400×100 grid size

Grid size: 400×100	**CPU time**	**Error**
Re=121	405.187916 s	9.6312e-05
Re=666	275.396228 s	9.9968e-05
Re=1000	275.511485 s	9.9958e-05

The Table 3 shows that CPU time decreases as Reynolds number increases which is different as that of uniform grid. While error increases which is opposite as that of uniform grid as Table 1. It is to be noted that non-uniform grid takes more time to converge to the solution as compared to uniform grid which is also shown in fig. 1, 2, 3 and 4.

Table 4. Maximum and minimum values of velocity, vorticity and pressure of 400×100 grid size

Re	u_{min}	u_{max}	v_{min}	v_{max}	ω_{min}	ω_{max}	p_{min}	p_{max}
121	-0.5047	1.0	-0.2873	0.5914	-827.6735	3.3408e+03	-0.7713	2.7119
666	-0.5379	1.0	-0.2895	0.6902	-1.1220e+03	4.7256e+03	0.3585	1.3408
1000	-0.5287	1.0	-0.3097	0.7024	-1.2201e+03	5.0777e+03	0.3576	1.2146

In above table, the size of primary vortice of $\boldsymbol{\omega}$ increases with the increase in Reynold's number. Pressure also decreases that is similar in Table 2. The u-velocity slowly decreases while v-velocity increases with the increase in Reynolds number which is opposite in Table 2.

5. CONCLUSION

For a 2-D lid-driven cavity flow and the pressure distribution along the walls an explicit numerical scheme is applied on 2-D incompressible Navier-Stokes equation with SET-1 and SET-2 of initial and boundary conditions. SET-1 uses uniform grid size while non-uniform grid size is taken on SET-2. Reynolds number is taken of values of 121, 666 and 1000. For each equation, the numerical formulation requires the solution of two tri-diagonal systems, which allows the use of large grid meshes easily. The results shows that uniform grid gives finer contours than non-uniform grid, and uniform grids converges faster to the solution. While pressure decreases as Reynolds number increases in both grid sizes. Also, error decreases in uniform grids while error increases in non-uniform grids as the Reynolds number increases. Numerical results and plots indicates that uniform grid sizes are necessary in order to obtain a steady solution and also resolve the vortices appear at the corners of the cavity, as the Reynolds number increases.

6. REFERENCES

1. Ahlman, D., Söderlund, F., Jackson, J., Kurdila, A., & Shyy, W. (2002). Proper orthogonal decomposition for time-dependent lid-driven cavity flows. *Numerical Heat Transfer: Part B: Fundamentals*, *42*(4), 285-306.

2. Albensoeder, S., & Kuhlmann, H. C. (2002). Linear stability of rectangular cavity flows driven by anti-parallel motion of two facing walls. *Journal of Fluid Mechanics*, *458*, 153-180.

3. Albensoeder, S., Kuhlmann, H. C., & Rath, H. J. (2001). Multiplicity of steady two-dimensional flows in two-sided lid-driven cavities. *Theoretical and Computational Fluid Dynamics*, *14*(4), 223-241.

4. Blohm, C. H., & Kuhlmann, H. C. (2002). The two-sided lid-driven cavity: experiments on stationary and time-dependent flows. *Journal of Fluid Mechanics*, *450*, 67-95.

5. Croce, G., Comini, G., & Shyy, W. (2000). Incompressible flow and heat transfer computations using a continuous pressure equation and nonstaggered grids. *Numerical Heat Transfer: Part B: Fundamentals*, *38*(3), 291-307.

6. Kuhlmann, H. C., Wanschura, M., & Rath, H. J. (1997). Flow in two-sided lid-driven cavities: non-uniqueness, instabilities, and cellular structures. *Journal of Fluid Mechanics*, *336*, 267-299.

7. Pan, F., & Acrivos, A. (1967). Steady flows in rectangular cavities. *Journal of Fluid Mechanics*, *28*(04), 643-655.

8. Prasad, A. K., & Koseff, J. R. (1989). Reynolds number and end-wall effects on a lid-driven cavity flow. *Physics of Fluids A: Fluid Dynamics (1989-1993)*, *1*(2), 208-218.

9. Yang, R. J., & Luo, W. J. (2002). Flow bifurcations in a thin gap between two rotating spheres. *Theoretical and computational fluid dynamics*, *16*(2), 115-131.

VIRTUAL REALITY BASED MEETING SYSTEM (VRMS)

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ABSTRACT: We started the journey to change the existing way of video calling into a whole new idea of Virtual Reality Based Meeting System. Our motivation is to give the world an innovation that can revolutionize the existing way of talking and watching each other through computers.

1. INTRODUCTION

A Virtual Reality Based Mobile and a desktop Application that will be helpful for the Office meet ups, trainings, Presentations and can be used for the hangouts. Users will be present virtually in the realistic Virtual Environment along with other users. Every User will be represented by its own looking avatars or any other avatar of choice in the Virtual Environment with their own real Voices that will be used for the VOIP (voice over internet protocol) System to interact with other users. This application will be used on Google cardboard (while in development phase). Creating a VR experience, Instead of displaying world in a single image on screen, it will display two images.

It comes from two Lenses placed a few inches apart, and the user views the image from the left Lens with the left eye and vice versa, creating the appearance of depth. And this functionality is done automatically by Google Cardboard SDK [1] for unity.

Additionally, with some judicious use of motion sensors which are present in our Smartphones, we can detect the direction the user is facing, and we will get the immersive experience.

1.1 Impact on Industry

Till now mostly Skype is used for calling, conference calling and video calling. Our project is also of that kind of software that will be used for the communication but this is the whole new idea to communicate. It will truly revolutionaries the way we see or talk via a computer nowadays.

1.2 Impact on Society

Society will surely love to have a new way to communicate with their loved ones. Companies will have a new way to do their meetings and presentations without moving an inch from their physical locations. As study Environment affects productivity, kids will love and gain more interest while studying in their desired virtual Environments.

2. LITERATURE REVIEW

All the work for this project is being carried out in CS-Script programming [2] language mainly with the combination of Unity IDE [3]. We have portioned this project in 3 different parts.

2.1 3d Models and Environments

A user avatar has to look like a user from head to toe. That's why we will be using Kinect sensor [4] to reconstruct the Human body in 3d model and that model later will be imported in our unity project for the further use. After that the reconstructed models of the humans will be made humanoid avatars to use their 24 bones and map it to the real skeleton data coming from the Kinect sensor.

Environments are made In Unity game engine and we have planned to download the readymade 3d objects which are available on the unity asset store [5] license free to use in our VR Environment. It will save a lot of our time.

Figure 1: Example of VR Environment.

2.2 Real Time Body Motion Mapping for Avatars

Body tracking and then mapping it to avatars in real time to do exactly how the user's body doing is real challenge to us. We are using Microsoft Kinect Sensor to track the human skeleton and change the coming coordinates of the bones in the format for the unity to understand and act the avatar as it is as human in real time.

There is some research work available in the web about human skeleton tracking. Initially we studied University of Barcelona, Spain research work about "real time motion mapping for avatars and robots'' [6]. We have carried out research for the real time human skeleton mapping through the web and come to the conclusion with the various knowledgeable stuff. We started working on the algorithm of human skeleton mapping but found a Microsoft API which is built for this purpose. Hence we stoped wasting precious time to "reinvent the wheel" and goes for that Microsoft's API for real time human skeleton tracking for Unity. Microsoft has included very useful skeleton tracking relation functionalities in their SDK of Kinect [7] and has provided very useful information about skeleton tracking in their MSDN [8].

Figure 2: Example of Real Time Human Skeleton Detection and motion mapping to avatar

Figure 3: Example of Real Time Human Skeleton Detection and motion mapping to avatar

3.3. Networking

Initially for this project we will be communicating to other devices through local area Network. Unity Provides 2 type of networking systems, HLAPI (high level API) and the LLAPI (low level API). We have done coping real time real human skeleton movement and mapping it to the avatar. We have used HLAPI to send the Avatars Transforms through the network. Voice Chat is the other main functionality that is to be developed. This functionality will be done Using LLAPI. A Voice input coming in the form of wave will be serialized and buffered to the other node in the network and then again it will be DE serialized on the other node to its original form.

3. SURVEY

3.1 What Wall street journal says about Virtual reality Based Meeting System

The survey, in a report from Dell Inc., Intel Corp. and consultants Penn Schoen Berland, found that 57% of employees around the world prefer face-to-face conversations with colleagues. But more than half said that better communications technology could make such interactions obsolete in the future. Millennial particularly were open to using virtual- and augmented-reality products at work, with 77% saying they would try it.

Jeremy Bailenson, the founding director of Stanford University's Virtual Human Interaction Lab, says business calls using virtual-reality technology can offer many benefits over videoconferencing.

"VR meetings will allow for nuanced nonverbal communication—proper eye contact, subtle cues such as interpersonal distance, and eventually virtual touch and smell (when desired)," Prof. Bailenson writes.[9]

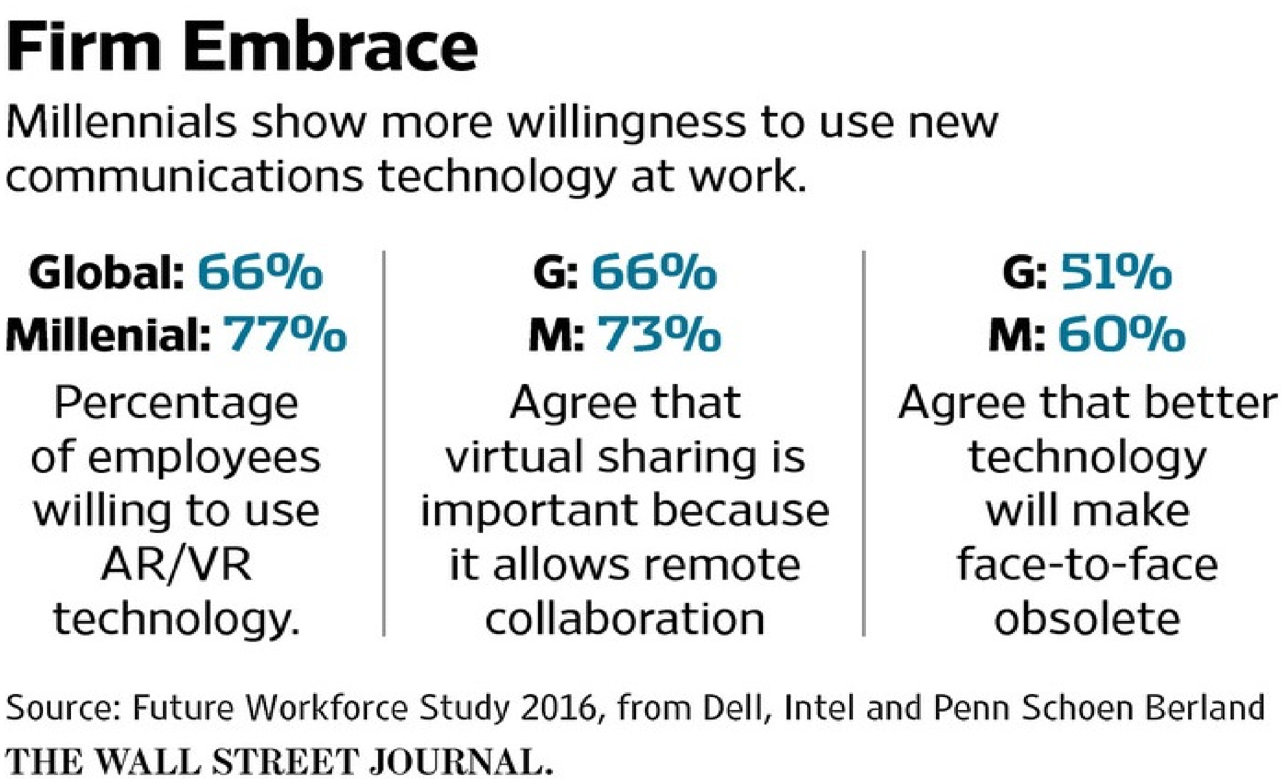

Figure 4: A survey Statistics from Wall street journal.

4. METHODOLOGY

Although we didn't implemented any formal process model of software construction to carry out our project development because of its uniqueness. VRMS (virtual reality based meeting system) is being developed using CS-Script programming language in Unity game engine. We initially planned to develop each of its major functionalities separately and then combine all of them in one in the end. The functionalities were VOIP (voice over internet protocol), Head tracking, Real time human skeleton tracking and mapping it to the avatars, 3dreconstruction, Photosphere as VR Environment, 3d VR Environment, 3dSound, Networking.

4.1 Networking

We have developed Networking system in unity with the help of unity's HLAPI which have built-in functionalities to host and manage the connections. The High Level API (HLAPI) is a system for building multiplayer capabilities for Unity games. It is built on top of the lower level transport real-time communication layer, and handles many of the common tasks that are required for multiplayer games. While the transport layer supports any kind of network topology, the HLAPI is a server authoritative system; although it allows one of the participants to be a client and the server at the same time, so no dedicated server process is required. Working in conjunction with the internet services, this allows multiplayer games to be played over the internet with little work from developers. The functionalities which are dependent on Networking are Avatar Movements and VoIP. Both need to be synced on the network so that other connected player can listen and see the movements of the players. We have successfully synced the avatar movement to the network

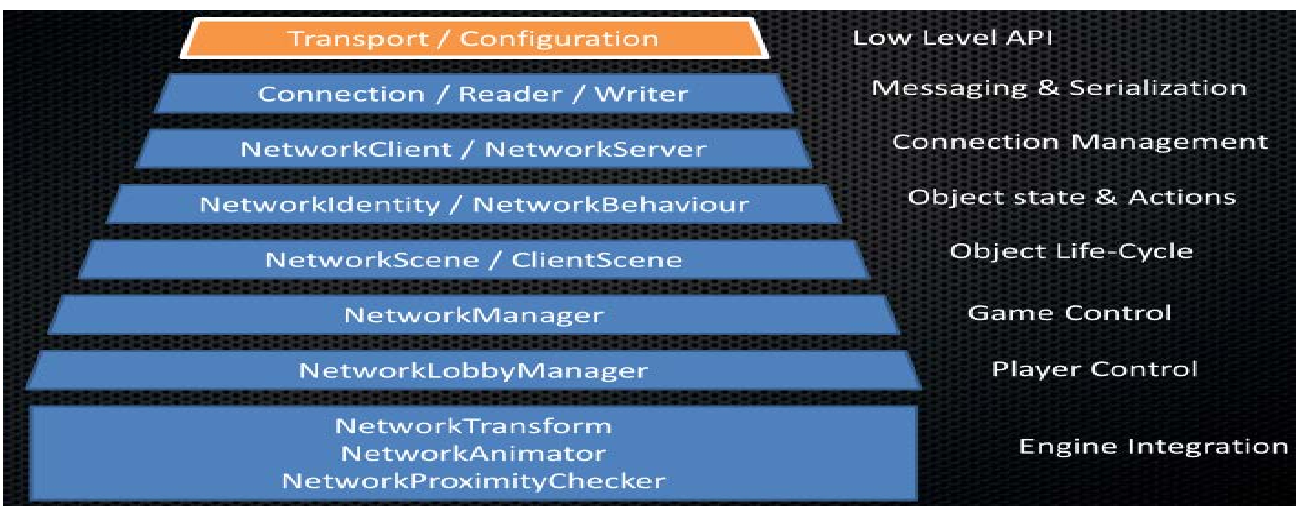

Figure 1: Networking Layer

But we faced problem when we tried to implement VoIP on the same networking method. We tried our best to somehow integrate VoIP to the Unity's HLAPI networking but failed because HLAPI does not allow any kind of functionality in their API for the Voice Chat.

So, we decided to start working on the Unity's LLAPI which is called UnetTransport. Initially we got some success but it wasn't that result which we were trying to achieve. After Studying Voice Chat to its core we decided to work on C# socket programming to implement voice chat and then later import it to our unity's project.

4.2 VoIP (Voice over IP)

After trying HLAPI and LLAPI UnetTransport we started studying the core fundamentals of Microphone data and its syncing techniques to the network. As data coming from the microphone are in the format of PCM (pulse code modulation) [10] it was our first challenge to convert it into bytes array in order to send it to the network. We choose C#

socket programming for this Functionality and started working in a separate project. First of all we converted the sound wave coming in the form of PCM from the microphone into samples, this process is called sampling [11]. Sampling is the reduction of a continuous-time signal [12] to a discrete-time signal [13]. A common example is the conversion of a sound wave (a continuous signal) to a sequence of samples (a discrete-time signal).

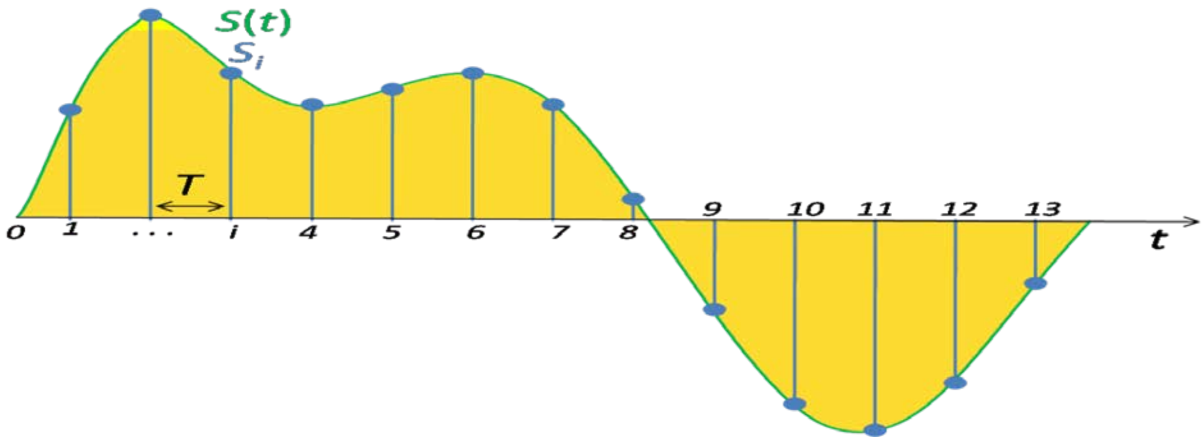

Figure 2: Signal sampling representation. The continuous signal is represented with a green colored line while the discrete samples are indicated by the blue vertical lines.

After taking the samples from the incoming microphone data, we converted them into array of bytes and started sending them to the server on every frame. Then we coded server to send every connected client the coming array of byte every time it receives. This all happens in blink of an eye and mistake in this type of code is very hard to be debugged. After many failed tries we finally send and received the data on the other side but there was another problem to play the receiving data that is in the form of byte array. In unity the sound is played using Audio source component and audio source component of unity only takes float value or audio clip in order to play it. That's why we have to convert the received byte array into float values. After converting the byte array into float we put it into the audio source data to play it in the VR Environment.

4.3 Head Tracking

Every object in unity has X Y Z axis float data which represent the object's position in the Scene. In order to track User's head we decided to simply get the Gyro coordinates from the cellphone and push them into the avatars head object X Y Z axis in real time.

4.4 Human skeleton tracking

After digging into www and doing research to achieve this functionality we found an ready-made API from Microsoft for this. So, we decided not to reinvent the wheel and use the ready-made stuff by the professionals.

4.5 Photosphere as VR Environment

Photo Sphere is a 360-degree panorama feature Google added in Android 4.2 that lets you take immersive pictures with your phone, then share them online. A photosphere can also be called as a single, non-stereoscopic spherical panorama image. We created a sphere surrounding the virtual camera in our scene, and put the image on the inside of that sphere. We could model the sphere in something like Blender, but Unity already has a sphere primitive. That primitive even has vertex locations and texture coordinates that are perfect for an equirectangular projection. The only problem is that the sphere has its outside showing, and we need its inside showing. To do that, we used a shader. The shader we used is the simplest one available, the "Unlit/Textured" shader. All we did is added a line to the shader to tell it to cull (i.e. ignore) the front faces, which by implication means to show the back faces, of each polygon it renders. That will cause the sphere to appear inside-out, and the texture that we apply to it will be on the inside. That's almost what we wanted, except it appeared backwards since we're looking at it from the opposite side (imagine writing something on a piece of glass, and then looking at it from the other side). To turn it around, we replace the X (i.e. U, the horizontal textures coordinate) with 1-X, so instead of ranging from zero to one it goes from one to zero. After shader, We created a sphere. Put it at the origin (0,0,0) and scales it up a bit (I arbitrarily scaled it by a factor of 10). Created a new material, and applied it to the sphere. Drag and dropped the new shader into the material, then imported the photosphere image and dropped it onto that material. That's it.

5. RESULT

After compiling all of those functionalities we are now capable of meeting virtually in Realistic Photospheric environments and 3d VR environments. Indeed it's a new and futuristic way of communication. Our hopes are high that this Application will be helpful for the users and people will surely love to enjoy the new way of communication.

6. CONCLUSION AND FUTURE WORK

This project innovates the existing way of communication. This virtual reality based meeting system will help the people to get their conferences, presentation and meeting done without moving an inch from their places. By saving their time, effort and money this virtual reality based meeting system is ready to revolutionaries the existing way of communication.

Till now we have successfully developed a desktop and android application that is capable of providing real time human motion to VR Environment with Voice chat. Further we have thought to improve it day by day with a lot of more functionalities including "a video streaming from the internet to the VR environment", facial expressions, More clear voice chat, message chatting, , lip syncing and registration and profile system of each user.

7. REFERENCES

[1] Google Cardboard, (2017). Available at https://vr.google.com/cardboard
[2] CS-Script, MIT, (2017) Available at http://www.csscript.net
[3] Unity, (2017) ultimate game development platform. Available at https://**unity3d**.com
[4] Kinect Sensor, (2017). Available at https://msdn.microsoft.com/en-us/library/hh438998.aspx
[5] Unity Asset Store, (2017). Available at https://www.assetstore.unity3d.com/en/#!/list/welcome-to-asset-store
[6] Real time human skeleton motion mapping: http://publicationslist.org/data/melslater/ref-266/p175-spanlang.pdf University of Barcelona research paper on motion mapping.
[7] Kinect SDK, (2017). Available at https://www.microsoft.com/en-pk/download/details.aspx?id=40278
[8] MSDN, (2017). Available at https://msdn.microsoft.com/en-us/
[9] Virtual Reality Takes On the Videoconference: CAT ZAKRZEWSKI. http://www.wsj.com/articles/virtual-reality-takes-on-the-videoconference-1474250761
[10] PCM, (2017) Available at https://en.wikipedia.org/wiki/Pulse-code_modulation
[11] Signal Processing, (2017) Available at https://en.wikipedia.org/wiki/Sampling_(signal_processing)#Sampling_rate
[12] Continuous time signal, (2017) Available at https://en.wikipedia.org/wiki/Continuous_signal
[13] Discrete time signal, (2017) Available at https://en.wikipedia.org/wiki/Discrete-time_signal
[14] InstantVR: http://passervr.com/ . An API for the head movement of avatar.
[15] Photosphere: Benie Roehl. http://bernieroehl.com/360stereoinunity/
[16] Free 3d models: http://www.3dvalley.com

PROJECT MANAGEMENT-ROLE OF HR AND LINE MANAGER

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Abstract: The purpose of this paper is to investigate the role of human resources (HR) department and line managers towards the organizational development. Traditionally, finance department in the organizations has been related to the money matters, whereas the HR department has not been related to money matters, even in case of giving of the training to the employees and subsequent organizational growth. This paper attempts to establish link between HR and finance (money matters) and the role of line managers. Finally, it has been observed that the role of HR has been limited to that of the administrative rather than the development of employees, and much its role has been taken over by the line managers who are not equipped with the HR practices.

The study is based on the qualitative research approach adopting direct/participant observation method when the researchers were part of their respective organizations. Semi- structured interviews were also conducted from the HR and employees for in depth understanding of the HR processes and subsequently role played by HR and its impact on the performance of the employees. It also highlights significant part of the HR role being performed by the lime managers, specially for the recruitment of the staff for the projects.

The data collection was carried out when the researchers were part of their respective organizations, where the role of a participant observer was involved. This is limited to the organizations and the HR interaction and the role played by line managers. However, the data collection through semi-structured interviews helped increase depth of the data collection. The role of HR in developing the employees has impact on the employee satisfaction and motivation which results into increased organizational performance. The employees within such organizations achieve their career targets within the organizations. This was possible though research framework of TALENT, TRAINING and TASKS. At the heart of this framework is value fit/cultural fit.

1. INTRODUCTION

The research paper aims to identify the role of HR in the organizations in the UAE and the need for improvement based on the latest trends in the HR connecting it with business and the line managers. Historically HR departments in the organizations have been called as the personnel department, due to its strong focus on the humane side of the organizations, and this caring practice started after the World War II. However, the HR departments lacked business side of the organizational growth. This led to the irrelevance of the HR in the organizations. With the ongoing trend of getting to the business side of their role, the HR was limited to the following of the CEO and CFO instructions, without having any say in the strategy formulating, its execution or performance evaluation whereas performance is defined as performance is defined as a kind of competitive ability in which to estimate firm’s values (Yang etal., 2007). HR was out of touch with the business side of the organizations/projects, therefore the influence over the organization was limited. HR has been like architects in the construction where they were neither the designers nor the executors. However they are equipped with the information and knowledge that helps organization build blueprints which guides to the design and construct (Ulrich etal., 2009). Likewise when asked to the CEOs by Brandl and Pohler (2010) the most important resource in their organizations, the response was human resource conversely the HR department was named at eighth or ninth ranking as significant to the organization. This clearly shows gap in expectations and practice. And in general and specific to the projects this role of the HR has been taken over by the line managers. They are responsible for the selection of the project staff, whereas the HR role has been limited to only administrative work. A project is defined as a “temporary endeavour undertaken to create a unique product, service or result” (PMI, 2008). Wysocki (2007) sees a project as a consequence of unique, complex and connected activities having one goal or purpose that must be completed by a specific date, within budget and according to specification. This emphasizes the importance of the right recruitment of the staff for the projects.

HR has to redefine itself. The role of HR is not limited to administration but to talent, training and tasking of the employees as per the strategy outlined. Human Resources Management (HRM) is defined as a “strategic and comprehensive management area that involves establishing policies, practices and administrative structures that focus on an organization’s most valuable resource-its people”. It has also been defined as “the design of formal systems in an organization to ensure the effective and efficient use of human talent to accomplish the organizational goals” (Solomon etal, 2013). But in the recent times there is a more emphasis on connecting HR with strategic management. Therefore it is a shift from the tactic role of the HR (Ulrich etal, 2009) to the strategic role. Strategic role refers to the hierarchical position HR has in the organization, participation of senior HR managers in the strategic planning processes and involvement of the senior management in the HR matters as covered by Storey (1992). Due to the difference in strategy formulation and strategy execution, the role of HR has been limited to its execution: measurements, rewards, staffing, training and communication. However there is a call (Charan etal, 2015) for the central role of HR in the organization in the form of Chief Human Resource Officer (CHRO) who should be contributing right from strategy formation to its execution. HR attempts to create a central position within the organizations. There is an apparent shift in the role of HR in the organizations from the people oriented, communicating care, concern, and compassion to strategy architect to finally connecting the HR to the customer demands.

2. PROBLEM STATEMENT/WHY THIS RESEARCH IS IMPORTANT NOW

Harvard Business Review issued its edition of July-August 2015 fully devoted to HR. The title of the issue was “It’s time to blow up HR and build something new”. This turned attention of the researchers into the vast domain of HR influencing lives of all the employees greatly. Some even say “Why HR Gets No Respect” leading to the demand for a seat for HR person on a decision table (Vosburgh etal, 2007). This disrespecting of the HR goes from being of no significance to the organizational success as the department is not directly executing the works for the Clients brining fee to the extent of being called as the personnel administration and policy police-hated by the people. However, the influence of HR is not measured in the form of business and financial targets as ROI, but its influence on finding the right talent, training the talent for the strategic goals and establishing the culture of performance contributes significantly on the long term basis for the organizational success. Hammonds (2005) laments that the HR has become a “henchmen for the chief financial officer” and that it has become “a dark bureaucratic force that blindly enforces nonsensical rules, resists creativity and impedes constructive change”. Ehrlich (1997) says that the administrative role (Beer (1997) studied administrative role which refers to payroll and benefits leading to promoting employee benefits) HR was focused on control, compliance and consistency with a preventive mindset. However the positive impact of the HR the role in finding the right talent, providing adequate training to achieve organizational target helps in individual satisfaction and motivation. Therefore, there is a gap in the literature on theory and practice.

This paper therefore attempts to look back into the historical context of HR and the practice within the organizations and draw reflection for their active involvement in shaping future of the organizations. This paper, therefore attempts to answer the research question of “Changing role of HR: where do we stand now? No research study was found to have covered this aspect of the HR in general and in the UAE particular.

3. HISTORICAL CONTEXT OF HR

First time the word Human Resource appeared in Merriam-Webster dictionary in 1961 (www.marriam-webster.com). The historical change from administrative department to personnel department happened in the 1970s due to the industrial business relations (Tyson, 1987). In 1980s came HR management opposed to personnel management resulting into people management as the heart of strategic management of the business. The personnel and administrative departments were considered as manipulative (Armstrong, 1987). Solomon etal (2013) however presents historical context of the HR evaluation in table 1 below:

Table 1: Evaluation of human resource administration

Early Stages	**1900-1960**	**1960-today**
Evidence of workers	Personal department	Business partnership
Voluntary social program	Strict work safety	Soft skills
Safety laws	Social programs	Talent management

Basic hard skills	Hard skill training	War for talent
Schools at factories	Social program for employers	Outsourcing
	Productivity focus	Leadership
		Diversity
		Innovation

The above table shows that the changes in the HR were aimed at engaging them in strategic planning and in order to anticipate the future changes and utilize various components of the organization resulting into increase business performance. These changes have been brought about mainly due to the diversity in the work force, economic and technological changes, innovations, globalization, organizational restructuring, changes in the nature of work, and outsourcing of activities. The detailed description of the changing role of the HR is presented in the following section.

4. THE CHANGING ROLE OF HR

The perception about the HR is the measurement of the CEO's/top management's expectations from HR which are limited to their experience of HR and are limited to only executive compensations and succession planning (Vosburgh etal., 2007). Jamrog and Overholt (2004) suggest need for the evaluation of the HR based on the human capital side as a differentiator in their book "past, present, and future". Their emphasis is on the measurement of the organizational effectiveness by thinking, acting and measuring devices in a more systematic way-how actions create results.

Boudreau and Ramstad (2007) highlighted decision role for the HR than the support service. They call for a seat for the HR in the decision making along with CEO and CFO, because success of the organization depends on improved decisions that depend or impact the people. Much of this depends on what the management is expecting from the HR and what management should be expecting from the HR, and both are different from each other.

In the past the role of HR was that of the administrative nature not connecting with business (Ulrich etal., 2008). These HR departments were liked because of their being affinity to the people, however did not succeed on the business side, as HR was not ready to manage the business side of the organization, such as market intelligence, capability and competency of the competitors. On the other hand the organizations focusing on the business alone for the results resulted into a short term gains losing the war of talent. HR's ultimate job is to link the human side of the business with business strategies and to frame and implement individual abilities and organizational capabilities as a critical source of competitive advantage (Ulrich etal., 1995). Cappelli (2015) gives difference in the shift from personnel department in the organizations to the leadership era of HR. He traces history of HR during the great depression when the HR was used to "drive" performance of the employees by threatening and hitting them to achieve the performance targets. However, after the World War II when there was a shortage of the talent importance of the HR soared. The modern HR focuses on coaching, developmental assignment centers, high potential tracks, and succession plans.

The personal administrative department was concerned with the technical aspects of hiring, evaluating, training, and compensating employees (Bala, 2011 in Solomon) whereas HRM was concerned with recruitment, retention, motivation of the employees to assure better performance of the enterprise. Ulrich (1997) in Solomon etal. (2013) defined HR responsibilities which include strategy execution, administrative efficiency, employee contribution, and capacity for change. There has been a continued shift in the HR roles from employee compensation and benefits, relationship between employee and employer, performance appraisal, safety, recruitment, selection retention, to today's need of strategic human resource management, human resource planning and strategic human resource management. Solomon etal. (2013) presents difference between personnel and human resource management in the table below:

Table 2: Comparison between personnel and human resource management

Dimensions	Personnel	Human Resource
Contract	Careful delineation of written contracts	Go beyond contracts
Rules	Clear mutual agreed rules	Can do outlook
Guide to management	Procedures	Business-need
Behavior	Customs and practices	Values and mission
Managerial task	Monitoring	Nurturing

Speed of decision	Slow	Fast
Management role	Transactional	Transformational
Communication	Indirect	Direct
Job design	Division of labour	Teamwork

The changing role of the HR from personnel, industrial relations to human resource management, and subsequent importance of HR is because of the (1) motivational theories such as Douglas McGregor (1960) and Abrham Maslow (1943) with the theory of hierarchy of needs; (2) rise of the service industry; (3) rise of the global competition; (4) importance of knowledge workers and (5) increased legislation regulating employment relationship (Ehrlich, 1997). Cappelli (2015) calls for the setting of the agenda by the HR and not following what has been asked to do and finally " bring first-rate analytic minds into the function to help companies make sense of their employee data and get the most from their human capital".

There is no doubt the people side of HR is essential, the HR should put a case for the financial gains to be achieved from their actions. This perception of not contributing to the finances in concrete comes from the fact that HR practices are not measured in terms of ROI. There is ongoing research on finding tools and metrics that measure talent investments within the organizations and subsequently connecting talent management expenditures with organizational performance (Boudreau and Rice, 2015). Moreover companies seldom have long-term plans with straightforward talent requirements. Therefore Charan etal. (2015) suggest to bring HR in par with finance by including a position/role of Chief Human Resource Officer (CHRO) within the organization and becoming a strategic partner. The CHRO will have a central role in corporate decision making. All that the organizations need is fit between the people and the job and the HR can determine what a particular job needs and assessing if the person selected for the role would be able to achieve (strategic) targets. The 2% of the employees in a business drive 98% of the impact and that nothing overcomes a poor fit (Charan etal., 2015). The CHRO should be armed with information about competitors and how their key decision makers and executors stack up against those at the CHRO's organization.

Boudreau and Rice (2015) emphasize on values and culture within the organizations that outperforms the competition and mention of the right talent placed at the right place in a similar way as mentioned by (Jim) Collins (2001) for a right person in the right seat. To connect the relationship between HR and business and to make former relevant to the present times, Boudreau and Rice (2015) suggest HR to start analyzing talent with the same framework that business people use to tackle supply chain challenges-focusing on quantity, quality, cost and timing needed talent, and what stands in the way of meeting those needs. One has to be cautious the perception of the CEO/top management and conditions affect HR role (Brandl and Pohler, 2010). Similarly, there is a need for the management to have training on learning soft skills. The section below discusses development of the research framework.

5. DEVELOPING RESEARCH FRAMEWORK

This section explains development of the research framework for this research based on the review of the existing research frameworks and the gap left in theory and practice. Brandl and Pohler (2010) studied perception of CEOs affecting HR role using semi-structured interview. The study revealed that factors such as strategy, HR competency, legislation and governance structure play significant role in HR development. Ulrich etal. (2009) provided a research framework dividing HR role between "People" and "Business". The four fold model Dave Ulrich published in his book "Human Resource Champion" given in Vosburgh etal. (2007) includes "strategic Partner" and "Change Agent" on the strategic side and "Administrative Expert" and "Employee Relations Expert" on the administrative side. This research framework has been criticized for being not applicable in other cultures (Mamman and Somantri, 2014). Other research frameworks include Contingency and Institutional theories which concerns to external factors such as labor market, legislation and unionization (Truss etal., 2002) and internal factors include centralization of the HR and the aptitude of the HR managers (Guest and King, 2004). Strategic Choice and Negotiated Evaluation framework calls for the key personnel the HR should negotiate for more strategic role (Truss etal., 2002). Social constructionist framework suggests for the political maneuvering by the HR (Berger and Luckmann, 1966).

All of the above research frameworks lack inherent objectives of the HR: connecting talent with roles and providing necessary training for individual as well as organizational success. This comes under talent management for the strategic goals. Talent is defined as the recurring pattern of thought, feeling and behavior (Buckingham and Clifton, 2004). Creelman in McDonnell etal. (2010) say talent management is a mindset and it is at the forefront of the organizational success. Blass (2007) considers it as opportunities made available to the people in an organization. Cappelli (2008) define it as a matter of anticipating the need for human capital and then setting out a plan to meet it. Finally Boudreau and Rice (2015) call for the measurement tools for the talent giving HR importance as close to finance and management departments. Therefore there is a gap in the literature and theory connecting talent with tasks as a part of the strategy through appropriate training. This is the hard side of the research framework. The soft side of the research framework is central to the hard side and it is value fit/cultural fit within the organizations. This research therefore has come with the framework presented below in Figure 1.

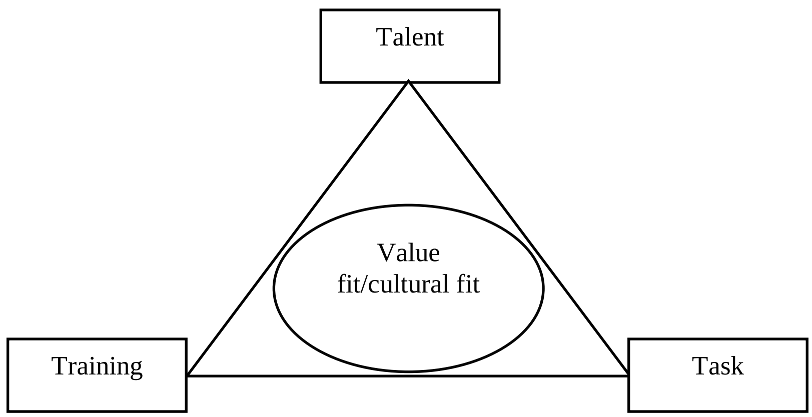

Figure 1: Research framework

In the above framework business side of the HR is TASKS which are aligned with the strategic objectives of the organization. The employee selection is based on the TALENT and the TASKS to be accomplished by the TALENT. TRAINING could be required to increase skill or knowledge of the employee as per the role requirements. At the heart of the framework is the value fit/cultural.

6. METHODOLOGY

The research methodology for the paper is based on the observation method of qualitative research when both of the researchers were part of their respective organizations. Semi-structured interviews were also conducted to confirm the data collected during the observations. Observation method requires both emotional involvement and objective detachment (Tedlock, 2000). This is a method of ethnographic study which collects data in the field and needs the researchers' hands to get dirty. In this kind of research, the researcher enters the organization or the research setting and becomes a part of the work team (Sekaran, 2003). The observational research method is used to get closer to the social reality, which has both social and economic implications. The HR should therefore be equipped with both personnel and business model understanding of the organizations relevant to research framework presented in figure 1.

7. DATA COLLECTION AND ANALYSIS

The data collection was in the form of observation when the researchers were part of their respective organization. The role of HR limited to administrative works and the overriding role of line managers in the recruitment of the project staff. We name researcher Alpha and researcher Beta for recording of their narrations during their observations. We have divided the data collection during different stages of the career stint within the organizations. This will help in understanding of the processes adopted by the organizations and involvement of their respective HR departments. The following table present data collection during observation stage of pre-selection, onboarding and finally training and development.

Table 3: Pre-selection observational data collection

Alpha	Beta
"The first contact in organizations has always been	The role of HR was that of administrative arranging for the

done by the HR. However, after arranging of the interview, the HR has no role."	interview with the technical teams".
"HR was involved at the time of issuing Letter of Appointment (LOA) and collecting of the documents for the processing of the visa in the UAE, which was an administrative role performed by the Public Relations Officer (PRO)."	"In my career of over 27 years and changing many organizations, I was only interviewed once by the HR in an organization.
"No interview was conducted by the HR person prior to/after the technical interview by the line managers. During my career it happened only once that the interview was conducted by HR prior to the technical interview."	"In the past there was no HR department in the organizations, it was only recently that we hear about the HR department. Earlier, HR was called as the administrative department."

The analysis of the observation method of the data collected reveals that both the authors found no role of HR in the selection process of the candidates. The HR was responsible only for the arrangements of the interview with the line manager and not even participating in the interview. Therefore the authors conclude that the HR was not focused on talent of the people being employed but skills and knowledge of the candidates which was determined by the line manager. The HR therefore was not looking at the organizational values/cultural fit of the candidates.

Table 4: Onboarding observational data collection

Alpha	Beta
"in all of the organizations I worked, none of the HR representative explained values, vision and mission of their organizations. It shows to me that once the technical acceptance of the candidate was secured from the line manager, the role of HR comes to an end in terms of the selection of the candidate."	"after the selection, the HR arranged for the Letter of Award. The onboarding was limited to providing of the literature of the company. The HR did not introduce to values and vision of the organization. At no stage was provided information about the strategy of the company. "
"no one in the HR explained to me what the strategy of the organization is and what are the future roles expected that would enable me to be a part of the organization in the future. I wanted a career growth in the organizations. The vision and strategy are important from the sustainable employment point of view."	"Strategy was never explained to me during my career life."

Onboarding of the employee is the information about the company profile and the purpose of the organization. During the career journey of both the researchers, the HR did not inform about the values of the company and there was no emphasis on the value/cultural fit. The mission and vision of the company were never made clear to the employees, enabling them to understand the purpose of coming to their office.

Table 5: Employee/Organizational Development observational data collection

Alpha	Beta
"Attended three courses in two organizations in my career. None of the course was suggested by the HR, but the line manager. The HR role in development was limited to reimbursing of the fee paid for the courses and that too after the acceptance by the line manager."	"HR was not involved in my training and development within the organizations. The HR was suggesting upcoming course and the line manager would propose candidates for the course. I think line managers and HR should know some of their respective roles."
"The role of HR has always been limited to perusing administrative roles and as such not connecting talent with task through adequate training programs."	"It has been proven over the time that the company/firm's inability to recruit and maintain good work force will be bottleneck for the development/growth. Hence both line manager and human resource manager should have HR duties. It is important to establish what duties are carried out by the line manager."

The HR did not play any role in the development of the employees within an organization. In only one of the organization that both the researchers worked at one point in time, the training courses schedule was announced by the HR, and the line managers were asked to nominate employees for the courses. This shows that there could be a possible link between the HR and the line managers for the recruitment of the project staff. Both line manager and the HR should possess awareness of the each of other's role so that the importance of respective role for HR and the line manager is highlighted in the hiring, training, development and firing of the employees.

1.1 Semi-structured interviews

The semi-structured interviews were also conducted to confirm data collection during the observation process. The interview questions were within the three domains of the pre-selection stage, onboarding and finally employee development. Below are the questions by the interviewee and corresponding answers by the HR. The following table presents questions by Alpha and corresponding answers by a HR officer.

Table 6: Results of semi-structured interview conducted by Alpha.

Questions	HR officer answers
"Do you participate in the interview process?"	"We participate in the interview process by giving interview calls to the selected candidates by the line managers. After the interviews are conducted and on the recommendation of the line managers we issue letter of award. I (HR manager) sit in the interview for positions above certain grade. We don't interview below that grade (below director grade)."
"Do you explain value, vision and mission of the organization to the employees?"	"We only provide literature on the values, mission and vision, but we don't explain to the employees these aspects of the organization. I understand that by reading themselves helps understand better values, vision and mission of the organization."
"Do you participate in the employee and organizational development?"	"We participate in the employee development by arranging required courses for the training. These courses are selected by the line managers. Other important thing is the finances for the training. If we don't have funds, we would not be able to provide training courses to the employees."

Table 7: Results of semi-structured interviews conducted by Beta with HR officers during his career

Organization	Did HR conduct interview?	What role HR played?
NE	No	Administrative
SC	No	Administrative
NO	No	Administrative
HI	No	Administrative
NL	Present	Administrative
AP	No	Administrative
CI	No	Administrative
DD	No	Administrative

The above results clearly show that the HR role was limited to the administrative role and not connecting talent with business. This research attempted to fill this gap in theory and practice.

8. CONCLUSIONS AND RECOMMENDATIONS

The role of HR has been changing ever since the start of the 20th century with major changes during the economic cycles of boom and burst. Therefore, there is need for HR to be connected to business strategy, HR must anticipate change and understand how to implement it, balance between employee and business interests, focus on issues rather than personalities, and enhance necessary skills. The research revealed vast gap in theory and practice connecting HR with business and talent with roles and training. This paper attempted to fill the gap. Also highlighted the need for strong relationship between the HR and the line manager for the recruitment of the right staff for a project and organization.

Talent management is to take center stage at the management where HR would be an equal partner as finance and (line) management. The management would always need support of the professional HR people to carry it forward. A deep understanding of the change human behavior and the development of the work leadership is beyond the rightful domain of the management and finance department. Therefore, the strategic business targets must come to the HR and the HR must understand organizational business and accordingly fill the gap of talent and adequate training programs, in collaboration of the line manager. This research recommends further research and development of framework connecting HR and (line) management with Clients through internal framework of talent, tasks, training (3Ts) and value fit/cultural fit.

9. REFERENCES

1. Armstrong, M. (1987). Human Resource Management: A Case of Emperor's New Cloths'. *Personnel management,* August, pp. 30-35.

2. Bala, Y. (2011). The new human resources management in 21 century: a strategic view. *Annual Conference on Innovations in Business and Management*, London, UK.

3. Beer, M. (1997). The transformation of the human resource function: Resolving the tension between a traditional administrative and a new strategic role. *Human Resource Management, Vol. 36, No.1,* pp. 49-56.

4. Berger, P. and Luckmann, T. (1966). *The social construction of reality: a treatise in the sociology of knowledge*. Anchor Books, Garden City, NY.

5. Blass, E. (2007). *Talent management: Maximizing talent for business performance.* Chartered Management Institute and Ashridge Consulting, London and Hertfordshire.

6. Boudreau, J. and Rice, S. (2015). Bright, Shiny Objects and the Future of HR. *Harvard Business Review, July-August 2015,* pp. 72-78.

7. Brandl, J. and Pohler, D. (2010). The human resource department's role and conditions that affect its development: explanation from Australian CEOs. *Human resource Management, Vol. 49, No. 6,* pp. 1025-1046.

8. Buckingham, M. and Clifton, D.O. (2004). *Now discover your strengths*. Pocket Books, London, UK.

9. Cappelli, P. (2008). Talent management for the twenty-first century. *Harvard Business Review, Vol. 86,* pp. 74-81.

10. Charan, R., Barton, D. and Cary, D. (2015). People Before Strategy: A New Role for the CHRO. *Harvard Business Review, July-August 2015*, pp. 63-71.

11. Collins, J. (2001). *Good to great-why some companies make the leap and others don't.* HarperCollins Publishers, Inc, New York.

12. Ehrlich, C.J. (1997). Human resource management: a changing script for a changing world. *Human Resource Management, Vol. 36, No. 1,* pp. 85-89.

13. Goleman, D. (1999). *Working with emotional intelligence*. Bloomsbury publishing, London.

14. Guest, D. and King, Z. (2004). Power, innovation and problem-solving: The personnel manager's three steps to heaven. *Journal of Management Studies, Vol. 41, No. 4,* pp. 401-423.

15. Hammonds, K. (2005). Why We Hate HR. *Fast Company, 97 (Aug.):* 40.

16. Jamrog, J. and Overholt, M. (2004). Building a Strategic HR function. *Human Resource Planning, Vol. 27, No. 1,* pp. 51-62.

17. Mamman, A. and Somantri, Y. (2014). What role do HR practitioners play in developing countries: an exploratory study in an Indonesian organization undergoing major transformation. *The International Journal of Human Resource Management, Vol. 25, No. 11,* pp. 1567-1591.

18. McDonnell, A., Lamare, R., Gunnigle, P. and Lavelle, J. (2010). Developing tomorrow's leaders-Evidence of global talent management in multinational enterprise. *Journal of World Business, Vol. 45,* pp. 150-160.

19. PMI (2008) *PMBOK, 4th ed.* Project Management Institute

20. Sekaran U (2003). *Research Methods for Business-A Skill-Building Approach, 4th ed..*. John Wiley and Sons, Hoboke.

21. Solomon, M.V., Bozga, R.E. and Mateescu, M.A. (2013). Management of Human Resource: Past and Present. *Managerial Challenges of the Contemporary Society, Proceedings 6*, Babes Bolyai University: pp. 185-190

22. Storey, J. (1992). *Developments in the management of human resources.* Blackwell, Oxford.

23. Tedlock B (2000). *Ethnography and Ethnographic Representation, in Denzin NK & Lincoln YS (ed.), Handbook of Qualitative Research, 2nd ed.*. Thousands Oaks, California, Sage Publications: 455–486.

24. Truss, C., Gratton, L., Hope-Haily, V., Stiles, P., and Zaleska, J. (2002). Paying the piper: Choice and constraint in changing HR functional roles. *Human Resource Management Journal, Vol. 12, No. 2,* pp. 39-63.

25. Tyson, S. (1987). The management of the Personnel Function: *Journal of Management Studies, Vol. 24,* pp. 523-532.

26. Ulrich, D., Brockbank, W. and Johnson, D. (2009). The role of strategy architect in the strategic HR organization. *People and Strategy, Vol. 32, No. 1,* pp. 24-31.

27. Ulrich, D., Brockbank, W., Johnson, D., Sandholtz, K. and Younger, J. (2008). *HR Competencies: Mastery at the Inter-section of People and Business*. Society for Human Resource Management, Arlington

28. Ulrich, D., Brockbank, W., Yeung, A. and Lake, D. (1995). Human Resource Competencies: An Empirical Approach. *Human Resource Management Journal, Vol. 34,* pp. 4-14.

29. Vosburgh, R.M., Resorts, M. and Mirage, M.G.M. (2007). The Evaluation of HR: Developing HR as an Internal Consulting Organization. *Human Resource Planning, Vol. 30, No. 3,* pp. 11-23.

30. Wysocki, R.K. (2007). *Effective Project Management: Traditional, Agile, Extreme, 6th ed.,* Wiley and Sons Publications, Indianapolis.

31. Yang, C., Wang, Y.D., and Niu, H.J. (2007). Does industry matter in attributing organizational learning to its performance? A case of Taiwanese economy. *Asia Pacific Business Review, Vol. 13, No. 4,* pp.547-563.

A Study on Customer Payment Behavior in Organized Retail Outlets at Hyderabad City

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ABSTRACT:

The study put the touch on how consumers use cash or plastic money in retail organized for their purchases outlets. The aim was to find out how consumers found it easy to use plastic money to be, whether they like to use, and in particular how it compared to using cash. Conducted a qualitative survey of consumer plastic money and credit cards, debit cards and cash to use. And the attitudes and behavior analysis and opinions of the customers through the payment collected using a questionnaire. It has been studying the impact of factors such as income, education, comfort, and the advantages and disadvantages of the means of payment. The study analyzed the problems faced by consumers with regard to security and complexity of use and preference for alternative means of payment. Research shows advantages in the use of plastic money in some cases offered on the comparative advantage to differentiate consumers. The study of customers' payment behavior during the purchase and their way of payment chosen.

Keywords: Debit cards, credit cards, Cash, payment mode and payment behavior, organized Retail.

Introduction

It is a well-established fact that retail business plays a crucial role in the development of any economy. Almost every developed or developing economy makes sure to facilitate its retail business sector and to add more and more convenience for the end consumer. This trend helps both; the consumer and economy to prosper.

With the emergence of latest trends in the banking sector, the customers of various banks are offered multiple options to pay for their various needs. These ways include the debit card, the credit card and the good old cash transactions. The use of these facilities mainly depends upon the user convenience and their perception towards ease of transactions. Some user segments prefer to test their credit limits by using credit cards while some prefer to be served by getting their accounts debited by the way of a debit card. In the other hand the trend of using cash while transacting never deems to go out of vogue.

There are many shopping malls, multi storied malls and vast facilities offer a large variety of products in the term of quality, they are making value for money and makes shopping a memorable experience. In the world of technology there are many payment services for the customer to pay the money through internet and cards. Nowadays plastic money has come as form of suitability to customer.

This paper endeavors to assess the most popular payment options exercised by the customers at the retail outlets of the specified study area. The trend analysis may play a pivotal role in suggesting a policy statement for provision of better services to financial consumers locally as well as internationally.

Literature Review

Forbes magazine (2013), He pointed out that scientific research shows that people are more likely, if they intend to use a credit card than if they intend to pay by cash payment to complete the purchase. Cash seems relatively scarce, so people are more willing to try to protect it.

Pallister and Isaacs (2002), It reported that allows customers to debit their bank account deductions paid directly in different goods and services through retail outlets. On the other hand, the credit card holder to make access to credit and cash withdrawals to a prearranged ceiling.

Maganty (1996), "Changing Dimension." The author discusses the importance of trends and debit cards in daily life appear in Indian society. Debit cards are expected to be completed in cash or in supermarkets, gas stations, convenience stores, check transactions in most places use. There is a card designed for who like to pay with a plastic card, but did not want to credit customers. These cards not only to maintain the cardholder's debt free, but also provides a detailed account spending. These types of cards are ideal for those who have a tight budget, and want to keep them. Research shows that there are two types of debit cards, on-line and off-line debit card. With the computerization and modernization of plastic banknotes wascome a symbol of social status, tradition-bound Indian society in the 21st century.

Objectives of the study

- To evaluate the influence of socio- demographic factors on payment behavior.
- To assess the customer preference regarding various payment methods.
- To analyze the particular reasons for customer for favoring a particular payment method
- Analyzing the ways of promoting the use of most efficient method of payment

Research Methodology

The objective of the research is to measure the customer payment behavior at organized retail outlets for peoples to paying for purchasing items. Therefore descriptive research was be adopted to find out the customer attitude and characteristics of customers. Suitable sampling procedure was used for data collection. The structure questionnaire was design for data collecting through questionnaire distribution among respondents and online survey also was design through Google form. The sample size was retail outlets of Hyderabad City. Standards questionnaire was the research instrument for data collection. The questionnaire was designed in such way; the aim of questionnaire was collecting information for the study will meet the set of objectives.

RESEARCH METHODOLOGY

The objective of the study was to assess peoples of Hyderabad payment methods during the purchase of good and services. A descriptive survey type was used in this study.

In the descriptive survey design there is a scientific investigation methods was used to study large and small population

A descriptive survey design is a scientific investigation that is used to study large and small population through selecting and studying large samples chosen from the largest population in order to discover the relative incidents or distribution of variables on a specific topic.

Convenient sampling procedure was used for data collection.

Research design

The main aim of this study is to know the customer payment behavior at organized retail outlets and find out the key factors for the usage of particular payment methods. Therefore descriptive research is being adopted to find out the customer attitude and characteristics of consumers.

Area of the study

The survey is conducted among customers who make purchase at various organized retail outlets in Coimbatore.

Research approach

A structured questionnaire is used for collecting data from the respondents through survey method.

Sample Size

Sample size taken in this study is 250.

Period of Study

The study was conducted during the period July 2016 to October 2016.

Sampling Technique

Convenience sampling was employed in the study.

Data Analysis and Discussion

A standard questionnaire was prepared for the collection of data from various respondents. The questionnaire was designed in such a way that the aim of collecting essential information for the study would meet the set of objectives.

Demographic Characteristics (Respondent and Customer)

Monthly (No of Purchase)	Frequency	Percentage %
1-5	95	38
6-10	70	28
11-15	55	22
Above 15	30	12
Total	250	100

Table 1: Monthly Purchasing frequency by customers

The table1show that maximum 38% of respondents make a purchase at organized retail outlets on the monthly basis at Hyderabad City.

Quantity of monthly Purchases frequency

Monthly (Quantity of Purchases)	Frequency	Percentage %
Less than 5000	115	46
5001 to 10,000	70	28
10,001 to 15000	45	18
Greater than 15001	20	8
Total	250	100

Table 2: Monthly Purchases Frequency

In the table2 R.S. 5000 maximum quantities of purchases on the monthly basis is 46%

Type of Store for Purchase

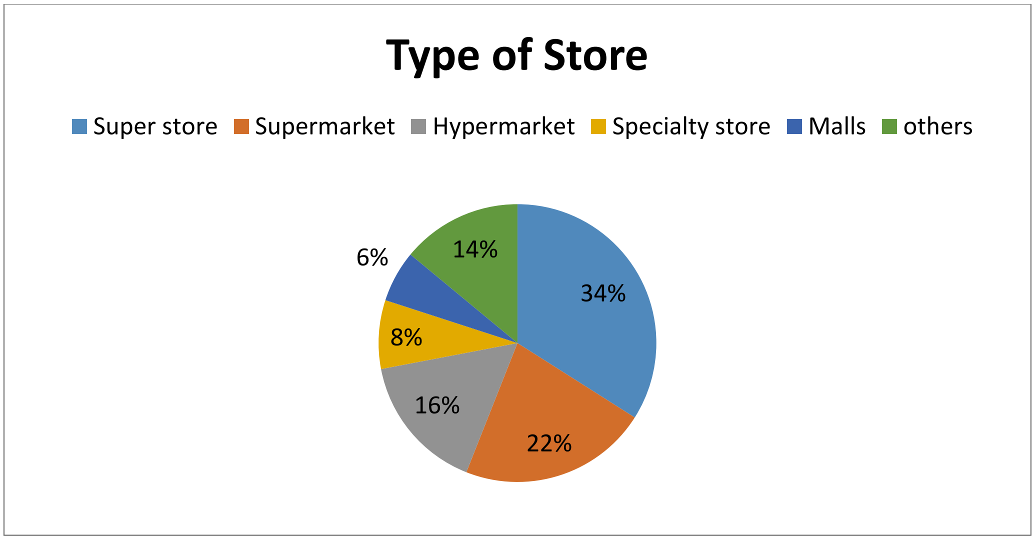

Figure 1. Type of Store for Purchase

Above figure show that the majority of customer purchases from the super store of Hyderabad City.

Method of Payment (Card and Cash)

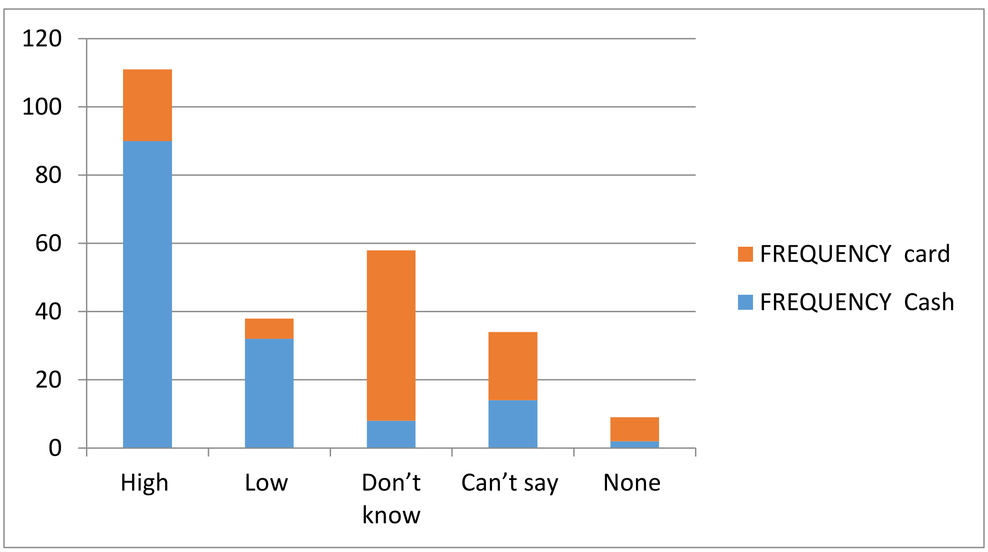

Figure 2. Payment Method Frequency

In the above Figure 2 shows that the majority of customer uses cash methods to purchase from multiple outlet stores

Type of payment mode used by occupations of respondents

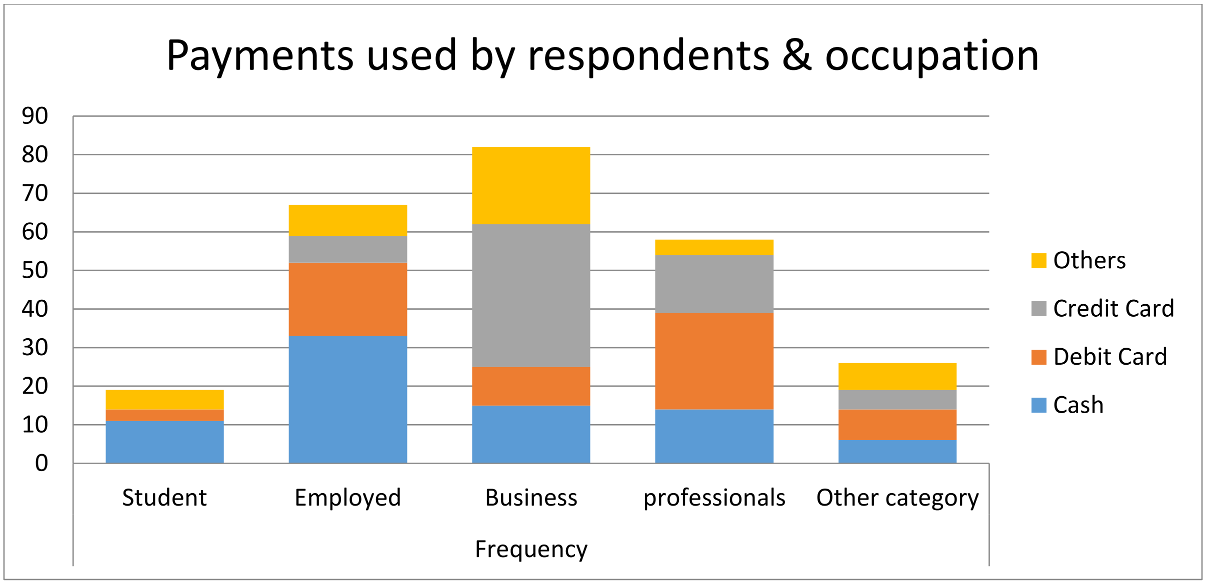

Figure 3. Payment Method Used by Respondent & Occupation

In the above figure 3 shows that the business persons used credit cards to purchases items from outlets and cash is used by employees.

Plastic money benefits

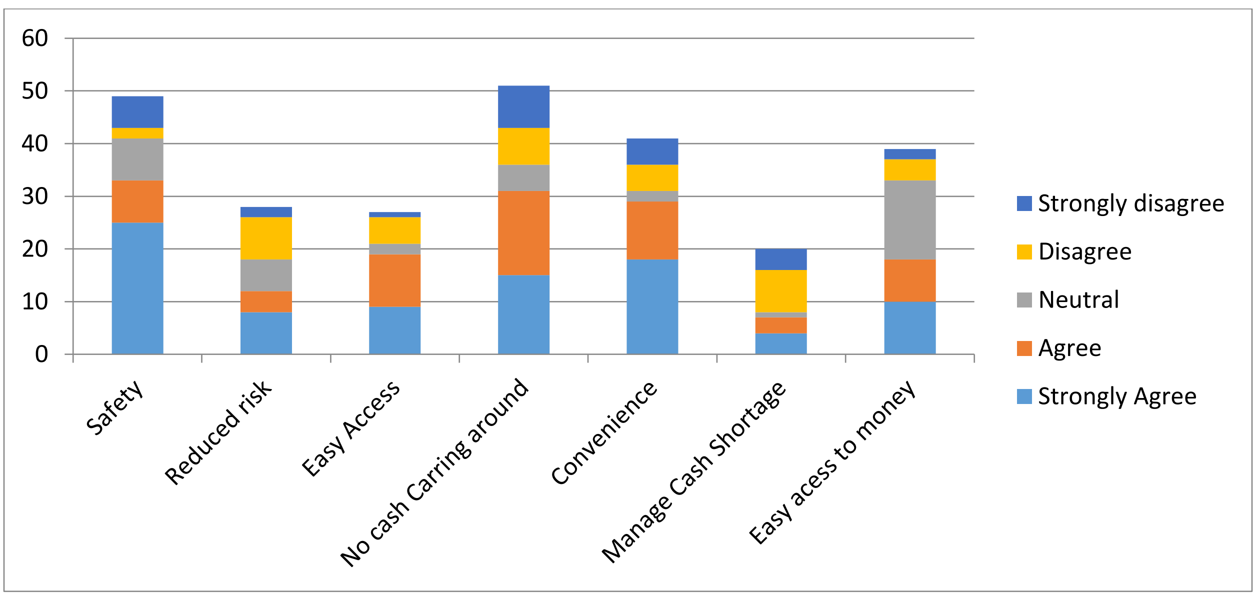

Figure 4. Plastic Money Used Benefits

The above table shows that majority of consumers feel that safety and convenience are the benefits in using plastic money.

Challenges of Respondent used Plastic Money

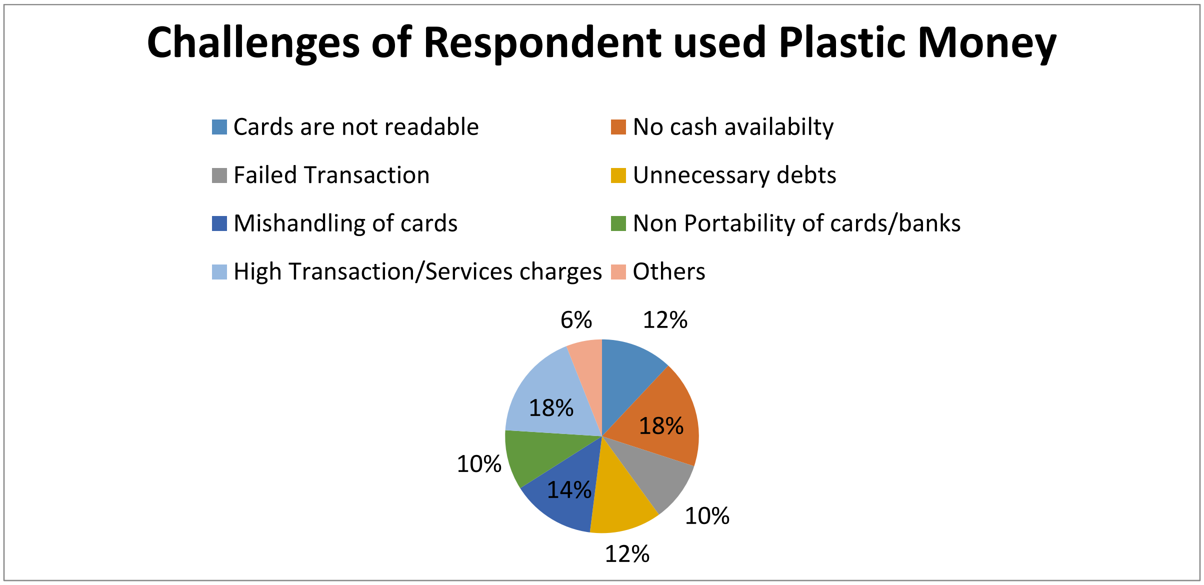

Figure 5. Challenges of Plastic Money

The above table shows that major customers faced high transaction/service charges and no cash availability in using plastic money.

Promotion of Plastic Money Source

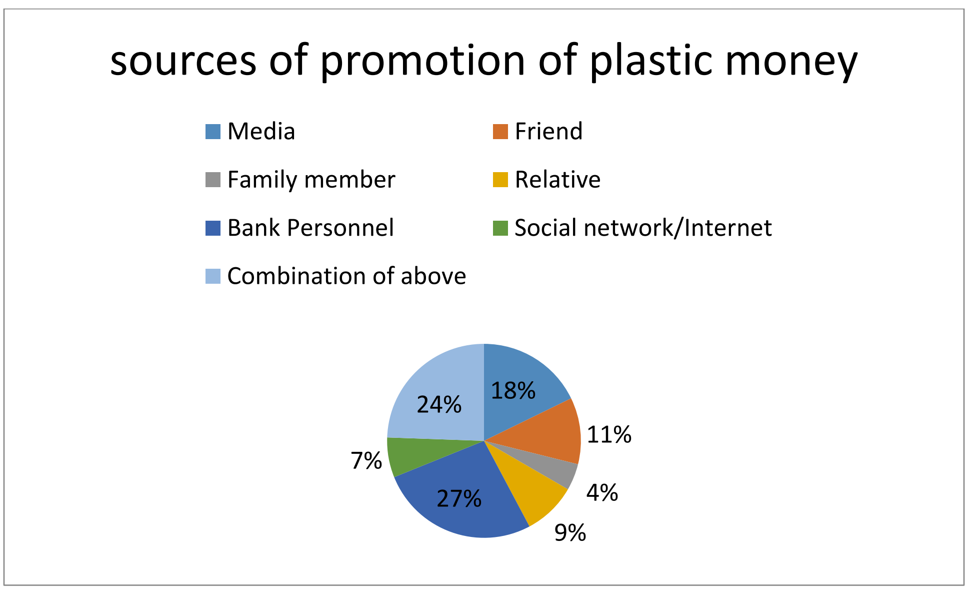

Figure 6. Source of Promotion of Plastic Money

The above table shows that bank person is the main source of promotion for plastic money.

Showing rank the easiness of payment process

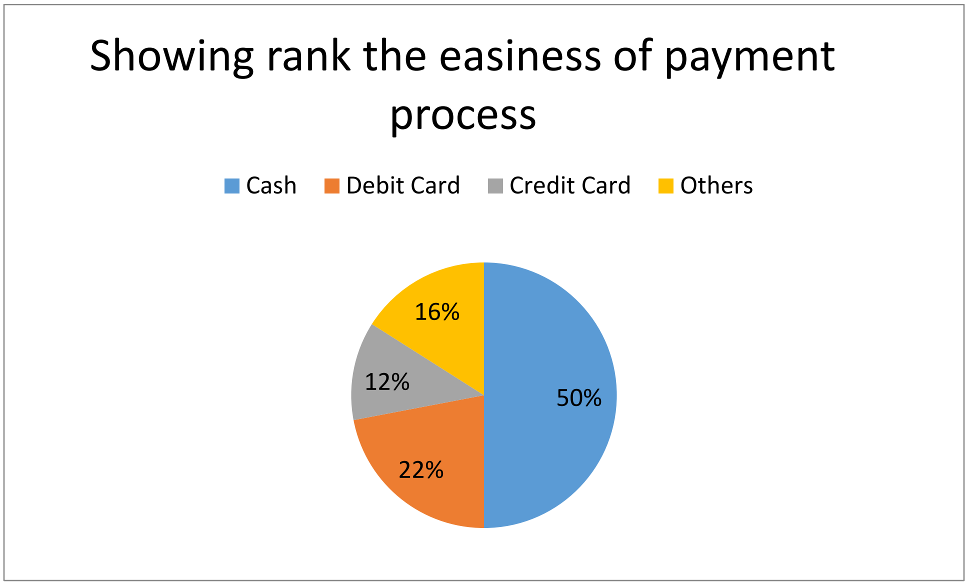

Figure7. Showing rank the easiness of payment process

CONCLUSION

Payment behavior is heavily influenced by age, education and income. As age increases, the tendency to use cash also increases markedly. Respondents aged 30 and over effected the most transactions using cash. Irrespective of age, individuals with higher levels of educational attainment and those with higher incomes tend to make greater use of payment cards.

Respondents generally have a lower level of education and a lower level of income, whereas middle-aged respondents are generally better educated and enjoy higher levels of monthly net household income. Therefore socio-demographic factors had a significant influence on payment behavior.

Cash is used almost exclusively for payments to private individuals and transactions in cafes, bars, snack bars and fast-food restaurants. This is due to the fact that these payments are often for small amounts and it is not usually possible to use cashless payment instruments for transactions between private individuals. The majority of purchases at vending machines and restaurant transactions are also settled in cash due to the extremely high number of low-value payments

The study considers the state of our understanding of how and why consumers choose their payment methods and what is needed to make more advance in understanding consumer payment decisions. Today's interest in consumer payments is really an interest is called as "payment instruments. Cash, Credit cards, debit cards are the leading payment instruments today.

Reference

- Sabah Abdullah Al-Somali, R. G. (2007). *Internet Banking Acceptance in the Context of Developing Countries: An Extension of the Technology Acceptance Model.* Birmingham: Operations &Information Management Group, Aston Business School, Birmingham B47ET, UK.
- Mariri Tendai and Chipunza Crispen (2009) "In-store shopping environment and impulsive buying" African Journal of Marketing Management Vol. 1(4) pp. 102-108 July, 2009.
- Maxwell K. Hsu, Yinghua Huang and Scott Swanson (2010) "Grocery store image, travel distance, satisfaction and behavioral intentions Evidence from a Midwest college town" International Journal of Retail & Distribution Management Vol. 38 No. 2, 2010 pp. 115-132.
- Pauline Sullivan and Ronald Savitt (1997) "Store patronage and lifestyle factors: implications for rural grocery retailers" International Journal of Retail & Distribution Management Volume 25 Number 11 1997 pp. 351–364.
- Pedro Quelhas Brito (2009) "Shopping centre image dynamics of a new entrant" International Journal of Retail & Distribution Management Vol. 37 No. 7, 2009 pp. 580-599.
- Chimedza, C., Chipoyera, H. W., & Mupambireyi, F., 2004. Statistics for managers. Module MBA 04. Second Revised Edition. ZOU, Harare. Zimbabwe
- Whitely, B.E., 2002. Principles of Research in Behaviour science, 2rded. McGraw Hill, Montreal
- Letecia N. Moye & Doris H. Kincade(2002) "Influenceof usage situations and consumer shopping orientations on the importance of the retail store environment", The International Review of Retail, Distribution and Consumer Research Volume 12, Issue 1, 2002 pp 59-79.
- Yingjiao Xu (2007) "Impact of Store Environment on Adult Generation Y Consumers Impulse Buying" Journal of Shopping Center Research (2007), 14, 1, pp. 39-56.
- http://iq.ecu.com/reports/remars-report/check-credit-card-or-debit-card-choosing-a-payment-method-for-security-and-convenience.html
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Biological Treatment of Drilling Waste; A step towards Friendly Environment.

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Abstract

It is very serious issue for Petroleum Industry to treat the drilling waste in safe and economical manner. For that they use traditional methods, but these methods do not give the environmental friendly results. Now-a-days we use microorganisms to treat drilling waste. Bioremediation is the methods of waste treatment to promote optimal biological activity for the detoxification of drilling waste.

Biological usually involves treating organic pollution, where microbial cells that use HC molecules as a source of carbon, therefore these organism extract energies for their respiration and C for cell growth. Bacteria, fungi and actinomycetes are primary microorganism in the process of degradation of HC contaminants. The motor of all physiological biological responses is the acquisition of energy for living, such as metabolic processes, reproduction, mobility, etc. To maintain a healthy environment for good biological activities, the focus is on controlling oxygen, moisture, pH and nutrients. This is very easy, cheaper and environment friendly waste treatment method.

Keywords: Actinomycetes,Bioremedation, metabolic

1.Introduction

It is very serious issue for Petroleum Industry to treat the drilling waste in safe and economical manner. So for that they use traditional methods, but these traditional methods do not give the environmental friendly results. Now-a-days we use microorganisms to treat drilling waste. Some microorganisms have the ability to use organic compounds to digest specialized proteins, known as enzymes. Enzymes are called biological catalysts. Certain microorganisms produce enzymes that accelerate the biodegradation of biological contaminants harmless CO_2 & clean of solid and water. This natural method can be used & used in the oil industry to treat cuttings.

The bioremediation takes place to produce a stabilized soil amendment product. The biodegradation of biodegradable mass as a result of biological action, turn it into a loss of humus. Therefore, when the compost is deposited in the soil, it is subjected to biochemical changes caused by a native soil microflora. This microflora is not only important for the decomposition of organic matter; It also provides nutrients and biomass in the soil. That is, once the oily waste is extracted into the compost, it has as soil conditioner. Compost is an organic material that, when added to the soil, a part of the soil. Therefore, bioremediation of oily solid waste is strongly recommended. Treatment of oily waste like compost recycles soil where it helps to improve soil conditions. In fact, compost is a more advanced stage of decomposition of most organic materials, which are normally applied to the soil (z. B crop residues, manure, leaves, etc.), because most of the Sugars, proteins, simple sugars and amino acids in compost is metabolized as a source of carbon and nitrogen for microorganisms. What remains are mainly humic substances. Essentially form seven main organic substance elements: carbohydrates and sugars, proteins, fats, hemicellulose, lignin, cellulose, minerals.

Bioremediation usually involves the treatment of organic pollution, where the hydrocarbon molecules of microbial cells used as a source of carbon, which provides energy for respiration and carbon for cell growth. These biological processes are for a variety of organic pollutants. The treatment is essentially a destructive method based on oxidation or reduction reactions. A simplified version of this process is shown below: basic metabolic processes with bio remediation of petroleum HC.

(Metabolic process)

H - C – H H2O + CO2 + Protein

(HC waste)

The primary active microorganisms in Bioremediations process are naturally in the soil. These are divided into five main groups, namely bacteria, actinomycetes, fungi, algae and protozoa. The first three groups of microorganisms are responsible for the conversion of organic pollutants into the soil at most. The treated bars were carried out by the biological body and used as a filler material for the construction of different access routes. The next batch of drill sections has been transferred for processing into the biological body. The treatment process involved mixing cuts with the filler, the native soil and Bio Enhancer according to predetermined ratios.

Bioremediation typically comprises treating organic pollution, where micro cells, HC molecules used as a source of carbon, bringing the energy to breathing & C for cell progress. Bacteria, fungi & actinomycetes are the most important microorganism procedure of the deprivation of petroleum HC contamination. The driving energy behind all physiological bacterial reactions is an acquisition of energy for survival, such as metabolic processes, reproduction, mobility. In order to maintain a healthy environment for good microbial activity requires consideration to control O_2, humidity, pH and nutrients,

2.Culture preparation

These biological organisms grown on potato dextrose agar, composed of 200g potatoes,20g of dextrose and 20g of agar dissolved in one litter of distilled water. The culture will maintain in at 40C.

3.Preparation of inoculums

The inoculums were prepared in one litter bottles.200g of boiled wheat corn seeds or straw mixed with 6 % CaC03 and 2% CaS04 will be add and sterilize at 121' C for one hour in two successive days, Grains will inoculate with mycelium, developed separately in Petri dishes and incubated at 25 0 C until the mycelium covered all the wheat seeds which took around 10 days.

4.Step by Step Process

1- Drill cutting in cells applied to the treatment with sand & sawdust.

2- Mixing boring bars, sand and sawdust until all well mixed.

3- A microorganism and nutrient mixture is scattered onto the sections.

4- In the process, the mixture is pulverized and washed regularly until the measured OOC is less than 1%.

5- When the oil content of the mixture has been planted to an acceptable level, seeds are planted, which is now known as growth medium.

6- Once the plants have increased toxicity values that are tested to prove that the rehabilitated bio cuttings are suitable for disposal.

Fig: Preparation of site for treatment

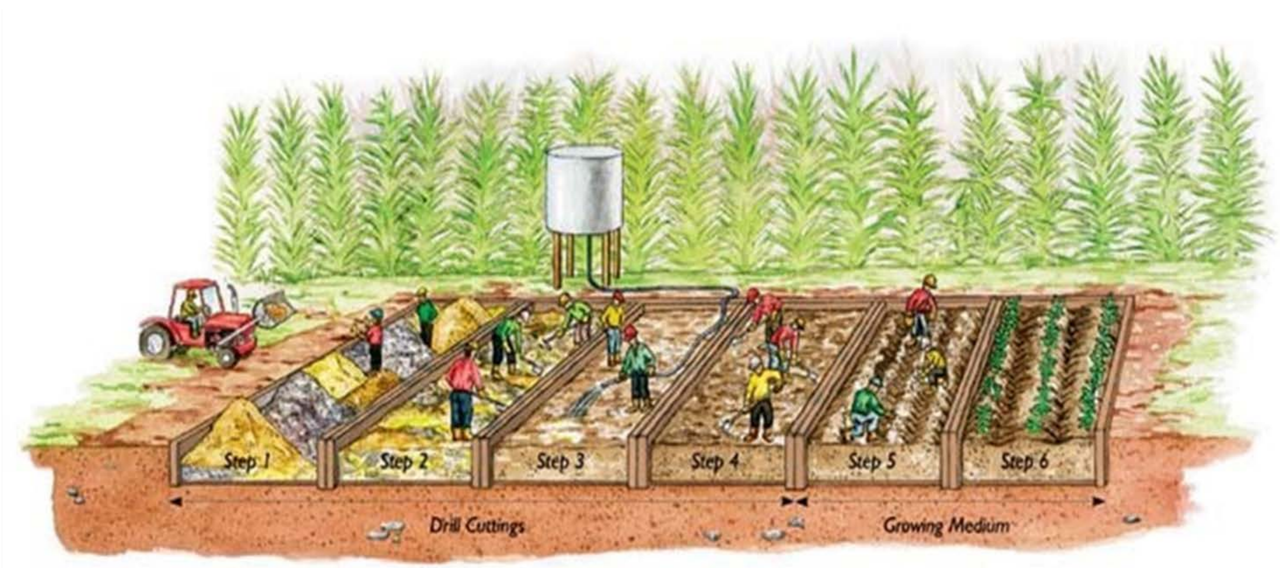

Figure 2: Step by Step Process

5.Benefits of Biological Treatment

- Bioremediation can be achieved with a minimum of resources, since only the real world needs space (Earth) and time.
- Using Bio vermehrung can accelerate bioremediation.
- Heavy metals in the residues can also be safely removed by appropriate trees and plants are planted, after the 1% by weight oil content has been reduced.
- After a successful Bioremediations project land can be used again for vegetation.

- It is relatively inexpensive. Usually moderate weather.
- The best choice for the environment and without emissions.
- Insurance of workers involved in the project.
- After compost oily waste detoxification can be used for soil conditioning.
- The main advantages of bio-remediation of other technologies are: Relatively cheap, usually takes a moderate time, the best choice in terms of environment, zero emissions. Insurance for workers who are involved in the project, after the detoxification of oily waste compost can be used for soil conditioning, there is a failure, do not stop to check without problem solving and not all.
- This is a treatment process that decomposes and decomposes naturally occurring microorganisms (yeasts, fungi or bacteria) & decomposes living bodies. Disassemble organic substances microorganisms to carbon dioxide and clean water. As soon as the pollutants are degraded, the microorganisms of the population naturally decrease, since they have used all their food sources.

5.1Some other Benefits of Biological Treatment

5.1.1 Impact on the environment:

- Remove all products of the process without further treatment or special care for <1% w / w oil content.

5.1.2 Cost

- biological rehabilitation is a relatively cost-effective method of re-ordered materials rehabilitated. When cuttings are treated in situ, transport costs are lower compared to other methods.

5.1.3 Safety:

Some machines are required to facilitate biological rehabilitation, reduce operational risks.

5.1.4 Beneficial Products:

The final product was triturated with certain biological additives. It can be used as adjunctive soil or the culture medium.

5.1.5 Low maintenance:

-Like a low-technical method that requires some machines, some delays due to immobilization devices.

6. Requirement for Effective Treatment

Control of pH, Temperature, Moisture level, residue will be transmitted frequently, appropriate mix of residue formation, soil and loading agents.

Other microbes may be added to waste to increase processing speed if necessary.

7.Drilling Waste Management

Cuttings are placed in the cells of the curved and amounts of wood sawdust, sand, natural nutrients and microbes are measured. The mixture can be plowed by work or machine, either depending on the size of the project. The mixture of regular time passes and organized properly allows contaminants to be processed in cuttings & used up by microorganisms. This method will result in a decrease in the percentage of the oil in cuttings from an agreed level with the operator to be environmentally friendly. In many cases, the final product containing safe nutrients can be used as a culture medium. Scomi oil tools can require a biological rehabilitation system adapted to drill a design require treatment. The balance of microorganisms and chemicals required depends largely on the composition of the cuttings or other impurities. A prior approval of the best treatment scheme is necessary to determine. This is a composite task that needs skilled data. Once strong-minded, the treatment is easy to set up and manage.

8.Conclusion

• For the first time, Trichoderma harizanum and Pleurotus ostreatus were shown in this study as hydrocarbon-degrading microorganisms.

• Trichoderma Hari: anum as a biological control and fertilizer known as "Al-Tahadi" has been shown to play an important role in this activity bio based production of extracellular enzymes.

• The possibility of using different substrates agricultural residues cost-effectively and available in the oyster mushroom culture results in the use of this fungus 9. in a wide range of biological control treatment.

• Biological treatment could be considered an effective treatment, since most of the materials have been used in the incubation and growth of microorganisms that were available and cheap.

• Specific local conditions may affect biological activity. For example, a certain degree of the limit temperature of microbial activity and decrease the biodegradation of hydrocarbons. The study showed that the optimal temperature and humidity between 15 and 35% and between 20 and 400 ° C was.

• Better degradation of hydrocarbons, which are generated by two in a concentration ratio of 5 by weight. -% microorganisms used and the addition of nutrients (5% nutrient concentration and C / N / P = 100/50) degradation of hydrocarbons ppm / day. Treatment with BIO could be used as an effective treatment option because most of the materials used in the incubation and growth of microorganisms were available and cheap.

9.References

1. www.scomigroup.com.my
2. McMillen, S.J., Smart, R. Bernier, and R.E. Hoffman: "Bio treating E & P Wastes: Lessons Learned from 1992-2003," SPE 86794, presented at the Seventh International Conference on Health, Safety, Environment in Oil and Gas Exploration and Production, Calgary, Alberta, Canada, March 29-31 (2004).
3. Quimio, T. H. ; Chang, S. T. and Royes, D. J. "Technical guidelines for mushroom growing in the tropics. "FAO. Plant Production and Protection, paper 106 , Rome , Italy (1990).
4. Iraqi journal of Chemical and Petroleum Engineering Vol.8 No.3 (September 2007)3 7-41 ISSN: 1997-488c.
5. Fryadda Sandoval1, J.B. Randle2 Polaris Energy Nicaragua S.A., Of plaza El Retiro #723, Rotonda El Periodical, 150 m al sur, Managua, Nicaragua.
6. Phillips, A.J., Gerlach, R., Cunningham, A.B., Spangler, L. Montana State University, Bozeman, Montana, USA Hiebert, R. Montana Emergent Technologies, Butte, Montana, USA Kirksey, J. Schlumberger Carbon Services, Urbana-Champaign, Illinois, USA Esposito, R. Southern Company, Birmingham, Alabama, USA.
7. Chaineau, C. H,, Morel, J. L., and Oudot, J.: "Biodegradatiun of Fuel Oil Hydrocarbons in The Rhizophere of Maize, J. Environ. Qual',29, pp. 569578, (2000).
8. Zimmerman, P.K,, and Robert, J' D,: "Oil BasedD rill Cuttings Treated by Landfarming," Oil and GasJ oumal, 81 (1991).
9. Chaineau, C. H., Morel, J. L., and Oudot, J.: "Land Treatment of Oil Based Drill Cutting in an Agricultural Soil," J. Environ. Qual., 25, 858 - 867 (re96).

CRITICAL FACTORS AFFECTING COMPETENCIES OF CIVIL ENGINEER IN CONSTRUCTION: PRELIMINARY STUDY

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Abstract : Success factors are inputs to project management practice which can lead directly or indirectly to project success. It encompasses many important elements, which have to be synchronized to ensure the project delivered on time and within the allocated budget to the client. However, there are less of studies focusing on civil engineers competencies in the country. Therefore, this paper aims to reveal critical factors affecting competencies of civil engineer for construction project in Malaysia. This study is used past article reviewed technique for identifying critical success factors affecting competencies of civil engineer. The study has found six (6) critical factors in affecting the competencies of civil engineer namely Top Management Commitment and Support to the Project, Learning and Training Development, Team Management related factor, Employee Involvement, Contractor related factor and Stakeholders factor. This paper reveals the key factors for construction personnel which can be used as a direction to determine the level of competency of civil engineer in Malaysia.

Keywords : Success Factors, Competencies, Construction, Civil Engineer.

1. INTRODUCTION

Construction industry is one of the most significant sectors in the Malaysian economic. The industry is critical to rational wealth creation as it acts as a substance for multiplies effects to the economy, which enables other industries such as manufacturing, professional services, financial services and education (CIDB, 2012). According to Myer (2013) stated many studies have emphasized the significant contribution of the construction industry to development of national economic. It also increases the quality of life by providing the necessary infrastructure such as highways, universities, housing and other basic and improved facilities. Therefore, it is basically crucial to ensure the construction projects completed successfully within the time scheduled, budget allocated, good quality and productivity. Nevertheless, being a complex, fragmented and schedule driven industry it always facing chronic problems such lack of competencies, low quality and productivity non-achievement, lack of communication between project team, time overrun, waste of construction and others. Furthermore, Lapiņa & Ščeulovs (2014) and, Omar & Fayek, (2016) stated that the competencies are a severe problem because it effects the overall development of any country.

Success of the construction project importantly depends on how the project has been planned, managed and organized by a qualified project team besides support and commitment by the top management itself. The critical success factors (CSFs) are more helpful in decision-making support; more player-based research studies should be conducted. Several factors determine the progress of the Malaysia construction industry. These include the availability of labour, financial resources, building materials, and machinery. In construction industry, the manpower plays a pivotal role particularly. The wide ranges of construction personnel from project managers, executives, civil engineers, employees at different levels, and general workers. The overall outcome of the project in one way or another are affected from the performance of each individual involved in a project. Engineers, particularly civil engineers, are crucial in construction projects. Before a project is realized, they have to study and assess its feasibility; once the project was approved, civil engineers need to plan, design and monitor every stage of the construction. To ensure that the project goals are reached, before construction work at the site starts, civil engineers need to coordinate with the owners, project advisors, consultants, main contractors, subcontractors, and suppliers appropriately. Hereafter, civil engineers need to have adequate on-site experiences. Frequently, they are also entrusted with high levels of managerial level and administrative responsibilities. At that time, organisations owning such as directors, general managers and project managers the project should monitor the performance of their engineers to ensure that their projects are successfully executed.

2. DEFINITION OF COMPETENCIES

Competencies are beneficial concepts that try to describe why certain people accomplish better than other (Vries, 2001;Boyatzis,1982; Boyatzis, 2008; Hopkins, 2008; McClelland, 2008; Liikamaa, 2015). Competency is an individual's fundamental characteristic that is causally related to in effect performance in a job or situation and job tasks. A person needs competencies, which are abilities to use knowledge and to make happen. The reveal what a person is capable of doing and why he or she acts in a certain way. According to PMI (2000) stated the competencies have been grouped in the International Competence Baseline into three categories: behavioural, technical and contextual competencies. Table 1 revealed the definitions of competencies from 1993 until 2015.

Table 1 : Definition of competencies

Authors	Definition of Competencies
Spencer & Spencer (1993)	Competency is fundamental characteristic of the individual that is causally related to a standard of effectiveness and /or to a superior performance in a job or situation.
Glader (2001)	Competence is used to achieve something. It includes knowledge in all their shapes, but it also includes personality traits and abilities, such as persistence, stress tolerance ,social competence and so on
Markus (2005)	Competencies is a generic body of knowledge, motives, traits, self-images and social roles and skill that are casually related to superior or effective performance in the job.
Caupin et al., (2006) ; Muller & Turner (2010)	Competencies are a combination set of an individual's knowledge, personal characteristics and abilities used to execute a particular activity or task.
Crawford (2005)	Competency in term of skill, knowledge & behavior
Serpell & Ferrada (2007)	Basic competencies as entry attributes this are the knowledge, attitudes and abilities of people upon joining an organisation.
Brozova & Subrt (2008)	Competencies are a standardised requirement for an individual to properly perform a particular job and it includes a combined set of knowledge, skills and behavior utilised to develop performance".
Buntat et al., (2013)	Competency is required to guide implementers of competency – based initiatives
Liikamaa (2015)	Competencies are as a ability or capability; it consists of a set of alternate behaviors organized around an underlying construct.

3. SUCCESS CRITERIA FOR CONSTRUCTION PROJECTS.

According to Chan & Chan (2004) and, Alzahrani & Emsley (2013) stated success are defines as the grade to which project objectives and expectation are encountered. In addition, Alias et al., (2014) stated project success means that certain expectation for given member were met, either, owner or client, consultant, main contractor etc.

For example, Frodell (2008) has drawn a list of success criteria in construction through reviewing 16 articles. His empirical study has originated success measures, as success on a project means different things to different people (Chan and Chan, 2004; Freeman and Beale, 1992; Liu and walker, 1998). Delivered on time, within budget and meeting the preset quality measures are the main criteria to success on a project for construction project, while, safety and environment are also addition criteria that contribute to success on a project nowadays. Table 2 summaries and discusses the potential factors selected from previous literature.

Table 2. Project Success Factors For Construction Projects.

Factors	Sources	Discussion
Company's technical capacity	Alzahrani & Emsley (2013)	Successful project based on having the right planning, goals, capacity at the right time, knowing and targeting the related customers, cost effective supply and then constant innovation.
Planning efforts	Doloi et al., (2012), Jha & Iyer (2007)	Successful project implies the use of advanced planning methods that allow to determine the feasible sequences of activities and to finish a project within budget and delivered on time.
Adequate project management techniques	Gudiene et al., (2014), Chan & Chan (2004)	Implementation of Project management techniques such as planning and control of time, cost and quality have been widely recognised to project success. Besides, success of one project are depend on having such as realistic and definite goal, client satisfaction, competition and etc.
Effective site management	Doloi et al.,(2012)	Effective site management requires competent such as civil engineer, Project manager to allocate work in line with the workers skill, ability and knowledge they have. Then, evaluate workers when they do jobs efficiently.
Team motivation	Kog & Loh (2012), Tabish & Jha (2012)	All personnel such as civil engineer, project manager and workers in the worksite must be motivated to achieve their target and planning, carry out their job responsibilities safely. Hopefully, the possibilities of achievement and recognition will give an opportunity for rewards, additional responsibilities and personal development

4. CRITICAL FACTORS AFFECTING THE CIVIL ENGINEER COMPETENCIES

From the perspective of Project Management, critical success factors (CSFs) are conditions and characteristics on variables that can have a major impact on project success when properly managed, sustained and maintained. (Patanakul & Milosevic, 2009; Stevenson & Starkweather, 2010). Fortune & White, (2006) have identified a some different critical success factors and also lack of opinion among researchers on the criteria and factors that influences project success. Whilst, numerous studies on critical success factors have observed the impact of context on which factors are considered most critical as well as whether certain on critical success factors indeed related to success. In some construction companies, management activities in construction project can be a better understanding by exploring the critical success factors for improving the performance in their building projects. There are various factors that are currently being perceived to be critical for successful that affecting civil engineer competencies. Six (6) critical factors are being highlighted and discussed various researchers. The explainations of these factors are as follows;

Top Management Commitment and Support To The Project

The need for support and commitment by management to the project is highlighted by most authors such as Kog,Loh (2012), Doloi et al., (2012), Yang et al., (2011), Zou et al., (2014). According to Aziz et al.,(2016) stated a good management always be aware of demand for change. The ability to plan an asset shows skill in managing the organisation's leaders. Among the commitments that need to be highlighted is to renew and update main elements of the organisations, preparation for the new job specification, make structural changes in the organisation, resolving conflicts to be faced, make sure the involvement of members and create an effective plan to improve the administration of an organisation. Whilst, management should provide the employees with sufficient resources like technical, financial and physical in order for them to perform their work effectively and improve their competencies. The appointment of a coordinator is also needed to managed and coordinate all related activities in daily operations and translate what the management expectations so that the people at the lower levels of the organization can understand and able to carry-out their job efficiently and effectively (Mohammad et al., 2007; Zutshi & Sohal, 2005).

Learning and Training Development

Appropriate training and learning are essential to acquire involvement of management and employees'. Management and employees especially civil engineer have to be trained to ensure that they are aware and improve the level of competencies. Good management should demonstrate that they are prepared to learn and arrange for learning opportunities for all employees in organisations. Tabish & Jha, (2012, Zutshi & Sohal, (2005) stated that all employees should have well founded knowledge about internal company procedures and some of the employees are trained for interpretation of the management systems standard. Whilst, the organisation should regularly review the training planning and modules to ensure it is relevant and sufficient for successful affecting the civil engineer competencies (Mohammad et al., 2007). According Salas et al., (2006), training is a process of enhancement in the competencies, skills, capabilities, knowledge and intelligence of employees. Ability involves the ability of worker's task are entrusted with by their own experiences. In the meantime competence and skill is the ability to complete a task because of continuous training, knowledge is stored in the mind and the ways in which it is understood and used.

Team management related factor

The appropriate selection of team members also influences the success of a construction projects. A good coordination between all parties in management factors plays the main role (Ismail et al., 2012). This group includes such factors as decision making effectiveness, competence, experience, motivation, technical capability, personnel issues.

Employee Involvement

Employee involvement is a process for empowering to participate in managerial decision-making and enhancement activities suitable to their levels in the organisation. According to Lawler (1995),"Employee involvement", if well implemented, changes the fundamental relationship between individuals and the organisation they work for". It really builds employees in as a business partner, so they know more and they do more to make the organisation successful, particularly in industries where the human component is important most knowledge work, high-tech and kinds of service industries.

Contractor related factor

Contractor's performance and expertise play a important role in delivery of a project successful (Doloi et al., 2011).They start their main duties when a project reaches the construction or execution stage where the actual work of the project is accomplished (Alzahrani, 2013). The group includes these factors : company characteristics, technical and professional capability and competencies, experience, economic and financial situation, quality issues, health and safety conditions, work conditions.

Stakeholders

A stakeholder is a group of people who have a conferred in the project success and the environment within which the project operates. There are many stakeholders participating in the implementation process of construction projects: clients, designers, planners, main contractor, project manager and financial institutions. An important issue for a project management team is to recognise those stakeholders who can affect the project and manage their differing demands through good communication in the early stages of a project (Gudienė et al., 2013). Hence, effective communications between stakeholders are very significant to ensure the successful of construction projects.

CONCLUSION

Critical factors affecting the competence of civil engineers is essential to be identified at the early stage of construction projects. This review study found out six (6) factors namely Top Management Commitment and Support to the Project, Learning and Training Development, Team Management related factor, Employee Involvement, Contractor related factor and Stakeholders factor. This initial input will be used to develop a significant model in providing insight knowledge of the civil engineering practice.

REFERENCES

1. Alias, Z., Zawawi, E. M. A., Yusof, K., & Abra, A. (2014). Determining Critical Success Factors of Project Management Practice : A conceptual framework. Procedia - Social and Behavioral Sciences, 153, 61–69. http://doi.org/10.1016/j.sbspro.2014.10.041

2. Alzahrani. J, & Emsley. M. (2013). The impact of contractors' attributes on construction project success: A post construction. International Journal of Project Management 31. pp 313–322.

3. Atkinson R. Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria. International Journal of Project Management, 1999; 17; 6; 337-342 .

4. Aziz, N. A. A., Manab, N. A., & Othman, S. N. (2016). Critical Success Factors of Sustainability Risk Management (SRM) Practices in Malaysian Environmentally Sensitive Industries. Procedia - Social and Behavioral Sciences, 219, 4–11. http://doi.org/10.1016/j.sbspro.2016.04.025

5. Belassi W and Tukel O I. A New Framework for Determining Critical Success/Failure Factors in Projects. International Journal of Project Management, 1996; 14; 3; 141- 151.

6. Boyatzis R. The competent manager. A model for effective performance. John Wiley & Sons Inc. New York. 1982.

7. Boyazis R. Competencies in the 21th century. Journal of Management Development 2008: Vol. 27 No. 1.

8. Brozova, H., and Subrt, T. (2008). "Competency mapping and modelling in system design." Sci. Agric. Bohemoslov., 39(2), 125–131.

9. Buntat, Y., Mohamad, N., & Musban, M. (2013). Competency-Based Education : A Case of Akademi Binaan. *Procedia - Social and Behavioral Sciences*, *93*, 1536–1540. http://doi.org/10.1016/j.sbspro.2013.10.078

10. Caupin, G., Knoepfel, H., Koch, G., Pannenbacker, K., Peez-Polo, F. & Seabury, C., 2006, ICB-IPMA Competence Baseline – version 3, International Project Management Association, Netherlands.

11. Chan, A. P. C., & Chan, A. P. L. (2004). Key performance indicators for measuring construction success.Benchmarking: An International Journal, 11(2), 203-221. http://dx.doi.org/10.1108/14635770410532624

12. Construction Industry Development Board (2012). "Construction Industry Master Plan 2006-2015". On-line : http://www.cidb.gov.my. Accessed: 25th August 2016

13. Doloi, H., Iyer.K.C., & Sawhney. A. (2011). Structural equation model for assessing impacts of contractor's performance on project success. International Journal of Project Management 29. pp 687–695.

14. Doloi, H.; Sawhney, A.; Iyer, K. C.; Rentala, S. 2012. Analysing factors afecting delays in Indian construction projects, International Journal of Project Management 30(4): 479–489. http://dx.doi.org/10.1016/j.ijproman.2011.10.004

15. Fortune, J., & White, D. (2006). Framing of project critical success factors by a systems model. International Journal of Project Management, 24(1), 53–65. http://doi.org/10.1016/j.ijproman.2005.07.004

16. Freeman, M., Beale, P., 1992. Measuring project success. Project Management Journal 23, 8–17.

17. Frodell, M., 2008. Swedish construction clients' views on project success and measuring performance. Journal of Engineering, Design and Technology 6, 21–32.

18. Glader, A. (2001). Learning and competence development- The study of competence development in large Swedish organisations. (Master). Umea School of Business and Economics.

19. Gudiene, N.; Banaitis, A.; Podvezko, V.; Banaitiene, N. 2014. Identification and evaluation of the critical success factors for construction projects in Lithuania: AHP approach, Journal of Civil Engineering and Management 20(3): 350–359. http://dx.doi.org/10.3846/13923730.2014.914082

20. Gudienė, N., Banaitis, A., Banaitienė, N., & Lopes, J. (2013). Development of a Conceptual Critical Success Factors Model for Construction Projects : a Case of Lithuania. Procedia Engineering, 57, 392–397. http://doi.org/10.1016/j.proeng.2013.04.051

21. Hatush Z and Skitmore M. Evaluating Contractor Prequalification Data: selection criteria and project success factors. Construction Ma nagement and Economics, March 1997; 15; 2; 129-147.

22. Hopkins M.M. Social and emotional competencies predicting success for male and female executives. Journal of Management Development 2008: Vol. 27, No.1, 13–35.

23. Ismail, F., Yusuwan, N. M., Einur, H., & Baharuddin, A. (2012). Management Factors for Successful IBS Projects Implementation. Procedia - Social and Behavioral Sciences, 68, 99–107. http://doi.org/10.1016/j.sbspro.2012.12.210

24. Jha, K. N.; Iyer, K. C. 2007. Commitment, coordination, competence and the iron triangle, International Journal of Project Management 25(5): 527–540. http://dx.doi.org/10.1016/j.ijproman.2006.11.009

25. Kets De Vries M. The leadership mystiques: A user’s manual for the human enterprise. Biddles Ltd, Guildford & King’s Lynn. Great Britain. 2001.

26. Kog, Y. C.; Loh, P. K. 2012. Critical success factors for different components of construction projects, ASCE Journal of Construction Engineering And Management 138(4): 520–528. http://dx.doi.org/10.1061/(ASCE)CO.1943-7862.0000464 .

27. Lapiņa, I., & Ščeulovs, D. (2014). Employability and Skills Anticipation: Competences and Market Demands. Procedia - Social and Behavioral Sciences, 156(April), 404–408. http://doi.org/10.1016/j.sbspro.2014.11.211

28. Liikamaa, K. (2015). Developing a project manager’s competencies: A collective view of the most important competencies. 6th International Conference on Applied Human Factors and Ergonomics (AHFE 2015) and the Affiliated Conferences, AHFE 2015. Procedia Manufacturing 3.pp 681 – 687.

29. L. Markus, H. Thomas, K. Allpress. Confounded by competencies? An evaluation of the evolution and use of competency models. New Zeal.J. Psychol. 34 (2) (2005) 117.

30. Lawler,W.E.S.A, Mohrman and G.E Ledford (1995). “ Creating High Performance Organization: Practice and Recruit of Employee Involvement and Total Quality Management in Fortune 1000 Company”. San Francisco: Jossey – Bass Publisher.

31. Liu, A.M.M., Walker, A., 1998. Evaluation of project outcomes. Construction Management and Economics 16, 209–219.

32. Lynn Crawford. 2005. Senior management perceptions of project management competence. International Journal of Project Management 23, 7-16.

33. M.N.Omar, A. Robinson Fayek, Modeling and evaluating construction project competencies and their relationship to project performance. Automation in Construction. (2016), doi:10.1016/j.autcon.2016.05.021.

34. McClelland D. C. Identifying competencies with behavioral – event interviews. Psychological Science 1998: Vol.9, No. 5, 185-211.

35. Mohammad, M., Osman, M. R., Rosnah, M. Y., Ismail, N., Tun, U., & Onn, H. (2007). Critical Success Factors For Implementing Integrated Management System (IMS): Survey And Case Studies Results, *2004*(August), 5–9.

36. Muller, R. & Turner, R, 2010.' Leadership competency profiles of successful project managers', International Journal of Project Management, Vol. 28. No. 5. pp. 437-448.doi: http://dx.doi.org/10.1016/j.ijproman.2009.09.003

37. Myers, D. (2013). Construction Economics: A new approach (3rd ed.). New York: Routledge.

38. Patanakul, P., & Milosevic, D. (2009). The effectiveness in managing a group of multiple projects : Factors of influence and measurement criteria. International Journal of Project Management, 27(3), 216–233

39. Salas, E., Wilson, K., Priest, H. and Guthrie, J. (2006), 'Design, Delivery, and Evaluation of Training
40. Systems', in G. Salvendy (ed.),Handbook of Human Factors and Ergonomics, 3rd edn (Hoboken, NJ: John Wiley & Sons), pp. 472–512.

41. Serpell, A., & Ferrada, X. (2007). A competency-based model for construction supervisors in developing countries, 36(4), 585–602. http://doi.org/10.1108/00483480710752812

42. Spencer, L. and Spencer, S. (1993), Competency at Work: Models for Superior Performance, John Wiley & Sons, New York, NY.

43. Stevenson, D. H., & Starkweather, J. A. (2010). PM critical competency index: IT execs prefer soft skills. International Journal of Project Management, 28(7), 663–671

44. Tabish, S. Z.; Jha, K. N. 2012. Success traits for a construction project, ASCE Journal of Construction Engineering and Management 138(10): 1131–1138. http://dx.doi.org/10.1061/(ASCE)CO.1943-7862.0000538

45. Walker D H T. An Investigation into Construction Time Performance. Construction Management and Economics, May 1995; 13; 3; 263-274.

46. Walker D H T. The Contribution of the Construction Management Team to Good Construction Time performance – an Australian Experience. Journal of Construction Procurement, November 1996; 2; 2; 4-18.

47. Yang, L. R.; Huang, C. F.; Wu, K. S. 2011. Te association among project manager's leadership style, teamwork and project success, International Journal of Project Management 29: 258–267. http://dx.doi.org/10.1016/j.ijproman.2010.03.006

48. Zou, W.; Kumaraswamy, M.; Chung, J.; Wong, J. 2014. Identifying the critical success factors for relationship management in PPP projects, International Journal of Project Management 32(2): 265–274. http://dx.doi.org/10.1016/j.ijproman.2013.05.004

49. Zutshi, A. & Sohal, A.S. (2005). Integrated management system: the experiences of three Australian organisations. Journal of Manufacturing Technology Management, 16 (2), 211-232

Analyzing the Waste Issues Using Subjective and Objective Techniques A Case Study at Radiator Shop

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Abstract: lean manufacturing play a vital role in any manufacturing industry in order to increase productivity and improve workforce. Lean manufacturing helps to identify non value added activities. This research was carried out to accumulate the data from workers of Atlas Engineering limited situated in Karachi, Sindh, Pakistan. The theme of the research is to elaborate lean manufacturing process in Atlas Engineering Limited (AEL) and indicate the wastage in production process. (AEL) is using very efficient ways of manufacturing process and it is quite efficient in its production to some extent. (AEL) using different standards of operation and making continuous improvement within the industry. Atlas Engineering Limited is also very much conscious and takes good care for their employees. AEL is really dedicated toward health and safety of employee and plant updating and maintenance. AEL is registered under the different quality societies such as ANSI/ISO/QMS. Through our observation and interview with concerned person and analyzing the issue and comparing their SOP's (standard operating procedure) we noticed that there are mostly repetitive task involved in every steps in all the radiator core assembling from tinning section to the jigs filling station. Due to this situation worker getting bored which was the cause of inappropriate workforce. In order to complete the required target of the core we have to analyze the waste issue in radiator department in terms of idle time and inappropriate workforce.

Keywords: Productivity, Inappropriate workforce, idle time, Quality Management System

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1. INTRODUCTION:

Non value added activities are the most important factor in which the companies cannot be neglected. In any type of industry wants to eliminate and to reduce in order to achieve the desired goal. Lean manufacturing helps in enhancing production processes and boosting up the employees job satisfaction **(Singh, Garg, Sharma, &Grewal, 2010)**.Lean manufacturing is different from traditional manufacturing. The market is becoming more volatile day by day, so understanding market dynamics is an essential factor if one wants to design manufacturing systems better **(Gadalla, 2010).** Lean manufacturing believes the simple fact that customers will pay for the value of product or services they receive, but will not pay for mistakes **(Rawabdeh, 2005).** According to **Sohal and Eggleston (1994**), two-thirds of companies believed strategic advantages had been generated with bigger improvements coming from customer relationships, quality constraints and market competitive positioning. **Lathin (2001)** stated that traditional mass producers could expect a reduction of 90% in inventory, 90% in cost of quality, 90% in lead time and a 50% increase in labor productivity. This research aimed to increase productivity and improve workforce. By the help of work study methods, recording the time activity of the jigs filling operation. We analyze the time of worker who complete their task and those time in which the company given by the worker. And then compare them. There is lot of difference in the target time and the actual completion time in core assembling.

2. MATERIALS AND METHODS: Variation Measurements in Similar Processes Using Work Study Methods.

During the observation of radiator shop at atlas engineering the most problematic area according to us is core assembling area in radiator shop where fins and tube are assemble and form core of radiator. At this station workers has to fill tube into jigs and then insert tubes into it. The whole process is manually done, each worker have their own target of cores in eight (8) hours shift, and there are six and half hours (6.5hours) out of 08 hours after eliminating lunch , prayer and tea breaks. This process is time consuming because of manual operation also we found inappropriate workforce, but they compete their task in approximately half of the time and company has to pay too much for their idle time. For increasing the productivity of core assembling we are using work study methods through which we can find idle time and motion of worker.

In Atlas Engineering, Radiator shop are produce more than 400 types of radiators or you can say all running vehicles and generator radiator are manufactured. Due to large variation in radiator, it is impossible to conduct all types of radiator idle time. So we have to divide all types of radiator in three categories based on sizes and their time type.

3. Observation

There are two types of radiator core in order to meet the customer demand (i.e. flat fin type radiator and zigzag fin type radiator) but we have to measure the recoding activity only flat fin type radiator core by using stop watch and camcorder. In flat fin radiator core AEL categorize into three types based on sizes. In each category of sizes consume equal time and target of core respectively. We have to measure the time only one (01) size of radiator core of each category.

1) Small Fin Type of Radiator Core.

Size of core	Target of core in one shift	Time given to the worker	Time taken by worker per core	Idle time of worker per core
18 3/4 * 23 1/8	14	6.5 hours	27 min and 52 sec	10min 32 sec

2) Medium Fin Type of Radiator Core.

Size of core	Target of core in one shift	Time given to the worker	Time taken by worker per core	Idle time of worker per core
22 * 25	9	6.5 hours	43min 20sec	17min 13sec

3) Large Fin Type of Radiator Core.

Size of core	Target of core in one shift	Time given to the worker	Time taken by worker per core	Idle time of worker per core
28 * 28	4	6.5 hours	1 hour 38 min	1 hour 38 min

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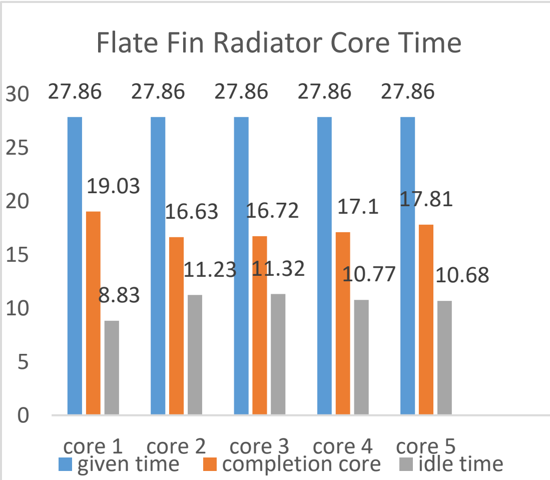
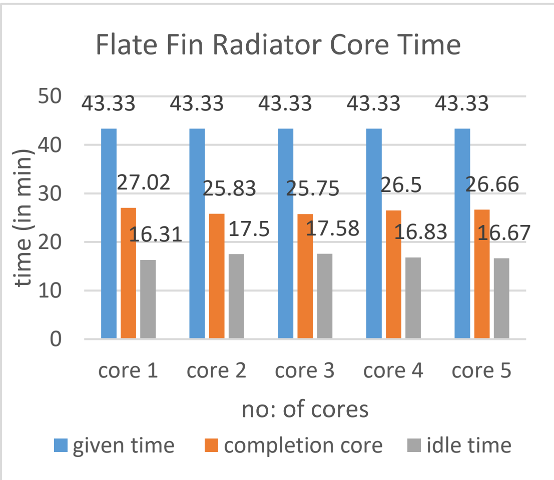
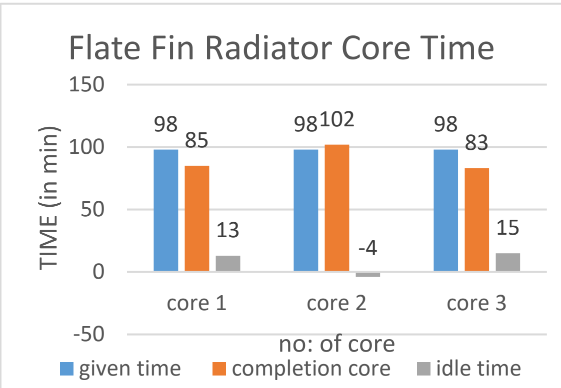
Each table indicate the size of core, Target of core in one shift, Time given to the worker by the company, Time taken by worker per core and idle time of worker per core of all type of radiator core.

4. RESULT AND DISCUSSION







Calculation:

- **Small core**

Target of the core per shift = 14
Time given to the worker by the company = 08hours = 4800 mins
Time taken to the worker for lunch + prayer = 1 hour
Time taken to the worker for tea break + other activity = 30 min
Remaining working time to compete the task = 8hours – 1hour – half hour = 6.5 hours = 390 min
Time given to the worker by the company per core = max 27 min and 52 sec
01 worker complete the their work per core = 17min 20secs
Idle time of the worker = 27min 52sec – 17min 20sec = 10min 32sec per core
Idle time of the total core per worker = 10min 32sec * 14 = 147 min 28sec cores per worker

Percentage of idle time in one shift =

$$\frac{147 \text{ min } 28 \textit{ sec}}{6.5 \text{ hours}} = \frac{147.47\text{min}}{390\text{min}} = 37.81\%$$

<u>In off season there are 02 (two) shifts required to meet the customer demand</u>

So, the total idle time of the workers in 01 day = 147 min 28sec *02 = 294min 54sec
Hence,
Idle time in one month = 294min 54sec * 23 = 6782min 42sec

<u>In on season there are 03 (three) shifts required to meet the customer demand</u>

So, the total idle time of the workers in 01 day = 147 min 28sec *03 = 442min 24sec
Hence,
Idle time in one month = 442min 24sec * 23 = 10175min 12sec

Similarly

- **Medium core**

Percentage of idle time in one shift =

$$\frac{154 \text{ min } 57\textit{sec}}{6.5 \text{ hours}} = \frac{154.95\text{min}}{390\text{min}} = \mathbf{39.73\%}$$

Similarly

- **Large core**

Percentage of idle time in one shift =

$$\frac{32\text{min}}{6.5 \text{ hours}} = \frac{32\text{min}}{390\text{min}} = \mathbf{8.21\%}$$

The objective of this research is to improve and to increase the workforce and productivity respectively. By the help of work study methods, recording the time activity of the jigs filling operation. We analyzed and compared the actual time of task completed by the worker and the time of task given to the worker by the company. The results showed a significant difference in the target time and the actual completion time in core assembling.

Results

- It was found that worker completed their task in approximately two-third of his given time by the company. In AEL more than 400 (four hundred) types of radiator being produce or you can say all running vehicle and generator of radiator being produce.
- We have been found that the idle time of the following different sizes of core due to high variation and they are not follow the new strategical tool like lean manufacturing tools and techniques.
- They are going to follow has its own traditional strategy according to their ancestor. Because in AEL worker/operator has no awareness of such types of tools and technique, require training and education about the tools and techniques. Due to high variation of radiator core there is no much more time to train their worker.

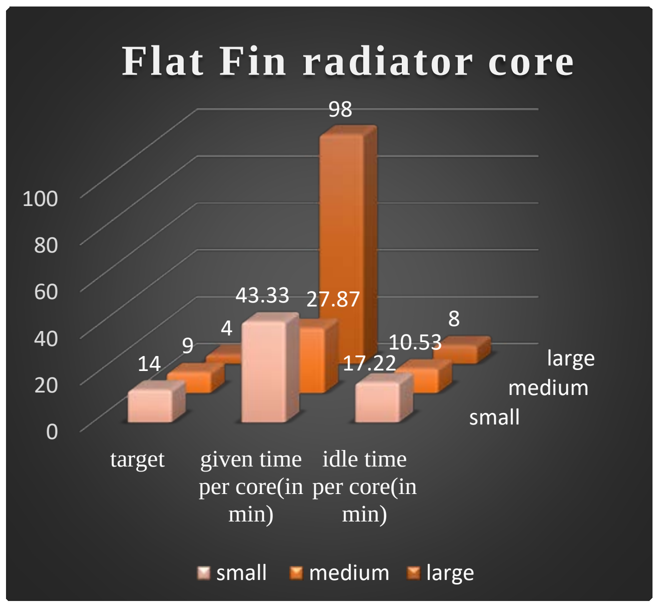
Suggestion

Company should reduce their Takt time of jigs filling station which may help to increase the productivity.
Company should maximize the productivity in order to fill the gap between the comparison of actual time of worker who complete their work and the time of worker which is given by the company's jigs filler of flat fin radiator core as well as zigzag radiator core.

Idle time variance illustrates the adverse impact on the profitability of an organization as a result of having paid for the labor time which did not result in any production. Idle time variance is therefore always described as an 'adverse' variance. The separate calculation of idle time variance ensures a more meaningful analysis of the underlying productivity of the workforce demonstrated in the labor efficiency variance as illustrated in the previous chapter. As with the labor efficiency variance, the calculation of idle time variance is based on the standard rate since the variance between actual and standard labor rate is separately accounted for in the labor rate variance.

Conclusion and Recommendation:

Through our observation and interview with concerned person and analyzing the issue and comparing their SOP's (standard operating procedure) we noticed that there are mostly repetitive task involved in every steps in all the radiator core assembling from tinning section to the jigs filling station. Due to this situation worker getting bored which was the cause of inappropriate workforce. In order to complete the required target of the core we have to analyze the waste issue in radiator department in terms of idle time and inappropriate workforce. And we have to recommend or suggest according to our data collection and analysis based on stopwatch and camcorder the takt time of jigs filling station should reduce. Because the worker has complete to assemble the core consume less time as compared to time given by the company to the worker for completion of core. We have to conclude that the following results in radiator shop.



Small core

Time given to the worker by the company per core = max 27 min and 52 sec
Worker has to complete their work per core = 17min 20secs
Above mention time represent how much idle time we have ignored. If we utilize the workforce we can maximize their productivity.
According to previous chapter (05) calculation we can maximize productivity of their radiator core assemble up to 360 core per month.

Medium core

Time given to the worker by the company per core = max 43min 20sec
Worker complete their work per core = 26min 07secs
According to above calculation we can maximize productivity of their radiator core assemble up to 400 core per month.

Large core

Time given to the worker by the company per core = max 1 hour 38min
01 worker complete their work per core = 1hr 30min
According to above calculation we can maximize productivity of their radiator core assemble up to 400 core per month.

References

1. Gupta, Shaman, and Sanjiv Kumar Jain. "A literature review of lean manufacturing." *International Journal of Management Science and Engineering Management* 8.4 (2013): 241-249.

2. Wyrwicka, Magdalena K., and Beata Mrugalska. "Barriers to Eliminating Waste in Production System."

3. Bevilacqua, M., et al. "A Changeover Time Reduction through an integration of lean practices: a case study from pharmaceutical sector." *Assembly Automation* 35.1 (2015): 22-34.

4. Negrão, Léony Luis Lopes, Moacir Godinho Filho, and Giuliano Marodin. "Lean practices and their effect on performance: a literature review." *Production Planning & Control* (2016): 1-24.

5. Salem, Roba, et al. "An empirical study on lean awareness and potential for lean implementations in Qatar industries." *The International Journal of Advanced Manufacturing Technology* 82.9-12 (2016): 1607-1625.

6. Smith, Ricky, and Bruce Hawkins. *Lean maintenance: reduce costs, improve quality, and increase market share*. Butterworth-Heinemann, 2004.

7. Arunagiri, P., and A. Gnanavelbabu. "Identification of High Impact Lean Production Tools in Automobile Industries using Weighted Average Method." *Procedia Engineering* 97 (2014): 2072-2080.

8. Prakash, D., and C. Kumar. "Implementation of lean manufacturing principles in auto industry." *Industrial Engineering Letters* 1.1 (2011): 56-60.

9. Valle, Felipe, et al. "changeover reduction: a case study in an automotive company process improvement through lean manufacturing, vsm and smed."

10. Mohanty, R. P., O. P. Yadav, and R. Jain. "Implementation of lean manufacturing principles in auto industry." *Vilakshan–XIMB Journal of Management* 1.1 (2007): 1-32.
11. Adams, Larry. "Get lean and improve quality." *Quality* 41.10 (2002): 44.

CRITICAL FACTORS OF COST ESCALATION IN HIGHWAY PROEJCTS OF PAKISTAN

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Abstract: Cost escalation is increase in the cost or price of specific things or services in a given budget over a period. Cost escalation is a major problem in the construction projects of all sectors in Pakistan. The objectives of this paper are to highlight the critical factors of cost escalation from literature review and to relate the importance of factors through survey from experts. To achieve the objectives total seventy three factors which contribute to cost escalation were identified from literature review, based on questionnaire survey critical factors have been identified. Based on the results of questionnaire survey from the field experts the identified critical factors are financial difficulties by the owner, cash flow & financial difficulties faced by the owner, frequent design changes, political influence, delay of drawing, changes in material, specification & type, owner interference, fluctuation of price of material, inadequate planning & scheduling, delay in inspection & approval of works, poor monitoring & control, acts of God, inaccurate time & cost estimates and lack of coordination between parties etc. This study can help stakeholders to control cost escalation in highway projects of Pakistan

1. Introduction

Construction projects, private and public alike, have a long history of cost escalation (Jennifer et., 2009). Escalation can account for a substantial part of construction costs. Therefore forecasts of the amount of escalation are required for budgetary and bidding purposes (Andrew et al.,1993). To compute the fluctuation rate, calculating the price fluctuation of overall articles was more desirable than using price indices. A bidding date was more reasonable as the initial date of change in price. Losses caused by price change should be shared between contractor and owner; therefore a deduction rate should be introduced in contract price escalation. Meanwhile, overhead and profit should be adjusted in proportion to the fluctuation rate; but advance payment or the delayed construction amount should be deducted from the adjusted amount (Minsoo et al.,2006).Budgeting for cost escalation is a major issue in the planning phase of these projects. Researchers introduce a system for modeling the escalation uncertainty in large multiyear construction projects. The system uses a Monte Carlo simulation approach and considers variability of project component durations and the uncertainty of escalation factor during the project lifetime and calculates the distribution for the cost. The system can be used by planners and cost estimators for budgeting the effect of cost escalation in large projects with multiyear schedules (Ali & Roman,2006). There are two main contributors to cost variation in such projects: (1) delays for each individual project that may have an impact on total program finish time, and (2) the uncertainty in the value of escalation factor, especially in multi-year projects (Ali & Roman,2005). The wealth of any nation is gauged by its performance in infrastructure provision through its construction industry. The construction industry is large, volatile, and requires tremendous capital outlays. For developing economies, road construction constitutes a major component of the construction industry. This means that much of the national budget on infrastructure development is channeled to road construction projects. The aim of the study reported in this paper was to identify causes and effects of cost escalation and schedule delays in road construction projects. Using a detailed literature review, structured interviews and questionnaire surveys, the results of the study confirmed the prevalence of cost escalation and schedule delays in road construction projects in Zambia. The study established that bad or inclement weather due to heavy rains and floods, scope changes, environmental protection and mitigation costs, schedule delay, strikes, technical challenges, inflation and local government pressures were the major causes of cost escalation in Zambia's road construction projects. On the other hand, delayed payments, financial processes and difficulties on the part of contractors and clients, contract modification, economic problems, materials procurement, changes in drawings, staffing problems, equipment unavailability, poor supervision, construction mistakes, poor coordination on site, changes in specifications and labor disputes and strikes were found to be the major causes of schedule delays in road construction projects. Appropriate project management practices are thus required to curb the causes and effects of cost escalation and schedule delays in road construction projects (Chaboota et al., 2009).

2. Research Methodology

An extensive literature review and unstructured interviews are carried out to identify factors of cost escalation.
(2) Questionnaire survey is carried out and critical factors are identified through statistical analysis.
(3) Questionnaire survey has been carried out from field experts to relate the factors with causes

3. Data Collection and analysis

Questionnaires Survey is designed on Likerts scale. Likert item is simply a statement which the respondent is asked to evaluate according to any kind of subjective or objective criteria; generally the level of agreement or disagreement is measured.
The questionnaire is built on Linkert's scale of five ordinal actions from one (1) to five (5) according to level of a contribution Each scale signifies the resulting score:
(5) = Very high contribution
(4) = High contributing;
(3) = Medium contributing;
(2) = Low contributing; and
(1) = Very low

In this study average index method has been used to analyze data of survey and explained as follows:
The Average Index Method is to analyze the data in the ordinal or rank

Average index method = $\left(\dfrac{\sum_{i=1}^{5} a_i x_i}{5\sum_{i=1}^{5} x_i}\right)$

ai = Constant expressing the weight given to i,
Xi = variable expressing the frequency of the response for;
i = 1, 2, 3, 4, 5 and illustrated as follows:
X1 = frequency of the 'very rare' response and corresponding to a1 = 1;
X2 = frequency of the 'rare' response and corresponding to a2 = 2;
X3 = frequency of the 'slightly frequently response and corresponding to a3 = 3;
X4 = frequency of the 'frequently' response and corresponding to a3 = 4; and
X5 = frequency of the 'very frequently' response and corresponding to a5 = 5.

The developed questionnaire was distributed to one hundred forty targeted respondents. Eighty five sets were distributed to the contractors selected randomly from various projects of highways, and sixty five sets were distributed to the consultants and client selected randomly from various projects of highways of Pakistan. Forty questionnaires were received from contractors and forty from client and consultants.

Table 1: Details of conducted survey

Parameter	Value
Total no: of questionnaire distributed	140
Total no: of questionnaire received	109
Total no of incomplete information	08
Total no of valid questionnaire	101
% of questionnaire received	77.8
% of questionnaire valid	92

4. Results and Discussions

After analysis by using average index method in excel. Following are results of analysis of each factor with score.

Table 2: Results of analysis of each factor with score by average index method

No	Factor	Score	No	Factor	Score
01	Financial difficulties by the owner	3.94	42	Shortage of technical personnel(skilled labor)	2.31
02	Cash flow and financial difficulties faced by the contractor	3.93	43	Schedule delay	2.30
03	Frequent design changes	3.89	44	Mistakes and discrepancies in contract document	2.30
04	Political influence	3.86	45	Contractual procedure and type of contract	2.82
05	Delay of drawing	3.85	46	Omissions and errors in the bills of quantities	2.81
06	Changes in material specification and type	3.83	47	Impractical and complicated design	2.78
07	Owner interference	3.81	48	Social and cultural impacts	2.71
08	Fluctuation in price of materials	3.73	49	Rework	2.69
09	Inadequate planning and scheduling	3.53	50	Delay payment to supplier/subcontractor	2.69
10	Delays in inspection and approval of completed works	3.52	51	Limited range of supplier	2.68
11	Poor monitoring and control	3.51	52	Insufficient number of equipment	2.66
12	Acts of God	3.50	53	Shortage of material	2.64
13	Inaccurate time and cost estimates	3.49	54	High cost of machinery and its maintenance	2.63
14	Lack of coordination between parties	3.48	55	Inflationary pressure	2.62
15	Change in scope of the project	3.45	56	Shortage of site workers	2.60
16	Working in remote areas	3.41	57	Policy in bidding tender to the lowest price one	2.57
17	approval of drawings	3.13	58	Severe overtime	2.55
18	Poor design	3.02	59	Poor project management	2.51
19	Unsuitable construction methods	2.98	60	Contractual claims, such as, extension of time with cost claims	2.49
20	Inaccurate site investigation	2.91	61	Inaccurate quantity take-off	2.47
21	Unrealistic contract duration and requirements imposed	2.88	62	Problem with neighbors	2.41
22	Effect of weather	2.81	63	Waste on site	2.36
23	Labor disputes and strikes	2.76	64	Additional works	2.33
24	Disputes on site	2.71	65	Mistakes during construction	2.31
25	Poor Judgment	2.65	66	High cost of labor	2.21
26	Poor contract management	2.63	67	High interest rates charged by banks on loans received by contractors	2.15
27	Incomplete design at the time of tender	2.61	68	Insurance cost	1.78
28	Inflationary pressure	2.53	69	Economic instability	1.74
29	Frequently change of subcontractors	2.51	70	Inadequate modern equipment	1.72
30	Lack of constructability	2.49	71	Changes in material, specification and type	1.61

31	Mistakes and errors in design	2.48	72	Quality of materials	1.57
32	Lack of productivity standards	2.46	73	Damaged materials	1.53
33	Inadequate monitoring and control	2.45			
34	Approval of drawings	2.41			
35	Unforeseen ground condition	2.37			
36	Quality assurance/control	2.37			
37	Bureaucracy in tendering document	2.36			
38	Number of construction projects going on at same time	2.35			
39	Inappropriate practices/procedures	2.35			
40	Labor productivity	2.33			

After analysis of each factor, the factors whose values were above 3.6 are selected as critical factors of cost escalation in highway projects. The results of analysis show that financial difficulties by owner, cash flow difficulties by contactor, frequent design changes, political influence, delay of drawing, change of specification of materials, owner interference and fluctuation of price of materials with their score 3.94, 3.93, 3.89, 3.86, 3.85, 3.8, 3.81 and 3.73 respectively are the critical factors of cost escalation in highway projects of Pakistan as shown in Table 3.

Table3: Critical Factors of Cost Escalation

Factor	Score	Rank
Financial difficulties by owner	3.94	1
Cash flow difficulties by contractor	3.93	2
Frequent design changes	3.89	3
Political influence	3.86	4
Delay of drawing	3.85	5
Change of specification of material	3.83	6
Owner interference	3.81	7
Fluctuation of price of materials	3.73	8

Financial Difficulties by Owner

After analysis financial difficulties by owner was found top most critical factor of cost escalation in highway projects of Pakistan. Client or owner are facing problem in funding of project because of this issue cost escalation issue arises in the highway projects of Pakistan.

Cash Flow Difficulties Faced by Contractor

Contractor plays important role to complete the project in time and in schedule if contractor has no any problem for cash flow from client. Because of shortage of funds or cash flow problem faced by contractor stopped or delay his construction activities at site which can cause escalation problem in highway projects.

Frequent Design Changes

Activities of construction project starts with provided designs by client and consultant. If frequent design changes are made in construction activities of project which can causes the escalation in the highway projects.

Political influence

A project is approved with sufficient budget which is approved for particular project but because of political influence funds of that projects are transferred and shifted to any other project or because of political influence that contract of project is awarded to the inexperience contractor which may causes escalation in highway projects.

Delay of Drawing

Delay of drawing from client and consultant stop the construction activities for particular time period which can causes the cost escalation in the project. It is observed that client and consultants are responsible for that factor.

Change of specification of material

Change of specification of materials can causes cost escalation in highway projects because once specification of materials are changed then it will take time for approval and also it takes times to reach at construction site.

Owner interference

Because of interference of client or owner in project, an activity of project stopped or sometimes takes time for approval from client. This interference of client causes cost escalation in the highway project.

Fluctuation of price of materials
Price of materials changes from time to time which can causes cost escalation in highway projects because the rates of different materials are signed in contract document while tendering.

5. Conclusion

Cost escalation in highway projects of Sindh is an important issue which has been addressed in this study .The research work explores the critical factors which influences cost escalation of construction projects. The 76 factors of cost escalation were identified through deep literature review and from unstructured interviews. After analysis the critical factors were found whose score was more than value 3.6. The critical factors of cost escalation were financial difficulties faced by contractor, cash flow problem faced by contractor, frequent design changes, political influence, delay of drawing, change of specification of material, owner specification and fluctuation of price of materials were critical factors were found as critical factors in highway projects of Pakistan.

The outcomes of this research will not only be useful in controlling cost escalation in highway projects but it will also help in improve the environment in construction industry. Besides this, it will also help to reduce project cost reduction which is advantage from government sector clients' perspective.

6. References

1. Andrew N. Blair, Leonard M. Lye, W. J. Campbell, (1993), "Forecasting construction cost escalation" J. of *Canadian Journal of Civil Engineering*, Vol 20,Issue 4

2. Ali Touran and Ramon Lopez, (2006),"*Modeling Cost Escalation in Large Infrastructure Projects*" J of. Construction Engineering and Management, Vol 132, issue 8

3. Ali Touran[1] and Ramon Lopez, (2005), "*Modeling Cost Escalation as a Risk Factor in Construction Projects*" J. of American Society of Civil Engineers

4. ChabotaKaliba, MundiaMuya and KanyukaMumba,(2009)," *Cost escalation and schedule delays in road construction projects in Zambia*" J. of International Journal of Project management, Vol 27, Issue 5, Pages 522–531

5. Jennifer S. Shane, Keith R. Molenaar, Stuart Anderson and Cliff Schexnayder, (2009) " Construction Project Cost Escalation Factors" Journal of management in engineering pp,221-229

6. Minsoo Choi, Jinu Kim and Moohan Kim (2006) "A Study on the Price Escalation System in a Construction Contract" KSCE Journal of civil Engineering,Vol. 10, No. 4 pp. 227-232

Dynamic Model And Controller Design For Two-Wheeled Self-Balancing Robot Using Arduino

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Abstract— **Two-wheeled self-balancing Robot is, inherently an unstable and non-linear system, developed using an Arduino board. Dynamical model of robot is constructed in MATLAB, also the simulation results are obtained in it and the characteristics of robot model are studied. Based on the model, furthermore two different controllers are developed and tested in MATLAB. Then the physical model is constructed based on Arduino board. PID controller is implemented on the robot and vital response of different component are observed carefully. Balancing is claimed and the unstable and non-linear system is made stable. This balancing principle can also be used in humanoid robots, missile technology and aerial vehicles.**

Keywords— Two-wheeled robot, Microcontroller board, controllability, stability and observability.

I. INTRODUCTION

This research on two-wheeled self-balancing robot have gained momentum over the past decades since it is inherently an unstable and highly non-linear system. Researcher finds it interesting and it also proved to be a test bed for more advance researches in the field of Control System Engineering. Furthermore it has certain advantage over the traditional four wheeled robots. It can turn sharp corners, it can provide spin on a single point, it allows easy navigation on various uneven terrain. This technology has potential to solve many other problems. For example a two-wheeled chair will provide higher maneuverability and access to short and uneven terrain. Factories where heavy cars are inefficient to use. It is also environment friendly and less polluting as compared to others.

One such product is commercially available that is *Segway*, invented by Dean Kamen, is capable to balance a human on it and has a great maneuverability on uneven terrain. This technology uses five gyroscopes and tilt sensor. This is currently being used in shopping malls and hotels and by polices as well. [1]. Another research project named JOE also demonstrated the control of unstable inverted pendulum system. This robot is made up of two states space controllers as it is a 3-degree of freedom control design which is able to control linear straight line position, straight line speed, pitch angle, pitch rate, yaw angle and yaw rate. The digital signal processor are used with all necessary sensors and motors to keep robot at equilibrium. [2]. There are different types of controllers that have also been implemented, particularly PID and LQR. Results shows that LQR yields better response then the PID in [3][4], [5]. The tilt angle can be sensed either by accelerometer or Gyro. Since the accelerometer is more sensitive to high frequency noise and Gyro is prone to drift so alone neither accelerometer nor Gyro can provide accurate angle estimation so the *Kalman* filter or the complementary filter needs to be applied[6]–[9]. ARM and ATmega series of the Atmel have been popular in recent years. Arduino is open source prototyping platform of ATmega series programmed in C language-line environment and proved staple among students and researchers for prototyping and product development, with applications ranging from process control, network control and robotics. Two-wheeled self-balancing robot is constructed using Arduino board and shows promising results [10].

In this paper, the design and control of two-wheeled self-balancing robot is reported using Arduino ATmega2560 processor, inertial measurement unit (IMU) 6050 which comprises of 3-axis gyro and 3-axis accelerometer sensor for tilt angle determination and gear motors are used. The data from gyro and accelerometer passed through complementary filter to remove noise as this approach is much simpler than the Kalman filter. The linearized model is used in this paper to reduce the complexity which works for two-wheeled self-balancing robot. The two different controllers, proportional-integral-derivative (PID) and linear quadratic regulator (LQR) are designed in MATLAB and results are presented. PID controller is implemented on robot's physical model and results show that the upright position around a small tilt angle can be achieved and the robot is able to reject disturbances.

II. CONTROL SYSTEM

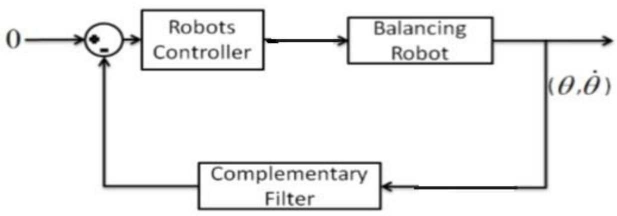

Fig. 1 control system of robot.

As shown in figure 1, the tilt angle and angular rate is measure from the sensors, complementary filter fuses it together to get an estimated tilt angle free from noise and drift. The robots controller block contains the respective controller Algorithm, PID or LQR. Balancing robot contains all the circuitry, sensor, and controller board hardware to steer the robot to maintain its vertically upward position.

A. *Mathematical Model*

The three dimensional model which includes roll, pitch and yaw. But for the sake of simplicity the research is limited to only the orientation along y-axis (pitch angle) that is tilt angle of robot.

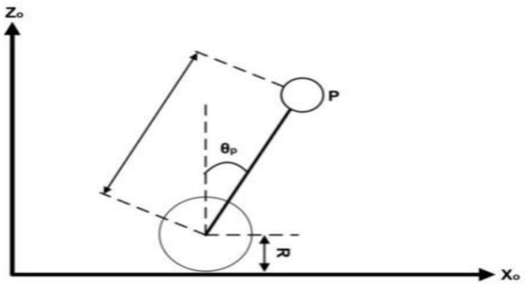

Fig 2. Dynamical modelling of robot of single degree of freedom [11]

$$\begin{bmatrix}\dot{x}\\ \ddot{x}\\ \dot{\phi}\\ \ddot{\phi}\end{bmatrix}=\begin{bmatrix}0 & 1 & 0 & 0\\ 0 & \frac{2k_mk_e\left(M_plr-I_p-M_pl^2\right)}{Rr^2\alpha} & \frac{M_p{}^2gl^2}{\alpha} & 0\\ 0 & 0 & 0 & 1\\ 0 & \frac{2k_mk_e\left(r\beta-M_pl\right)}{Rr^2\alpha} & \frac{M_pgl\beta}{\alpha} & 0\end{bmatrix}\begin{bmatrix}x\\ \dot{x}\\ \phi\\ \dot{\phi}\end{bmatrix}+\begin{bmatrix}0\\ \frac{2k_m\left(I_p+M_pl^2-M_plr\right)}{Rr\alpha}\\ 0\\ \frac{2k_m\left(M_pl-r\beta\right)}{Rr\alpha}\end{bmatrix}V_a \tag{1}$$

Where,

$$\beta=\left(2M_w+\frac{2I_w}{r2}+M_P\right)\quad \alpha=\left[I_p\beta+2M_pl2\left(M_w+\frac{I_w}{r2}\right)\right] \tag{2}$$

Where,

x - Displacement

$\dot{x}$ - Displacement velocity

φ - Angle

$\dot{\varphi}$ - Angular velocity

θ - Parameters position

$\ddot{x}$ - Linear Motion acting on center of wheel

$\ddot{\varphi}$ - Angular motion acting on wheel

In this model, it is assumed that the wheels of robot will always stay in contact with the ground and that there is no slip at wheels. Cornering forces are also considered negligible.

B. Design Specification

Physical parameters

Gravitational acceleration (m/s2)	g	9.81
Mass of body (kg)	M_p	2
Radius of wheel (m)	r	0.04
Mass of wheel (kg)	M_w	0.015
Inertia of wheel (kg m2)	I_w	0.000036
Inertia of body (kg m2	I_p	0.00845
Length of COG (m)	l	0.07
Motor torque constant (Nm/A)	K_m	0.098
Motor back EMF constant (V/rad/s)	K_e	0.024

Table 1. Hardware parameters specification

Design specification in terms of its response

Design Specification	Maximum	Minimum
2% Settling Time	5s	_
Percent Overshoot	<80%	_
Steady State error	10%	0
Title Angle	30 Degree	_

Table 2. Design specification

C. Controller Design

In this paper the two controller are studied and designed in MATLAB and response curves are presented. Only the PID controller is implemented on the hardware.

1) LQR design

Linear quadratic controller method is used for optimal control systems. Unlike conventional controllers, it takes input power into account and desired system is always stable.

Principle of LQR regulator states that the $x = Ax+Bu$ is state equation and we need to minimize the performance index for optimal control action.

$$J=\int_0^{\infty}(x^TQx+u^TRu)dt \tag{3}$$

u(t)=-Kx(t) is the control signal and *K* is the required gain matrix. *Q* and *R* are weighted matrix for *x* and *u*. from the (4) *K* is calculated.

$$K=R^{-1}B^TP \tag{4}$$

And the *P* is calculated from the algebraic Riccati equation given in (5)

$$A^TP+PA+Q-PBR^{-1}B^TP=0 \tag{5}$$

By solving Ricati equation we get the *P* and if *P* is positive definite matrix then the system is stable. Using *P* into (4) we get the *K* matrix The gain values of *K* and LQR simulation results are presented in table.3. The *R* and *Q* diagonals are *R*=1 and *Q*=[1000 1 6000 1]

The response curves are presented in figure 6.

2) PID Controller

PID as name suggests, is constructed by proportional, integral and derivative element.

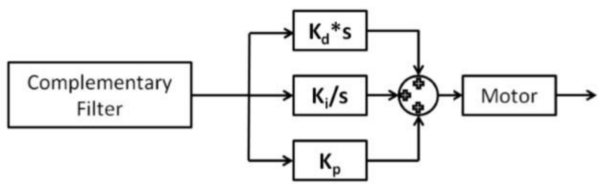

Fig.3 PID

$$u(t)=K_pe(t)+K_I\int_0^t e(t)dt+K_D\frac{de(t)}{dt} \tag{6}$$

K_P could change the steady-state error, stability and rise time of given system. Short rise time means larger overshoot the stability will be undermined. The K_I affects the response speed and adjusting time.

Faster response yields larger overshoot in result. The differential factor K_D effects response speed and error of the system. Too large K_D will make system unstable. The expression of PID is given in (7). The suitable values of K_P, K_I and K_D must be chosen to guarantee the system stability. The discrete PID controller is implemented on two-wheeled self-balancing robot. The respective terms are calculated as follows

$$u(t) = Kp \times e(n) + Ki \times [e(n) + (e(n) - e(n-1)) \times Ts] + Kd \times [\frac{e(n) - e(n-1)}{Ts}] \tag{7}$$

Where *e(n)* is the error term and is difference between actual tilt angle and the set point, *u(t)* is the control effort or the voltage given to the motors and T_s is the sampling time. This is one of important parameter that care must be taken to specify suitable sampling time. It must be less than the largest possible time parameter of robot. In this paper the sampling time is taken as 0.08 sec. Gain values or PID from the MATLAB are presented in table.3. Although simulation results gives clear idea how the parameters of robot's are related and what effect they have on each other but due to the inherent non-linearity in the actual model these doesn't prove perfect balance so we have to tune PID by Ziegler and Nichols tuning rule, trial and error method and the scaled down PID tuned values are [Kp Ki Kd]=[31 0.01 830] that are good enough to stabilize the robot upward. The PID tuned out curve of robot is shown in figure.8

D. *Complementary Filter*

It is basically fusion of high pass and low pass filter. That is the accelerometer data is filtered through low pass filter and the gyro data is filtered out through high pass filter and fused together. It removes noise from the accelerometer data and eliminate drift from the gyro data and ultimately the performance of robot is improved. Result of complementary filter output is given in figure 4.

$$Angle = A*(Angle + gyro*dt) + ((1-A)*x\_acc) \tag{8}$$

Where A is filter constant and calculated as

$$A = \frac{\tau}{\tau + dt}$$

Where τ is the filter time constant and taken as 0.8 sec. *dt* step size and calculated value is 1 µs in this paper. *gyro* is the angular rate from the gyro sensor and *x-acc* is the accelerometer x-axis value that is the tilt angle value. The result of complementary filter is shown in figure.4

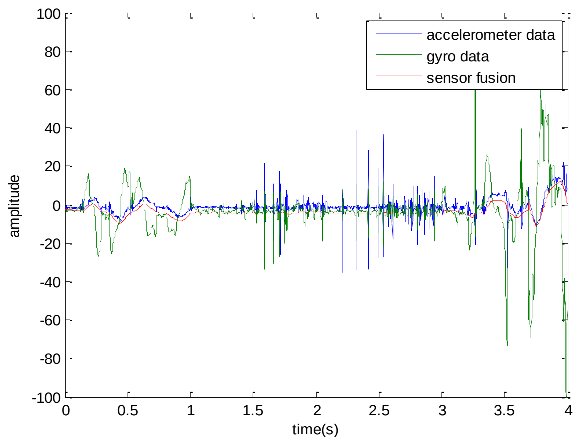

Fig 4. Complementary filter output

III. RESULTS AND DISCUSSION

A. *Matlab simulation results*

Figure 5 shows the open loop position and tilt angle response to an impulse. Robot is unable to stabilize its upward position unless a proper controller is applied.

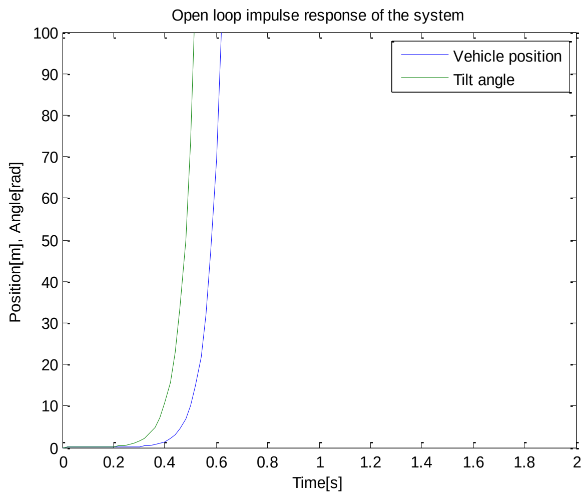

Fig 5. Open loop response of robot.

LQR controller is designed and implemented in MATLAB and the results are presented in figure 6. The states get back to equilibrium within settling time of 1.88 sec as is summarized in table 3

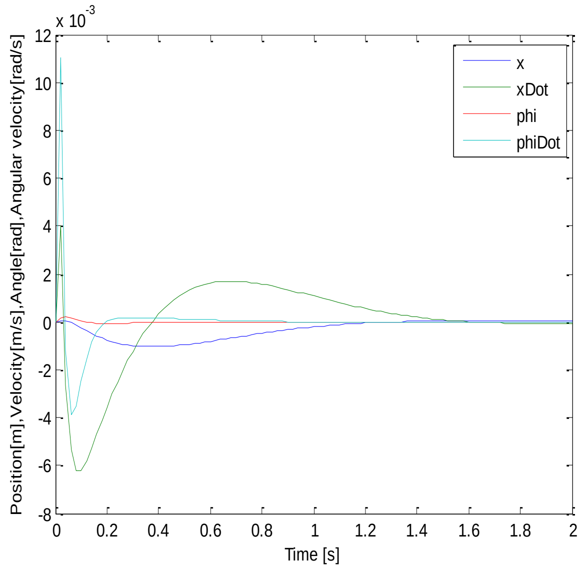

Fig 6. Close loop States response to an impulse

Step response to a PID designed controller in MATLAB shown in figure 7. 1.53 sec settling time is achieved with higher overshoot as compared to the LQR

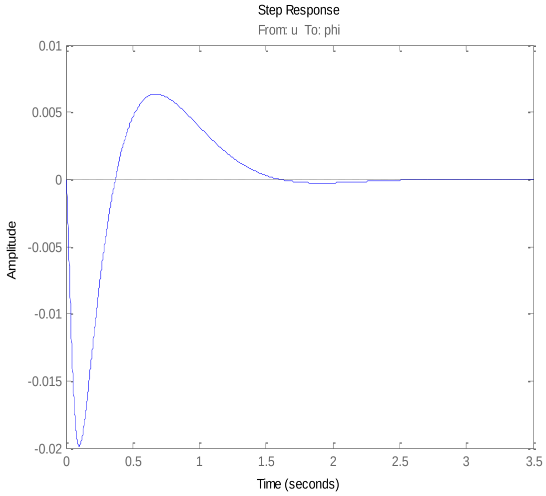

Fig 7. Closed loop Step response of tilt angle

Controllers	2% settling time	Percentage Overshoot	Steady state error	Gain values
LQR	1.88s	6%	0	[-31.6228 -19.8394 242.6099 18.9941]
PID	1.53s	23.3%	0	1051.5807 1382.4974 34.6576]

Table 3. MATLAB Gain Values

B. *Hardware implementation*

PID is tuned and the best result shown in figure 8. The initial response is unpredictable because some time is required to read the sensor values and make an estimation of tilt angle. At 2.3s the step disturbances is applied to the robot and it takes 1.66s approx to return to its original position that is vertically upward. At different time intervals robot is disturbed and it can be seen from the figure 8 that it balances itself within above mentioned settling time. It can be proved that the system is stabilized and proved robust. The physical robot model is constructed and shown in figure 9.

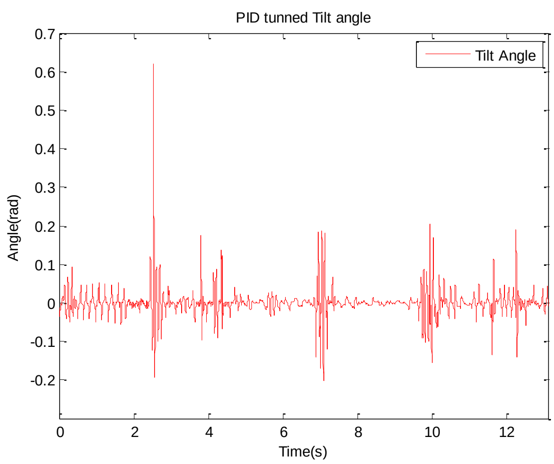

Fig 8. PID tuned tilt angle response

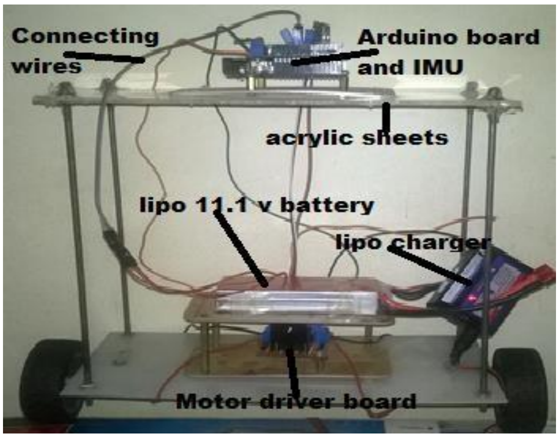

Fig 9. Physical Model

The model is successfully simulated in MATLAB It shows that system can be made stable by applying either of controller. It further shows that error of the LQR and the overshoot are larger as compared to the PID but the response time, rise time of LQR controller is better then PID. Whereas design of LQR controller is complicated as compared to the PID controller. When the error is small it is preferred to use LQR and if the error is relatively large then comes PID controller. In this paper only the PID controller is implemented on hardware and it shows promising results and the robot is stable. It was observed that accelerometer is prone to high frequency noise and the gyro has inherent drift problem associated with it. Either of them alone could not result satisfactory performance. Complementary filter was applied and the data from accelerometer and gyro was fused together to get the estimated tilt angle as shown in figure 5. Figure 6 shows the tilt angle response to impulse inputs. Robot was gently pushed at different time instant as it is clear from figure 6 and the PID controller quickly return the system to its stable state. The settling time was observed to be 1.66s so it was shown by the simulation as well as from the prototype that system is stable and able to reject gentle pushes and remains vertically stable at a predetermined point.

IV. CONCLUSION

The PID & LQR combined can yield better results and it is proposed as a future work. Other than this, the uncertainty or the non-linearity in the model should be included. The roll and yaw control be included in model as well. The motors with encoders can be used instead of simple geared motors and the information regarding positions of robot can be considered in model which further improves the stability of robot.

REFERENCES

[1] H. Transporter and V. Loucks, “no. January 2001, 2004.

[2] F. Grasser, A. D. Arrigo, S. Colombi, and A. Rufer, “JOE : A Mobile , Inverted Pendulum.”

[3] B. Bonafilia, N. Gustafsson, P. Nyman, and S. Nilsson, "Self-balancing two-wheeled robot," 1998.

[4] L. Sun and J. Gan, "Researching of two-wheeled self-balancing robot base on LQR combined with PID," *Proc. - 2010 2nd Int. Work. Intell. Syst. Appl. ISA 2010*, pp. 1–5, 2010.

[5] Z. Hu, S. Wei, and Q. Liao, "Design of LQR and PID Controllers for the Self Balancing Unicycle Robot," no. July, pp. 972–977, 2014.

[6] D. Simon, "Kalman Filtering," *Embed. Syst. Program.*, no. June, pp. 72 –79, 2001.

[7] S. Solution, I. Accelerometer, G. Measurements, B. Platform, S. Colton, and C. Delphi, "The Balance Filter," *ZzWebPage*, p. 20, 2007.

[8] B. Mccarron and B. Mccarron, "Low-Cost IMU Implementation via Sensor Fusion Algorithms in the Arduino Environment," no. June, 2013.

[9] K. Liu, M. Bai, and Y. Ni, "Two-wheel self-balanced car based on Kalman filtering and PID algorithm," *2011 IEEE 18th Int. Conf. Ind. Eng. Eng. Manag. IE EM 2011*, no. PART 1, pp. 281–285, 2011.

[10] H. S. Juang and K. Y. Lurrr, "Design and control of a two-wheel self-balancing robot using the arduino microcontroller board," *IEEE Int. Conf. Control Autom. ICCA*, pp. 634–639, 2013.

[11] R. C. Ooi, "Balancing a Two-Wheeled Autonomous Robot," pp. 1–72, 2003.

A Theoretical Review of the Critical Factors of Cost Overrun in Pakistan Construction Projects

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Abstract

Construction industry of Pakistan is playing important role for development and improvement of economy in Pakistan. However, it also provides number of opportunities in construction sector. Construction industry of Pakistan is facing problem of cost overrun. Cost overrun in construction industry gives negative impact to the stakeholders. Comprehensive understanding is required to overcome this cost overrun problem. This research identifies different factors which causes cost overrun in construction industry of Pakistan. Total 41 factors of cost overrun or budget overrun found in construction industry of Pakistan, the factors were summarized into 5 main groups namely consultants associated factors, contractors associated group, design associated group, material associated group and financial related group. Frequency of each factor was based on previous studies where were considered in this study. The factor with high frequency was considered as critical factor. The critical factor with high frequency by most researches was financial difficulties faced by contractor in Pakistan construction industry. This study can help stakeholders how to control cost overrun by finding most significant measures if each critical factor

Keywords: Cost overrun, critical factors of cost overrun, Impacts of cost overrun, Pakistan Construction Industry

1. Introduction:

Construction sector is developing nowadays very fast all over the world especially in developing countries. (Nagapan et al.2015).Construction industry plays an important role in the growth of economy of the country, besides this it is also proved that it is also facing many serious issues and challenges, among all budget overrun or cost overrun is one the critical issue (Mahamid & Dmaidi ,2013). Cost overrun problem is faced by developed and developing countries. Especially developing countries like Pakistan where cost overrun problem is crucial because budget of projects exceeds the limit up to 100% from approved budget. Because of financial problems faced by contractors, contractors stopped or delayed the construction activity which causes the cost overrun in construction projects of Pakistan (Azhar et al. 2008). It is observed that only few construction projects are completed within approved cost, quality and time globally. Cost overrun is constant problem in all project of developing and developed countries (Agren et al. 2011). Cost overrun in construction industry is a critical issue which creates low productivity, delay in projects, disputes between parties (Amoa-abban & Allotey 2014). Like other countries Pakistan is also facing problem of cost overrun. Therefore in order to reduce the cost overrun in construction projects, it is necessary to identify the critical factors of cost overrun.

2. Cost Overrun

Cost overrun can also be known as increase in cost, cost escalation or budget overrun from approved (Zhu & Liu 2004). Cost overrun arises when the final cost of the project exceeds the original cost of the project (Avotos 1983). Cost overrun can also be defined as the variance between the actual cost and estimated costs as a percentage of the estimated cost, with all costs calculated in constant prices (Lee, 2008). Cost overrun is a change between initially approved or estimated cost and final cost at the completion of the project (Amoa-abban & Allotey 2014).

3. Previous studies

Many factors which causes cost overrun in construction of projects from initial stage to final stage. Many studies have been found to identify factors of cost overrun in construction industry of Pakistan. A research conducted by Choudhry et al.(2012) has identified 10 major factors of cost increase or cost overrun in construction industry of Pakistan. From this research most critical factors of budget overrun were mistakes and error in design, inaccurate time and cost estimates, financial problem faced by contractor and client, change in price of materials, improper planning. Meanwhile, Nasir et al. (2011) identified the cost overrun factors in highway construction projects of Malaysia and result showed that critical factors were price adjustment, land acquisition, improper planning at site, poor management at site, inadequate time and cost duration, wrong cost estimation. Furthermore research carried by Azhar et al., (2008) identified the most important factors of cost overrun by distributing questionnaires in stakeholders of construction industry. Most important factors were change and fluctuation f price materials, cost of machinery, low bidding process, and long period of approval of drawing, wrong cost estimates, additional works of contractors, improper planning and sudden changes of government policies. Another, a research carried by Ejazet al. (2012) about the critical factors of cost overrun or cost increase in construction projects of Pakistan found that price escalation, project on lower bidding, delay in payment to contractor, shortage of materials at site, inadequate cost control, delay in approval of materials, mistakes during construction at site were the critical factors of budget overrun or increase in cost

4. Research Method

This research method for this study was carried by emerging the matrix for factors of cost overruns in Pakistan construction Projects. The matrix was based on past research papers of cost overrun in construction projects worldwide. The matrix analyzed on basis on frequency of each factor. These factors were categorized into five groups and then confirmed and verified by experts of construction industry of Pakistan. The aim of confirmation and verification was to putt the factors to particular categories. The process of confirmation and validation was done through conducting structured interview session with experts in handling construction projects. The interview was conducted with 8 personnel to cross check the factors. The structured interview was conducted from 15thMay 2016 until 05 June 2016 . The details of respondents for structured interviews are shown below in Table 2.

Table 2: Demographic information of the respondents

No	Position	Organization	Qualification	Working Experiences
1	Chief Engineer	Works Service Department	B.E in Civil Engineering	33 years
2	Engineer	WAPDA	Master of Project Management	29 years
3	Project Engineer	Contractor, Private	B.E in Civil Engineering	27 years
4	Director	National Highway Authority	B.E in Civil Engineering	24 years
05	Resident Engineer	Consultant, Private	Masters in Civil Engineering	20
6	Assistant Engineer	Irrigation Department	B.E in Civil Engineering	15 years
7	Project Engineer	Contractor, Private	B.E in Civil Engineering	13 years
08	Assistant Resident Engineer	Consultant, Private	Masters in Civil Engineering	11 years

Table 2 indicates the overall experience of the interviewed respondents is about 140 years and these respondents are handling projects with an average of 17.5 years in construction projects. From table 2 all respondents, six respondents have experience more than 20 years. 90% of the respondents are working in one organization since joining. This illustrates that the interviewees were qualified and reliable to explore the issues related to cost overrun. The purpose of the interview was to validate the factors belonging to relevant groups.

Fifteen research papers were deeply reviewed during this research and as a result 22 factors which causes cost overrun in Pakistan construction projects identified. From deep literature review of 15 research papers 22 factors which causes cost overrun were identified. 22 factors which are characterized into main 5 groups and through conducting interviews from construction experts of construction industry, it is confirmed that factors of cost overrun were summarized into relevant main group. The research on time increase was also considered as cost increase. (Aibinu & Jagboro, 2002; Sambasivan & Soon, 2007; Shehu et al. 2014a).

Table 3: Representing of Previous studies on Factors of Cost Overrun

Group	Factors of cost overrun	(Roslan et al. 2015)	(Azhar et al.,2008)	(Choudhry et al.,2012)	(Jamaludin et al. 2014)	(Roslan et al. 2014)	(Ismail et al. 2014)	(Rahman et al. 2013)	(Ismail et al. 2013)	(Hamzah et al. 2012)	(Memon et al. 2012)	(Memon et al. 2011)	(Abdullah et al. 2010)	(Memon et al. 2010)	(Alaghbari et al. 2007)	(Sambasivan & Soon 2007)	Frequency
1.Consulted associated factors	Underestimate project time duration	*	*	*		*	*	*		*		*		*			9
	Poor project management	*	*		*	*	*		*	*							7
	Inaccurate cost estimates		*				*		*	*		*					5
	Poor contract management		*														1
	Lack of consultant experience														*		1
.Contractor associated factors	Poor management at site	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	15
	Inadequate planning and scheduling	*	*	*	*	*	*	*	*			*	*	*		*	12
	Inadequate contactor experience	*		*			*	*	*	*		*	*	*		*	10
	Mistakes during construction	*			*	*	*				*	*			*	*	8
	Poor financial control on site		*					*			*	*					4
	Incompetent subcontractors	*				*	*	*			*		*			*	7

3.Design associated factors	Rapid and many changes in design						*	*	*		*	*					5
	Mistakes and errors in design						*	*				*					3
	Incomplete design drawings and specifications at tendering stage				*						*	*			*		4
4.Material associated factor	Change in materials specification		*					*	*	*	*	*	*			*	8
	Low speed of decisions making process						*										1
	Change in the project scope			*	*				*								3
	Shortage of workers at site							*	*	*	*				*	*	6
	Shortage of materials			*					*			*		*	*		5
	Delay in Material procurement			*					*			*		*	*		5
5.Financial associated factors	Financial problems by owner							*	*	*	*	*	*			*	7
	Inflation in project costs					*											1
	Financial difficulties faced by contractors	*		*	*	*		*	*	*	*	*	*	*	*		12
	Late payments from owner		*							*					*		3
	Variation in prices of raw materials			*	*			*			*		*	*			6
	Giving contract to the lowest bidder		*	*									*	*			4

Table 3 indicates that each factor has different frequency of impact in relevant associated factor.

5. Results and discussions

Table 4 - A critical factor that contributes to construction cost overrun based on each group from frequency.

Group of factors	Critical factor
Consultant associated factor	Underestimate project time duration
Contractor associated factors	Poor Management at site
Design associated Factors	Rapid/Frequent design changes
Material and Labour associated Factors	Shortage of workers at site
Financial associated Factors	Financial difficulties faced by contractor

4.1 Underestimate project time duration

In consultant associated factors group, 'underestimate project time duration' was the highest key factor of cost overrun. This problem is associated with the inexperience of consultant and inappropriate methods for estimating the projects time duration. Because of wrong estimation of time which causes cost overrun in construction projects.(Azhar et al. 2008)

4.2 *Poor management at site*

The 'poor management at site' was found to be critical factor from all factors associated with contractor associated factors of cost overrun. This problem occurs because of not managing daily routine works at sites and this also includes poor project management by site managers and contractors (Le-Hoai et al., 2008). When site managers have very little support from the top management it would worsen the matter even more. Sometimes when the site managers quit the job and the post is vacant for long duration it surely results in poor site management.

4. *Rapid/Frequent design changes*

Owner and consultant are responsible for frequent design changes in design which cause cost overrun in construction projects. The magnitude of these alters relies upon a number of variables. Unforeseen condition during construction, toughness of pre design investigation of site, plentitude of working drawings which are accessible at the time of proposal and estimate, Frequent change in design of project can increase the approved budget of the project (kaming et al 1997).

4.4 Shortage of workers at site

The fast growth of construction industry demands a large number of workers. As Malaysia is developed country and construction projects are growing and skilled labour are required but industry is facing shortage of skilled labour. The low quality and productivity workers will impact on the progress of projects especially large construction projects (Le-Hoai et al. 2008). This problem is always connected with the lack of knowledge about the real quantities required, lack of implementation on risk-mitigation plan, having no clear terms with materials suppliers, having no distinct savings goals, and no track for price changes.

4.5 Financial difficulties faced by contractors

In financial related factor group payment problems faced by contractors is on top. Many contractors stopped there works at sites just because of shortage of funds. It is fact that contractors play important role for execution of any project, it is also fact that contractors start work from initial to final completion of project (Rahman et al 2013).

6. Conclusion

This study found that cost overrun has a significant impact on construction projects in other countries including Pakistan cost overrun. The review of fifteen research articles has exposed that the three more important critical factors of budget overrun in Pakistan construction projects are poor management at site by contractor, insufficient planning and scheduling and financial problems faced by contractors. The results of this study will be used to find significant mitigation measures for the critical factors causing cost overrun in Pakistan construction projects.

References:

Agren, R., Jingmond, M. & Landin, A., 2011. Cost and Time Overrun in Construction Projects in a Multicultural Setting. In *Proceedings of the Second International Conference on Advances in Engineering and Technology*. pp. 291–297..

Aibinu, A.A. & Jagboro, G.O., 2002. The effects of construction delays on project delivery in Nigerian construction industry. *International Journal of Project Management*, 20(8), pp.593–599.

Alaghbari, W. et al., 2007. The significant factors causing delay of building construction projects in Malaysia. *Engineering, Construction and Architectural Management*, 14(2), pp.192–206.

Avotos, I., 1983. Cost-relevance analysis for overrun control. *International Journal of Project Management*, 1(3), pp.142–148.

Azhar, N., Farooqui, R.U. & Ahmed, S.M., 2008. Cost Overrun Factors In Construction Industry of Pakistan. In *First International Conference on Construction In Developing Countries (ICCIDC–I) "Advancing and Integrating Construction Education, Research & Practice" Karachi, Pakistan*. pp. 499–508.

Choudry, R., Nasir, A., & Gabriel, H. (2012). Cost and Time Overruns in Highway Projects in Pakistan. In *Pakistan Engineering Congress, Centenary Celebration Proceedings* (pp. 353-369).

Ejaz, N., Ali, I., & Tahir, M. F. (2013). Assessment of delays and cost overruns during construction projects in Pakistan.

Hamzah, N. et al., 2012. Identification of the causes of construction delay in Malaysia. *World Academy of Science, Engineering and Technology*, 72(12), pp.312–317.

Ismail, I., Memon, A.H. & Rahman, I.A., 2014. Expert opinion on risk level for factors affecting time and cost overrun along the project lifecycle in Malaysian Construction Projects. *International Journal of Construction Technoogy and Management*, 1(2), pp.10–15.

Jamaludin, S.Z.H.S., Mohammad, M.F. & Ahmad, K., 2014. Enhancing the Quality of Construction Environment by Minimizing the Cost Variance. In *Procedia - Social and Behavioral Sciences*. pp. 70–78.

Kaming, P. F., Olomolaiye, P. O., Holt, G. D., & Harris, F. C. (1997). Factors influencing construction time and cost overruns on high-rise projects in Indonesia. Construction Management & Economics, 15(1), 83-94.

Lee, J.-K., 2008. Cost Overrun and Cause in Korean Social Overhead Capital Projects: Roads, Rails, Airports, and Ports. *Journal of Urban Planning and Development*, 134(2), pp.59–62.

Le-Hoai, L., Y.D. Lee and J.Y. Lee, 2008. Delay and Cost Overruns in Vietnam large construction projects:A comparison with other selected countries. KSCE J. Civil Eng., 12: 367-377.

Mahamid, I. & Dmaidi, N., 2013. Risks Leading to Cost Overrun in Building Construction from Consultants' Perspective. *Organization, Technology & Management in Construction: An International Journal*, 5(2), pp.860–873.

Memon, A.H. et al., 2010. Factors affecting construction cost performance in project management projects :Perspective of

Project Management Consultant. *International Journal of Sustainable Construction Engineering & Technology*, 1(2), pp.30–35.

Memon, A.H. et al., 2014. Factors affecting construction cost performance in project management projects: Case of MARA large projects. *International Journal of Civil Engineering and Built Environment*, 1(1).

Memon, A.H. et al., 2011. Preliminary Study on Causative Factors Leading to Construction Cost Overrun. *International Journal of Sustainable Construction Engineering & Technology*, 2(1), pp.57–71.

Memon, A.H., Rahman, I.A. & Aziz, A.A.A., 2012. The Cause Factors of Large Project's Cost Overrun: A Survey in the Southern Part of Peninsular Malaysia. *International Journal of Real Estate Studies*, 7(2).

Nagapan, S., Rahman, I. A., Asmi, A., Hameed Memon, A., & Zin, R. M. (2012). Identifying Causes of Construction Waste -Case of Central Region of Peninsula Malaysia. *International Journal of Integrated Engineering*, *4*(2), 22–28.

Omoregie, a & Radford, D., 2006. Infrastructure delays and cost escalation: causes and effects in Nigeria. In *Proceeding of sixth international postgraduate research conference Netherlands, Delft University of Technology*. pp. 79–93.

Rahman, I.A., Memon, A.H. & Karim, A.T.A., 2013. Significant Factors Causing Cost Overruns in Large Construction Projects in Malaysia. *Journal of Applied Sciences*, 13(2), pp.286–293.

Rahman, I. A., Memon, A. H., Nagapan, S., Latif, Q. B. A. I., & Azis, A. A. A. (2012, December). Time and cost performance of costruction projects in southern and cenrtal regions of Penisular Malaysia. In Humanities, Science and Engineering (CHUSER), 2012 IEEE Colloquium, pp. 52-57.

Ramanathan, C., Potty, N.S. & Idrus, A.B., 2012. Analysis of time and cost overrun in Malaysian construction. *Advanced Materials Research*, 452-453, pp.1002–1008.

Roslan, N., Zainun, N.Y. & Memon, A.H., 2014. Measures for Controlling Time and Cost Overrun Factors during Execution Stage. *International Journal of Construction Technology and Management*, 1(1).

Roslan, N., Zainun, N.Y. & Memon, A.H., 2015. Relevancy of Factors and Mitigation Measures in Controlling Time and. *Applied Mechanics and Materials*, 773-774, pp.1007–1011.

Sambasivan, M. & Soon, Y.W., 2007. Causes and effects of delays in Malaysian construction industry. *International Journal of Project Management*, 25(5), pp.517–526.

Shehu, Z., Endut, I.R., et al., 2014. Cost overrun in the Malaysian construction industry projects: A deeper insight. *International Journal of Project Management*, 32(8), pp.1471–1480

Zhu, K. & Liu, L., 2004. Structuring Finance to Meet Client's Needs - A Stage-By-Stage Factor Control Framework for Cost Estimation of Construction Projects. *Paper presented at Owners Driving Innovation International Conference*, pp.1–19.

Impact of Medical Facilities Provided by Industrial organization on Productivity : A Case Study

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Abstract: Health is playing a significant role for improving human efficiency**.** This study helps to determine the impact of medical facilities provided by industrial organization on productivity. This research was carried out to accumulate the data from workers of sapphire textile mill situated in Kotri, Sindh, Pakistan. The questionnaire used in this research work was adopted of **Musa et al. 2012.** The SPSS software was used to examine the data. The main objective of this study was to analyze the problems related with medical facility at workplace and their influenced on productivity. Results revealed that majority of workers responded that medical facilities like medical treatment, first aid services, medical examination and qualified doctor were present at workplace. However there were no comprehensive health care services, health education counseling and medical ambulance at workplace. The study suggested that there is need to improve medical facilities in textile industry. These recommendations will provide more advantages for enhance workers' productivity in future.

Keywords: Medical Facility, Health, Textile Industry, Productivity

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1. INTRODUCTION

Health is most valuable social matter in public society and playing a significant role for improving human efficiency. The awareness about health education and conductive environment can improve the productivity rate. Health of workers is very important for their families and the organization. The performance workers is adversely affected if there is lacking in health care facilities by the organizations **(Hassa et al. 2001).** Most of the workers face severe health problems at working environment of industrial organizations. Inadequate health services bring irritation in the life of workers. It also interrupts the worker earning and output at profession **Ellen (2003**). The income of workers is already very low and they can't afford the expenditure of medical treatment. It is observed that majority of worker's families go through poverty life style which ultimately impact adversely on capability and production as well as both output and quality **(Bourdieu et al. 2005).** Workers face a numerous safety and health hazards. The worker's medical facility can boost productivity and help to establish successful organization. It is the responsibility of organization management to provide the medical facility to workers. These services can improve the work environment which is useful for production **OSHB (2012).** There is strong relation between productivity and health. Sick workers can results in lack productivity **(Loeppke et al. 2009).** Mostly industries cannot afford the medical expenditures to workers which develop the risk factors and reduce productivity. Better environment save expenditure of medical services **(Goetzel at al. 2009).** Poor health has a great impact on production rate **(Shaikh et al. 2016).** Health and safety environment help the developing countries to improve productivity that's why many organizations are struggling to manage the health and safety at the workplace **Lehtinen (2001).**

This research explore that there was no proper attention at the health of workers in textile industry. This situation also impact on the economy of Pakistan. Therefore, government should realize the importance of worker's health and take necessary measures to manage hospitals, dispensaries and health clinic at workplace.

2. MATERIAL AND METHOD

This study has been undertaken to collect the data from workers of sapphire textile mill situated in Kotri, Sindh, Pakistan. The questionnaire used in this study was adopted from Musa et al. 2012. 400 questionnaires were distributed among the workers, and they were provided instruction in their own language that how to fill questionnaires. Out of 400 questionnaires, 320 were discarded because 150 were blank, 140 were partially filled, 30 workers straight forward denied to fill. Therefore; only 80 questionnaires i.e. 20% were used for this research work. For analyzing the data SPSS Software was used and descriptive statistics was also used to compute frequency & percentage.

3. RESULT AND DISCUSSION

The productivity of workers can be increased by providing the proper medical facilities. Medical facility provides shelter to workers and help to perform better. The performance and motivation of workers base on the medical facilities at the workplace. The standard institutes of medical health care are focusing to maintain socially, physically and mentally strong to textile workers for achieving positive impact on the productivity of workers. There are few other factors which also impact on productivity and are considered as under.

3.1 Socio-Economic Characteristics

A Socio-economic characteristic is playing a very important role in accepting the socioeconomic status of the respondents. Socioeconomic contribute in analyzing and associating demographic and health condition to the workers. This characteristic is very essential in the development of behavior and human attitude. The present age, education, marital status and wages are most valuable socio-economic variables, which effect human judgment and opinion. Table 1 demonstrate that majority i.e. 31 (38.8%) of the respondents were in the age of 30~39 years, whereas; 26 (32.5%) of the respondents were in the age of 20~29 years, 13 (16.3%) were in the age of 40~49 years, and 10 (12.5%) of the respondents were in minority & their age were between 50~59 years. Table also illustrates the gender of the respondents. Majority 78 (97.5%) were male, whereas; only 2 (2.5%) were female. The female ratio was very low due to tough work in the spinning textile industry. Majority of the respondents 69 (86.3%) were permanent employees, while 5 (6.3%) were temporary and only 6 (7.5%) of the respondents were casual workers. The wages of the respondents appeared that majority 47 (58.85) were getting up to PKR. 11000-15000 per month, while 13 (16.3%) of the respondents were getting PKR. 5000~10000 per month, whereas; only 3 (3.8%) respondents were getting PKR. 26000 or above per month.

Table1. Distribution of the Respondent According to their Socio-Economic Status

Age (in years)	Frequency	Percentage
20~29	26	32.5
30~39	31	38.8
40~49	13	16.3
50~59	10	12.5
Gender		
Male	78	97.5
Female	2	2.5
Employment		
Permanent	69	86.3
Temporary	5	6.3
Casual worker	6	7.5
Monthly Salary (PKR)		
5000~10000	13	16.3
11000~15000	47	58.8
16000~20000	11	13.8
21000~25000	6	7.5
26000~above	3	3.8

3.2 Provision of Medical Treatment for Minor Injury

Provision of medical treatment for minor injury to the workers protect them from infections, diseases, develop healthy & peaceful environment in organization, prosperity in the family, protect them from economic crises, workers work with interest and ultimately positive impact on production. Good health positively brings productivity by decreasing the total cost of nonappearance and increasing income of the workers as well as organization (**Ellen 2003).** Table 2 shows that a majority 68 (85%) of the respondents replied that industry provide the medical treatment in minor injury, while 12 (15%) of the respondents replied in negative. It is therefore recognized from above statements of the workers that medical facilities were present in the industry.

Table2. Provision of medical treatment in case of minor injury

Provision medical treatment in case of minor injury	Frequency	Percentage
Yes	68	85
No	12	15

3.3 Provision of First Aid Services

First aid means to provide immediately medical facility to victims of accidents before reaching the hospital. It provides the safety and help to recover the health of workers. Workers may be easily saved by timely medical services, which raise the moral of workers. The owners and top management of the industry don't want big investment in first aid services for workers. Therefore, risk is increased at workplace. The problems of workers also increase and they themselves & their families face the difficulties in life **Galmessa (2006).** The facilities i.e. first aid training, kits, secure bandage & dressing, packets of aspirin, antibiotic ointment packets, adhesive cloth tape, breathing barriers, cough medicine, thermometer, painkillers and distilled water for cleaning wound should be necessary in first aid services. Table 3 illustrate that majority 75 (93.7%) of the respondents answered that their company provide first aid services, whereas; 5 (6.25%) of the respondents reported that their company is not providing the first aid service. It can be identify from above observation of the workers that first aid health care services were present at industry.

Table 3. Provision of first aid services

Provision of first aid services	Frequency	Percentage
Yes	75	93.7
No	5	6.25
Total	80	100

3.4 Provision of Comprehensive Health Care Services

Comprehensive health care services means to provide the comprehensive medical facilities i.e. respect, compassion, delivered with patience, provided skilled home health, personal care, skilled nursing, physical therapy, pediatric program, wound care, home healthcare team, skilled services, X-ray machines, testing laboratories and ultra-sound. These comprehensive health care services protect the life of workers from diseases and enhance the production at working environment. Energetic and healthy workers could be possible when comprehensive health care services will be available for every worker. Better health care services stop the worker from harmful diseases. It is very significant that the industrial organization should arrange the comprehensive health care services for the workers. Table 4 reflects that 11 (13.8%) of the respondent said that they are availing the comprehensive health care services, while majority 69 (86.3%) of respondents stated that industry is not providing the comprehensive health care services. It can be realized from above statements of the workers that comprehensive health care services were not provided to workers.

Table 4. Provision of Comprehensive Health Care Services

provision of comprehensive health care services	Frequency	Percentage
Yes	11	13.8
No	69	86.3
Total	80	100

3.5 Medical Examination for Workers

Medical examination is a common means of conducting such surveillance. Every year thousands of workers die due to insufficient medical examination at workplace environment. Workers face illness and injury from the worst condition of environment at workplace. Low profit organization and small companies don't provide the medical examination for workers. There are some factors which are very important in the medical examination like health surveillance, detect early abnormalities, regular medical examination and pre-employment medical examination. The efficiency of workers is reduced and influence on production **OSHB (2012)**. Table 5 is showing that majority 67 (83.3%) of respondents replied that medical examination is available, while only 13 (16.3%) of the respondents said that the industry is not providing the medical examination because; they were unaware about the clinic medical facility at industry. It is therefore perceived that medical examination for workers were present at industry.

Table 5. Medical Examination for workers

Medical examination for workers	Frequency	Percentage
Yes	67	83.8
No	13	16.3
Total	80	100

3.6 Health Education Counseling

The aim of health education counseling is to promote the healthy atmosphere for workers life and protect them from high accidents or injury rate. Health education counseling provide the education and information to creates awareness of health among the workers i.e. patient education, stress issue, anxiety & depression problems, pregnancy care , smoking effect and less sleeping disadvantages in the life of workers. Mostly information about health education is present at internet, television, books and magazines. Workers could not receive health education information from social media because most of the workers are un-educated less educated. Top management and industrial organization should hire the consultant related with health education. Table 6 shows that 5 (6.3%) of the respondents were receiving health education, while majority of respondents 75 (93.8%) said that there is no health education counseling at workplace. It is therefore noticed from the above statistic that majority of respondents had never gone through health education counseling.

Table 6. Provision of Health Education Counseling

Provision of health education counseling	Frequency	Percentage
Yes	5	6.3
No	75	93.8
Total	80	100

3.7 Provision of Ambulance at Work

Ambulance is used to carry the sick and injured workers to a place where workers can receive the secure surgical care and medical treatment in a short time. Presences of ambulance at work stabilize the condition of workers **Norwegian Red Cross (2013).** Medical ambulance should have the facilities like injury prevention equipment, airway and ventilation equipment, pulling tools devices, Air condition ambulance, cardiac, infection control, monitoring and defibrillation, skilled nursing facility and original medicine. Table 7 shows that 3 (3.8%) of the respondents stated that ambulance were present, while majority 77 (96.3%) of the respondents mentioned that ambulance were not always available at workplace. It is observed that from the data that there was no ambulance service at workplace.

Table 7. Provision of ambulance at workplace

Provision of ambulance at workplace	Frequency	Percentage
Yes	3	3.8
No	77	96.3
Total	80	100

3.8 Qualified Doctor at Clinic

Qualified Doctors working in industry are main component in the favorable development. Doctors have a high responsibility to provide a better potential treatment to workers. Qualified doctors always make decision in the favor of workers. Respondents were asked to indicate the presence of qualified doctor at clinic. Table 8 shows that 69 (86.3%) of the respondents indicated that qualified doctor were present at clinic, while minority 11 (13.8%) of the respondents replied in negative. Therefore it is distinguished from the statements that qualified doctor were present at workplace clinic.

Table 8. Qualified doctor at clinic

Qualified doctor at clinic	Frequency	Percentage
Yes	69	86.3
No	11	13.8
Total	80	100

4. CONCLUSION AND RECOMMENDATION

This study was carried out to determine the impact of medical facility provided by industrial organization on productivity in the textile industry. It was observed that majority of respondent were facing inadequate medical facilities at workplace. There were lack of comprehensive health care, health education counseling and medical ambulance at workplace. Medical treatment for minor injury, first aid services, medical examination for workers and qualified doctor were available at workplace. Workers are facing huge disease at workplace, because of lack of medical facilities. The provision of comprehensive health care, health education counseling and medical ambulance services at textile industry will protect the lives of workers at the stage of accident and emergency. It is the responsibility of every industry to promote the medical facilities to their workers. The study suggested that there is need to improve medical facilities in textile industry. These recommendations will provide more advantages for enhance workers' productivity in future.

5. REFERENCES

1. Bourdieu, J. and Reynand, B. (2005). *Factory Discipline, Health and Externalities in the Reduction of Working Time in Nineteenth Century France*. Jourdan Sciences Economiques, Paris, France.

2. Ellen (2003). Health May Contribute to Productivity by Reducing the Costs of Absenteeism and Turnover and By Increasing Workers' Productivity. *The Milbank, Quarterly*, 81:5-43.

3. Galmessa, A. (2006). First Aid and Accident Prevention. Lectures Notes Collaboration with Ethiopia Public Training Initiative, Ethiopia Ministry of Health and Ethiopia Ministry of Education. Haramaya University, Ethiopia.

4. Goetzel, R. and Carls, S. (2009). The Relationship between Modifiable Health Risk Factors and Medical Expenditures, Absenteeism, Short-Term Disability and Presenteeism among Employees at Novartis. *Journal of Occupational and Environmental Medicine*, 51: 487-499.

5. Hassa, J D. and Brownlie, T. (2001). Iron Deficiency and Reduced Work Capacity: A Critical Review of the Research to Determine a Causal Relationship. *The Journal of Nutrition*, 131: 676-688.

6. Loeppke, R. and Taitel, M. (2009). Health and Productivity as a Business Strategy: A Multiemployer Study. *Journal of Occupational and Environmental Medicine*, 51: 411-428.

7. Norwegian Red Cross. (2013). Ambulance and Pre-Hospital Services in Risk Situations: *Proceedings of the Workshop Organized by the International committee of Red Cross and Mexican Red Cross Held in Toluca, Mexico,* pp. 1-53.

8. Occupational Safety and Health Branch. (2012). Guidance Notes on Medical Examination in Hazardous Occupations in Industrial Undertakings. The Labor Government Department, Hong Kong.

9. Shaikh, M. and Nebhwani, M. (2016). Awarenesss of Workplace Hazards among Workers in Textile Mill: A Pilot Study. 2nd Multi-Disciplinary Student Research Conference, University of Wah,Taxila.

10. Lehtinen, S. (2001). Developing Occupational Health and Safety in Asia. Asian-Pacific Newsletter on Occupational Health and Safety, 7: 7-44.

The World Of Mobile Cloud Computing
(A Survey To The Concept, Challenges and Solutions)

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Abstract: Mobile devices are increasingly becoming an essential part of human life as the most effective and convenient communication tools not bounded by time and place. Mobile cloud Computing have emerged out in IT industry since last decade. Cloud Computing imitate vast experience of various services from mobile applications which run on devices and remote servers via wireless networks. This paper presents a review on the background and principle of Mobile Cloud Computing, characteristics, recent research work, challenges and proposed solutions. The ultimate goal of MCC is to enable execution of rich mobile applications on the mobile devices platform, with a rich user experience.
Keywords— Mobile Cloud Computing; Mobile Computing; Cloud Computing; Security.

1. INTRODUCTION

Today, cloud computing has emerged out very quickly and the increasing penetration of smartphones transformed the mobile Internet and allowed the users to have a rewarding mobile experience. Cloud computing allows its user to rent on demand hardware as well as software. But sometimes sharing resources in this way presents some security risks. These risks can be minimized depending on the type of technology wanted to include in the cloud computing concept. Cloud Computing has become an important research topic in scientific and industrial circles since 2007. We are now moving towards our goal of concatenating the phenomena of cloud computing and mobile computing and we have called it mobile cloud computing (MCC).

In more detail, the MCC can be defined as "a rich mobile computing technology that combines cloud computing and wireless networks to bring rich computing resources without compromising its functionality, storage and mobility to serve a multitude of devices Mobile everywhere, or Internet regardless of environments and heterogeneous platforms based on the principle of pay-as-you-use".

Mobility has become a very popular word and quickly part in the era of computers today. An incredible growth has appeared in the development of mobile devices such as, Smartphone, PDA, GPS navigation and laptops with a variety of mobile computing, networks and security technologies. Meanwhile smartphones are considered as the representatives for the various mobile devices as they have been connected to the internet with the rapidly growing wireless technology such as WiMAX and WIFI etc.

The basic concept of MCC is to connect various mobile devices as they have been to the Internet with the rapid growth of wireless network technology. The goal of MCC is to enable the execution of rich mobile applications on a mobile device platform, with a rich user experience. MCC offers business opportunities to mobile network operators and cloud service providers.

MCC offers many advantages to users by allowing them to use infrastructure, platform and software by cloud providers at low cost, and elastically in an on-demand fashion. As an inheritance and development of cloud computing, resources in cloud computing network are virtualized and assigned to number of different distributed computers and are provided to mobile devices such as smartphones etc. Meantime various applications based on mobile cloud computing are developed and served to the users, such as Google's Gmail, Maps, and Navigation systems for mobiles, voice search and some applications on android platforms MobileMe from Apple, Live Mesh from Microsoft, and Moto Blur from Motorola.

According to the research MCC make a great contribution to our daily lives but providing cloud services in a mobile environment brings many challenges and problems. Sometimes, mobile devices cannot handle the complication because of their inherent characters. In addition, it is impossible that a mobile device is always in line, the solution of the device should also be considered. A figure 1.1 below is showing an example of the Mobile Cloud Computing.

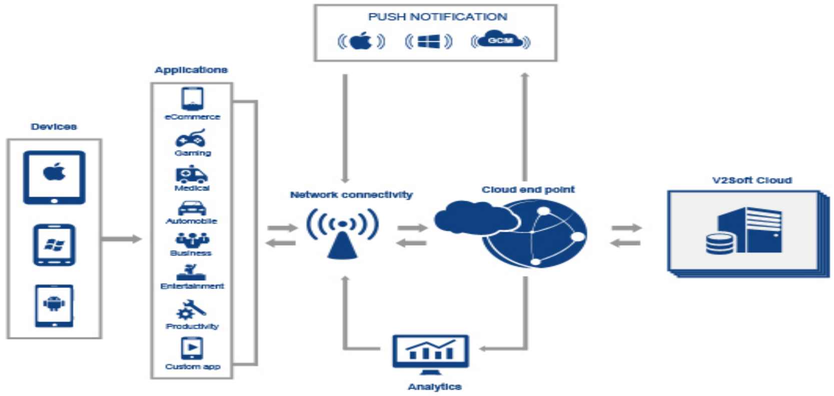

Figure 1. Mobile Cloud Computing

2. LITREATURE REVIEW

This section employs a methodical, structured, and rigorous analysis of existing literature in order to attain its objectives, which is to understand the trend of research interests so far in MCC.

Qi and Gani (2014) proposed the background and principles of MCC, along with features and modern trends in MCC. They considered the cloud computing is a large scale economic and business computing paradigm with virtualization as its core technology. In background reading they presented a brief description about mobile computing and cloud computing along with their features and challenges. They had written down the description on MCC including its concepts, principles, challenges and their solutions involving: limitations, Quality of communication and division of application service. Furthermore, open research issues.

Saggi and Bhatia (2015) described architecture, principals, features, Limitations of Mobile Computing and challenges along with proposed solutions. They proposed that according to the top ten technology trends for 2012 Satyanarayanan (1996) provided by Gartner (a famous global analytical and consulting company) cloud computing has been on the top of the list, which means cloud computing will have an increased impact on the enterprise and most organizations in 2012.

Leung (2013) along with his three colleagues put forward the four main challenges of Mobile Cloud Computing that are included, but are not limited to the comprehensive survey on diverse ways of combining cloud computing and mobile platforms towards a new computing/communication paradigm. In "Gearing Resource-poor mobile devices with powerful clouds: Architecture, Challenges and Applications," Luteal. Provide a complete taxonomy of mobile-cloud offloading architectures and a new genre of real-world commercial applications. The article presents a comprehensive survey of the technical challenges and existing solutions towards exploiting mobile cloud computing for rich media applications.

Canepa and Lee (2012) present the guidelines for a framework that mimics a traditional cloud provider using mobile devices in the vicinity of users. The framework detects the nearby nodes that are in a stable mode and presented the ways to save resources like energy and processing power. Pradhan (2015) written down a survey on Mobile Cloud Computing including: Features, Architecture, Challenges, solutions, advantages, applications, Research issues and Elements of MCC.

Gupta and Gupta (2012) written down the cloud computing service models including three service layers and deployment models including four different clouds and the detailed presentation on the Architecture of MCC with certain challenges and proposed solutions including the strategies that can be adopted by the service providers to address the issues.

Zhang, Cheng and Boutaba (2010) represented the research challenges. And other literature includes: Chun, Ihm, Maniatis, Naik, and Patti (2011), Zhang, Kunjithapatham, Jeong, and Gibbs (2011), Lu, Li, and Shen (2011), Endo, Rodrigues, Goncalves, Kelner, Sadok, and Curesce (2016), Puthal, Sahoo, Mishra, and Sawain (2015), Fonseca, and Boutaba (2015), Botran, Alonso, and Lozano (2014), Jennings, Stadler (2015), Mohamaddiah, Abdullah, Subramaniam, and Hussin (2014), Padala, Hou, Shin, Zhu, Uysal, Wang, Singhal, and Marchant (2009), Singh, and Chana (2016), Luna, Ghani, Vateva, and Suri (2011), Toeroe, and Tam, (2012), Dilion, Wu, and Chang (2010), Coutinho, Sousa, Rego, Gomes, and Souza, (2015).

3. BACKGROUND

The development and inheritance of Cloud Computing and Mobile Computing emerged in 2009. Mobile Computing can be thought of a infrastructure where data and processing could happen outside the device, with enabling the new types of applications in mobile social networks. The Mobile Cloud Computing can be divided into two types Mobile Computing and Cloud Computing. The mobile devices can be laptops, PDA's, smartphones etc. Which connect with the hotspot by radio links such as 3G, Wi-Fi or GPRS. Mobile users send request for the services to the cloud through a web browser or desktop application. The management component of the Cloud accepts the user request and allocates the resources to establish connection.

3.1 Mobile Computing

Mobility has become very popular in today's computing era and promptly increasing now a day. Mobile Computing allows for transmission of data, voice and video. Mobile Computing involves mobile communication, mobile hardware, and mobile software. With the development of wireless technology like: WiMAX, ad Hoc network, and Wi-Fi the users may be surfing the web much easier without limiting themselves with the cables as before, which forms the big part of the mobile communication. An incredibly growing mobile hardware devices with the development of portable computers, compact, lightweight units, notebooks, notepads, PDA's, smartphones, with the variety of mobile computing, networking and security technologies. Besides of all features there are certain limitations that are as follows:

Range and Bandwidth: Some mobile internet access technologies are generally slower than cable connections such as: GPRS and EDGE. While the more recently 3G, 4G networks and also upcoming 5G network. These networks are customarily available in within range of commercial cell phone tower. The high speed wireless network LAN's are inexpensive but have very limited range.

Power Consumption: Mobile computers must have to rely solely on battery power because when a power outlet or portable generator is not available. Considering the compact size, the expensive batteries must be used to obtain the necessary battery life.

Security Standards: (Luna, hani, Vateva & Suri, 2011) while working mobile, user is totally dependent on public networks, by VPN that is constructed using public wires usually internet, to connect to a private network. Security is an extensive concern while concerning the mobile computing standards.

3.1.1 Essential Characteristics

On demand Self-service: Cloud Computing is based on self-service (Toeroe & Tam, 2012) and on demand service models. It allows the user to interact with the cloud to perform tasks such as: building, deploying, managing and scheduling. The user should be able to access computing capabilities, such as server time, network and storage, as needed automatically without requiring human interaction with each service provider.

Diversity of Network: The networks used by mobile nodes are not unique; those networks include wired networks with high bandwidth or a wireless Wide Area Network (WWAN) with low bandwidth.

Resource Pooling: (Dilion, Wu & Chang, 2010) The resources are pooled to serve a large number of customers. The Cloud Computing uses multi-tenancy where different resources are dynamically allocated and de-allocated according to the demand. From the user's end, it is not possible to know where the resources actually reside. Resources includes: storage, processing, memory, network bandwidth, virtual machine etc.

Rapid Elasticity: (Coutinho, Sousa, Rego, Gomes & Souza, 2015) The resource allocation should be elastic, that it should change appropriately and quickly with the demand. When the load increases, more resources will be added and when demand wanes then remove the unneeded resources.

Accessibility: The Cloud Computing allows to launch the applications across platforms from laptop to Android phones to Apple TV, making resources more accessible and also more reliable.

3.1.2 Challenges

As compared with the wired network the mobile network may face many problems and challenges in many different aspects such as power, multiple network connections, security in wireless connections, low computing ability, signal disturbance etc. In addition to challenges mobile computing presents the following constraints.

a) *Mobile elements are resource poor relative to static elements.*

b) *Mobility is inherently hazards.*
c) Mobile connectivity is highly variable in performance and reliability.
d) Mobile elements rely on finite energy source.

These constraints are not artifacts of current technology but are natural in mobility.

3.2 Cloud Computing

In the era of Personal Computers, many users thought that the PC's they bought 2 years ago, cannot tread with the software development nowadays. They need more resources such as high speed CPU, a larger capacity hard disk and a higher performance Operating System. This urges the peoples to upgrade their PC's regularly. Thus, a term Cloud Computing emerged out in our lives. Cloud computing is latest trend in IT world. It is internet based computing, through shared resources, software and information, are provided to customers on demand. Generally, it is said that "Cloud Computing is commonly described as variety of facilities provided by group of low cost servers or personal computers generally called a cluster, via the internet the main part of the cloud computing system is this cluster system, called the Cloud".

Concept of this new trend started from 1960 used by telecommunication companies until 1990 offered virtual private networks. The development of Amazon played vital role by making modern data centers. In 2007 Google, IBM and many remarkable companies and universities adopted it, because of which Cloud Computing become a popular phrase in 2007. The cloud computing system is the development of parallel processing, distributed and grid computing on the internet, which provides various QoS (Singh & Chana, 2016) guaranteed services such as hardware, infrastructure, platform, software and storage to different internet users and applications.

3.2.1 Service Models

Cloud Computing systems can be considered as collection of different services; thus, the framework of cloud computing can be divided into three layers:

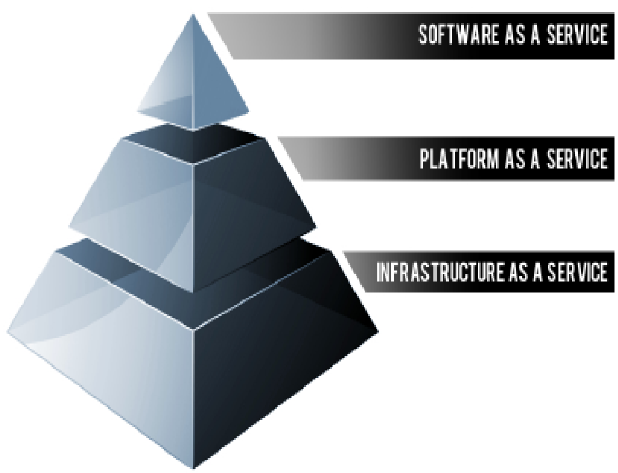

Figure 2. The 3 Layers of Cloud Computing

Software as a Service (SaaS): The capability provided to the customer is to use the provider's application running on a running on a cloud infrastructure. The applications are accessible from various client devices through a thin client interface such as web browser. The consumer does not manage, control or change the underlying cloud infrastructure because of limited user-specification application configuration settings. Services in this layer are: such as Google Online Office.

Platform as a Service (Paas): The capability provided to the customer to deploy onto the cloud infrastructure created by the consumer using programming languages and tools supported by the provider. The consumer does not manage or control the cloud infrastructure including networks, servers, operating systems or storage but has control over the deployed applications. The typical services in this layer are: such as Google App Engine and Azure from Microsoft.

Infrastructure as a Service (IaaS): The capability provided to the customer is to allocate processing, storage, networks and other fundamental computing resources where the consumer is able to deploy and run arbitrary software including Operating systems and applications. The consumer does not manage and control the underlying cloud infrastructure has control over operating systems, storage, deployed applications and networks. Services in this Layer are: such as Elastic Computing Cloud of Amazon. The figure below illustrates the cloud service examples.

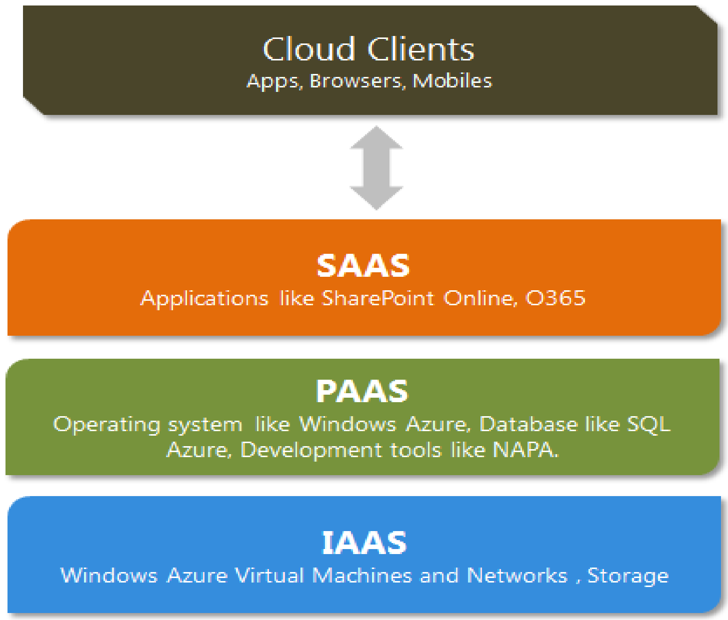

Figure 3. Cloud Services Examples

3.2.2 Deployment Models

Cloud hosting deployment models represent the category of cloud environment and are distinguished by size and access, telling about the nature and purpose of the cloud.

Private Cloud: The cloud infrastructure is provided and operated for entirely used by a single organization containing multiple consumers. It may be owned, managed and operated by the organization itself or a third party.

Community Cloud: The cloud infrastructure is provided for entirely used by a specific community of consumers in several shared organizations. It may be owned and managed by one or more organizations in the community or a third party.

Public Cloud: The cloud infrastructure is provided for open use by the general public or a large industry group. It is owned, managed and operated by the organization selling cloud services, or government organizations.

Hybrid Cloud: The cloud infrastructure that uses a mix of on-premises of two or more distinct cloud infrastructures such as private, community or public clouds. Beyond keeping each cloud a unique entity they are bound together by standardized technology that enables data and applications portability e.g. load balancing between clouds.

The figure below illustrates the public, private and hybrid cloud deployment examples.

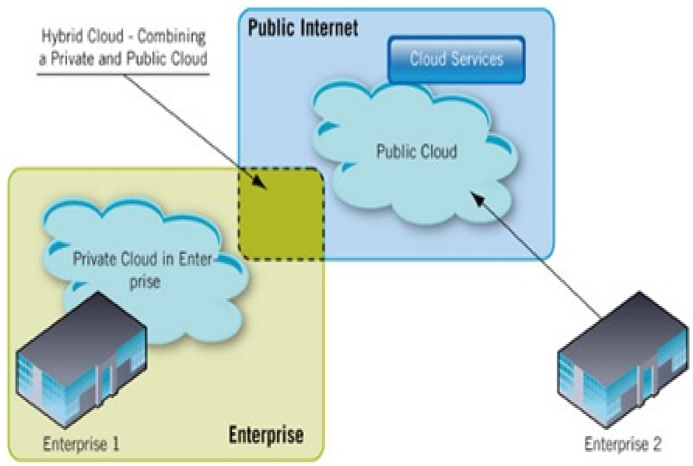

Fig. 4. The Public, Private and Hybrid Cloud Deployment

3.2.3 Features

High performance cloud capabilities include:

Virtualization: Virtualization is an important facet of the cloud, which is done by creating the virtual version of the device or resources such as server, storage device, networks and operating system. End users access the resources through the web browsers and get data from cloud computing providers. This framework divides the resources in one or more execution environments, virtual machines (VM's) are often installed in a server to improve the efficiency to use resources, such as VM's support load migration when there is server-overload.

Broad network access: Resources are available via the network and can be accessed by the multiple devices, including smartphones, tablets, laptops and desktops.

Reliability, Usability and Extensibility: Cloud computing provides the safe mode to store user's data and user's do not need to worry about the issues such as software updating, leak patching, virus attacks and data loss. The cloud computing systems transfers and backup the data to other machines in case of failure happens on a server or a virtual machine

Measured Services: Cloud systems automatically control and optimize the resource usage by controlling the metering capacity appropriate to the type of services. Such as storage, processing, bandwidth, networks etc. Resource usage can be monitored, controlled and reported providing transparency for both producer and consumer of utilized service.

Large Scale: In order to possess the capabilities of supercomputing and mass storage cloud can be extended from horizontal and vertical in a large-scale network to process diverse requests from thousands of nodes and host. A cloud computing system normally consists of thousands of servers and PC's. Google Cloud Computing, for example, has already controlled 2% of all services and 1 million servers located in two hundred different places in the world.

Autonomy: A cloud system is an automatic system, which automatically configures and allocates the resources of hardware, software and storage to clients on demand.

3.2.4 Challenges

Of course, cloud computing has many features but due to many characteristics it has effect on IT budget and effect on security and privacy issues, such as Data Security, Unauthorized secondary usage, Lack of user control, availability of the services, Data Lock in, Load balancing, scalability etc.

Cloud computing needs improved mechanism to provide safe and high efficiency service. In addition, due to data centers of resources using a mass of electricity, efficient resource scheduling strategy and methods are required in order to save energy. Last but not least, simple and convenient application interfaces are required for service providers; thus, a uniform standard is essential eagerly.

4. MOBILE CLOUD COMPUTING

In this modern era, the tasks for the mobile devices have extended beyond communicating and sending messages. Advancements have transformed the physique and software of mobile phones. In addition, these smartphones utilize the sensing technologies to facilitate the users. However, the bounded storage capabilities and limited computing are making the approach of users difficult to the sophisticated applications. This mobile cloud computing is a step of solution to such problem.

4.1 Principle of Mobile Cloud Computing

Mobile cloud computing integrates cloud computing and mobile computing in the presence of mobile internet. It is, obviously, an extension to cloud computing by providing cloud based services in mobile technology as well as an advancement in mobile computing by enhancing the processing and storage capacities of mobile devices. It has the same concept as cloud computing but client side of communication has been replaced by smartphones. These are only possible through wireless connections via web browsers on mobile phones. A user using a mobile, laptop or a smartphone, simply sends a request to a cloud via web browser. In response, the cloud management component helps in establishing a connection to the request.

4.2 Challenges and Solutions

The major aim of mobile cloud computing is to provide an easy, fast and convenient way to the users to communicate with the cloud by allowing them to use mobile devices via wireless networks. Some of the main factors affecting the mobile cloud computing include the limitations of mobile devices, network quality, nature of application etc. However, some the challenges that MCC is to face and their solutions are following:

4.2.1 Restrictions in mobile devices:

Mobile devices have various limitations in their storage capacities, processing speeds, resolution differences, nature of communication link etc. although they have been transformed into a smartphone. But in comparison with the home PC, their capabilities fall pale. One such issue is the battery drain in smartphones. Running the complicated applications require an improved battery technology in mobiles. So, a solution can be modeled in mobile computing i.e connecting a no of mobile devices to share and migrate data between them along with virtualization so that they can persist one of the challenges.

4.2.2 Communication links:

The wireless communication link between the mobile devices, being volatile link, face bandwidth inconsistency, discontinuous connection due to some weather reasons or network overlays. According to some estimates, the network latency delay for wireless connections may be 200 ms in a last mile while it is 50 ms in wired connections. Thus, they have a higher handover delay as compared to the wired communication links. Bandwidth upgrading can overcome the bandwidth issues.

4.2.3 Division of application services:

Keeping in view the limitations of mobile technology, some of the data bound and compute intensive tasks cannot be accomplished on mobiles. Due to which, they have to be distributed among the cloud and mobile. The core computing is to be done by the cloud while the remaining simpler tasks are handed over the mobile hosts. This causes issues in overall data processing in the data center and the device and thus, the handover delays. A standard solution for such a problem should provide an optimal elastic distribution of applications between the mobile and cloud with a throughput rate for fast data transmissions.

Table 1: Challenges for MCC corresponding to its solutions

Challenges	Optimal Solutions
Restrictions in mobile devices	Task sharing and Virtualization
Communication links	Upgrading Bandwidth
Division of application services	Elastic distribution of services

5. REFERENCES

1. Botran, T. L., Alonso, J. M., & Lozano, J. A. (2014). A Review of Auto-scaling Tecniques for Elastic Applications in Cloud Environments. *Journal of Grid Computing, 12(4). pp. 559-592*.

2. Canepa, G. H., & Lee, D. (2012). A virtual Cloud Computing Provider for Mobile Devices. *1st ACM workshop on Mobile cloud Computing & Services, Amsterdam.*

3. Chun, B., Ihm, S., Maniatis, P., Naik, M., & Patti, A. (2011). Clonecloud: Elastic execution between mobile device and cloud. *6th conferrance on computer systems, Salzburg, Austria.*

4. Coutinho, E. F., Sousa, F. R. D. C., Rego, P. A. L., Gomes, D. G., & Souza, J. N. D. (2015). Elasticity in cloud computing: a Survey. *annals of telecommunications, 70(7), pp. 289-309*.

5. Dilion, T., Wu, C., & Chang, E. (2010). Cloud Computing: Issues and Challenges. *Advanced Information Networking and Applications (AINA).*

6. Endo, P. T., Rodrigues, M., Goncalves, G. E., Kelner, J., Sadok, D. H., & Curesce, C. (2016). Hign Availability in Clouds: systematic review and ressearch challenges. *Journal of Cloud Computing Advances, Systems and Applications.*

7. Fonseca. N. L. S. D., & Boutaba, R. (2015). Cloud Architectures, Networks, Services, and Management. *Cloud Services, Networking and Management*.

8. Gupta, P., & Gupta, S. (2012). Mobile Cloud Computing: The Future of Cloud. 1(1), pp. 134-142.

9. Jennings, B., & Stadler, R. (2015). Resource Management in Clouds: Survey and ressearch challenges. *Journal of Network and Systems Management, 23(3), pp. 567-619*.

10. Leung, V. C. M.,Wen, Y., Chen, W., & Rong, C. (2013). Mobile Cloud Computing. pp. 11-13.

11. Luna, j., Ghani, H., Vateva, T., & Suri, N. (2011) . Quantiative assesment of Cloud Security level Agreements: A Case Study.

12. Lu, Y., Li, S., & Shen, S. (2011). Virtualized screen: A third element for cloud-mobile convergence. *Multimedia, IEEE, 18(2), pp. 4-11.*

13. Mohamaddiah, M. H., Abdullah, A., Subramaniam, S., & Hussin, M. (2014). A survey on resource allocation and monitoring in cloud computing. 4(1), pp. 31-38.

14. Padala, P., Hou, K., Shin, K. G., Zhu, X., Uysal, M., Wang, Z., Singhal, S., & Marchant, A. (2009). Automated control of multiple virtualized ressources. *EuroSys '09 proceedings of the 4 ACM Europen conference on Compter Systems, pp. 13-26, New York, USA.*

15. Pradhan, M. (2015). Cloud Computing in Smart Phone Technology. 3(1), pp. 308-318.

16. Puthal, D., Sahoo, B. P. S, Mishra, S., & Sawain, S. (2015). Cloud Computing Features, Issues, and Challenges: A big picture. *Computational Intelligence and Networks (CINE).*

17. Qi, H., & Ghani, A. (2014). Research on Mobile Cloud Computing: Review, Trend and Perspectives. 1(1), pp. 2-7.

18. Saggi, M. K., & Bhatia, A. S. (2015). A Review on Mobile Cloud Computing: Issues, Challenges and Solutions. *Internationol Jouranl of Advanced Research in Computer Science and Communication Engineering, 4(6), pp. 29-33.*

19. Singh, S., & Chana, I. (2016). QoS Aware autonomic resource management in cloud computing: a systematic review. *ACM Computing Surveys (CSUR), 48(3).*

20. Satyanarayanan, M., (1996). Fundamental Challenges in mobile computing. *5th Annual ACM symposium on Principles of distributed computing, India.*

21. Toeroe, M., &Tam, F. (2012). Service Availability: Principle and Practice.

22. Zhang, Q., Cheng, L., & Boutaba, R. (2010). Cloud Computing: State-of-the-art and rerssearch challenge. pp. 7-18.

23. Zhang, X., Kunjithapatham, A., Jeong, S., & Gibbs, S. (2011). Towords and elastic application model for augmenting the the computing capabilities of mobile devices with cloud computing: Mobile Networks and Applcations, 16(3), pp. 270-284.

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Comparative Study of Rheology of Heavy and Light Crude Oil for Pipeline Transmissibility

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Abstract: The Rheological property of heavy and light oil have been examined with using Rheo-Stress (RS-100).The properties of shear rate, temperature and oil focus lying on the viscosity of fluid has strong-minded. Therefore the rheological performance of mixture of heavy and light oil has been considered along with number experiments were showed [1]. Experiments were conducted by studying the effect of shear stress, shear rate, Yield stress and complex viscosity [2]. A large series of temperature was enclosed in this study to observe the result of temperature on the flow performance.
The experimental work has been performed in the department of Petroleum and Natural Gas MUET Jamshoro. It was observed through experimental work that viscosity of sample was decreased from 63.46 SUS to 35.51 SUS, when the concentrations of methanol and temperature conditions were increased i.e. methanol from 0.5% to 3% and temperature from 60℃ to 120℃ as mentioned above.

Key words: Rheolgy, heavy crude oil, effect of additives, viscosity and effect of temperature.

1. INTRODUCTION

Oil Transports have developed into very difficult with extremely scientific procedure. Main problem within pipeline be the transportation of highly thick fluid which needs well-organized and economical technique used for transmission of heavy oil. Study Rheological properties of heavy oil which help to determined finest way for decreasing viscosity of heavy oil.

1.1 LITERATURE REVIEW

Oil transmission has become very complex operation technically in petroleum industry the main problem in the pipeline transmissibility is the high viscous fluid which requires the powerful and prudent way to transfer the viscous fluids. Rheological properties identify the complexity of heavy crude and flow behavior for transmission to long distance in Pakistan the industry of oil and gas has developed [3] since 1947.When the produced hydrocarbon were in the scarce there was no production of gas after the 50 years passed the hydrocarbons played the vital role in the growth of many gas discoveries these are the sources by which the supply of the gas consumption from cores over 9,843 km program networks and 71,863 km of spreading method. Pakistan is economically good in energy sources containing coal, oil, hydropower & natural gas the recent supply of vitality per year of Pakistan is 65.02 million tons of oil [4]. The requirement of these natural gas & hydrocarbons are about 78% the development of oil and gas was introduced in September 1961 the group of company joints a local stock exchange as (XYZ SINDH FIELD). The initial successive well of the (XYZ SINDH FIELD) was the discovery of the small gas at (Sindh, 1965).

1.2 HEAVY CRUDE OIL (HIGH VISCOUS)

The high viscous fluid has the gravity less than the 20°API or the oil having the high viscosity and cannot flow easily from producing wells under normal reservoir condition [5]. It is known as "heavy crude oil' because of its solidity or thickness is greater than that of light crude oil it can be defined as liquid having the API gravity less than 20° [6]. Physical properties are different between heavy crude oil and light crude oil which include higher grades of Viscosity and specific gravity and also the composition of thicker molecular. It was cleared in 2010 that the oil having the API gravity of 10° is named as the heavy crude oil or high viscous fluid [7]. “The rheological properties play very vital role in term of flow transmissibility and behaviors [8].The main aim in heavy oil is not to find resources but to recover, to produce, and sell heavy crudes to change the economic guidelines. Heavy oil resources have the energy to generate many years of steady cash flow.

1.3 VISCOSITY

Viscosity is the measurement of the flow properties of the oil-material [9]. Crude oils are the fluids that make change in the hardness through the construction, departure, moving and purifying of oil [10]. The various techniques are used for the redact ion of the viscosity of the heavy crude oil arrange a method to make it possible for path by pipeline. For instance the mixture with light crude oil or spirits, temperature also the usage of surfactants, mixtures remain specific of the shared techniques [11] [12] formation emulsion is also the method which transports the high viscous fluid. In such a technique the thick oil is incomplete as micro spheres oil used now in an aquatic in nonstop stage through the practice of surfactants and cleaners establishing an oil-in-water (0/W) mixture and therefore succeeding a decrease in thickness [13]. Some intentions which are connecting to the measurements of liquid that need the importance of viscosity. This limit that is essential for the situations which are reaching from the opening shallow assembly organizations toward the reservoir. Relationship on behalf of control of viscosity be able toward remain predictable on the way to estimate viscosity aimed on temperature reaching from 35°F to 300°F. Reducing viscosity of heavy oil was investigated with mixture of heavy and light crude oil also oil viscosity is just about 0.300 Pa s. The performance of the viscosity after mixing the oil samples mixing fusion performs in the same way like so as to use meant for heavy simple oil.

1.4 EFFECT OF ADDITIVES

The discovery relates to decrease viscosity of heavy crude oil mainly to an additive biodegradation of crude oil decrease crude oil value. The consequential enhancement of heavy polar machinery lead to increase the specific gravity, viscosity, acidity and substance of sulfurs, asphaltenes and vanadium or nickel metals that makes it complex to transportation of extra heavy crude oil through pipeline [14]. The effect of various solvent concentrations of toluene, methanol, xylenes and reformate on viscosity of heavy crude oil at various temperature conditions. The viscosity of the crude oil will decrease as the solvent concentration is increased. Viscosity of heavy crude oil can be reduced up to 21.7 cst from 51.6 cst at 110°C with toluene, whereas with xyelenes, methanol and reformate the viscosity reduces 21.1, 27.5 and 24.4 cst at 40°C.

1.5 EFFECT OF TEMPERATURE

The formula discovered by Walther for viscosity and temperature that was suggested for correlation connecting to viscosity and temperature through ASTM [15] and is named as ASTM model given as below,

$$\log \log (\mu + 0.7) = \alpha + b \log T \qquad (1)$$

Where α and b are constant, T is Fahrenheit temperature, viscosity of heavy oil will reduce as the temperature increased viscosity and temperature are mostly dependable with ASTM model. Temperature has a well-built effect on viscosity of heavy crude oil the effect of temperature on heavy crude oil shows the stream performance of heavy crude oil on the expressions of viscosity shear rate correlation [16]. Crude oil determines the non-Newtonian shear thinning performance larger than the variety of shear rates from 70 to 700 s^{-1} where the apparent viscosity also reduces significantly as temperature is increased. Viscosity changes were better by short shear rates than at high shear rates.

1.6 RESEARCH WORK

The experimental work has been finished in which the crude oil sample was collected from the SINDH and research was done in IPNGE laboratory of MUET JAMSHORO.

The required material for research work is given as under;

- Heavy crude oil with specific gravity.
- Light crude oil with specific gravity.
- Viscosity reducing agent such as methanol.

1.7 RESULTS

Rheological properties of heavy crude oil were prepared by mixing 30% of light crude in order to estimate its flow ability and its behavior. For this reason its sweet ability should be analyzed through hydrometer (84 H) were used to measure °API gravity as depicted in table 1.

Table 1. API and specific gravity of mixed fluid

Specific gravity	0.781
API gravity	49.5

Viscosity of heavy oil can be reduced by mixing light crude with heavy crude oil, the viscosity of oil is just 0.300 pa s. as the 30% of light oil is mixed with heavy oil the viscosity of heavy crude oil reduces from 10.0 to 1.2 pa s whereas as the 40% of light is mixed with heavy oil and it leads high reduction of the viscosity from 10.0 to 0.375pa s.

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1.8 VISCOSITY MEASUREMENT

The viscosity of light crude oil was calculated at different temperature conditions such as from 30℃ to 65℃ as shown in table 2 by using the equipment say bolt viscometer.

Table 2. Viscosity of light crude oil at different temperature conditions

Temperature in ℃	Viscosity in SUS
30	35.44
35	33.24
45	32.90
55	32.60
65	32.40

It is clear noted that light crude oil is very much sensitive at temperature condition as increase the temperature the reduction in viscosity as shown in table 2 from 35.44 SUS to reduce at 32.40 SUS at temperature from 30℃ to 65℃.

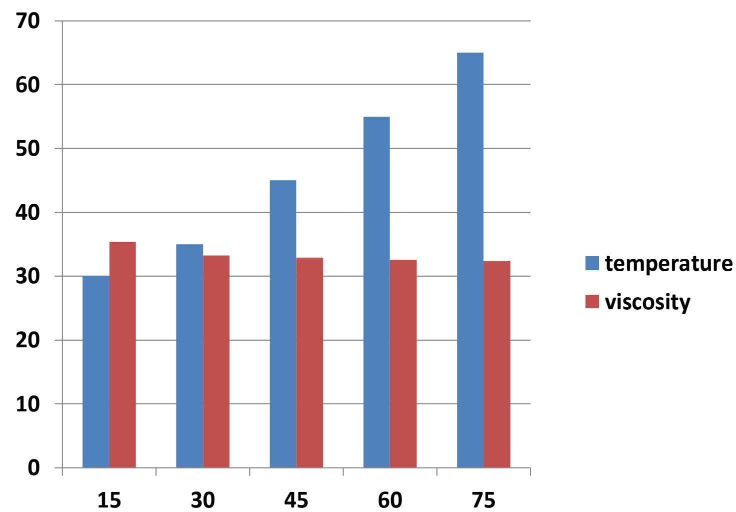

Figure 1. X-axis viscosity & Y-axis temperature

2. VISCOSITY OF HEAVY CRUDE OIL

Heavy crude oil cannot flow easily through pipeline due to its high viscosity it has high density and specific gravity is higher than light oil the API gravity less than 20°. The flow behavior is quite different because of its composition and molecular structure. The viscosity of heavy crude oil was measured at different temperature conditions $60^{\circ}C$ to $120^{\circ}C$ by using the equipment say bolt viscometer as shown in figure 2 in which the viscosity of heavy crude oil was reduced from 91 SUS to 18 SUS as shown in the table 3. In this condition temperature reduce internal friction of the particles to decrease its rigidity. At $30^{\circ}C$ the viscosity was measure 35.44 SUS, before it was 91 SUS, it is observed that crude particles will dispersed when temperature will effect, as temperature increases more viscosity reduce due to more spacing between the crude particles.

Figure 2. Say bolt viscometer

Table 3. Viscosity of heavy crude oil

Temperature in °C	Viscosity in SUS
60	91
80	44
100	26
120	18

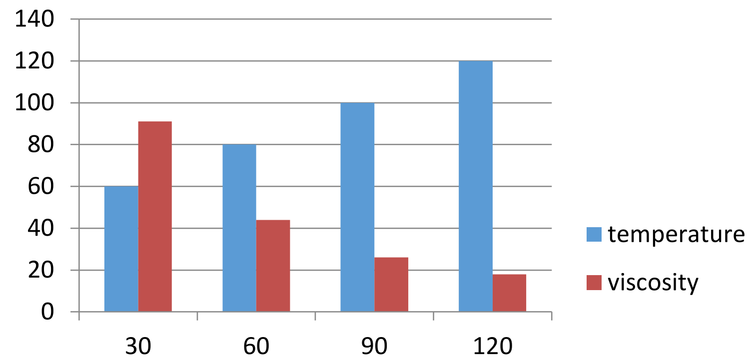

Figure 3. X-axis viscosity & y-axis temperature

2.1 EFFECT OF METHANOL AND TEMPERATURE ON HEAVY CRUDE

Methanol used as a viscosity reducing agent and certain percentage and concentration, in this scheme of methanol percentage from (0.5, 1, 1.5, 2, 2.5 and 3%) were used for experiments at different temperature conditions.

2.1.1 EFFECT OF METHANOL AT 60℃

With addition of methanol into heavy crude oil 0.5%vol was added in crude the outcome of viscosity 63.46 SUS from 91 SUS, in this condition it is observed that reduce internal resistance of heavy crude by the addition of additive to work as reducing agent of heavy and complex chain of crude, at above given temperature condition thus agent mix properly with crude to reduce rigidity and closeness to decrease viscosity, as observed the variation of fluid viscosity decreasing from 63.46sus to 48.5sus with increasing the concentration of methanol from 0.5 to 3 % as mentioned in table 4.

Table 4. Reduction of viscosity by addition of methanol

Methanol in %	Viscosity in SUS
0.5	63.46
1	58.23
1.5	54.70
2	52.25
2.5	50.38
3	48.5

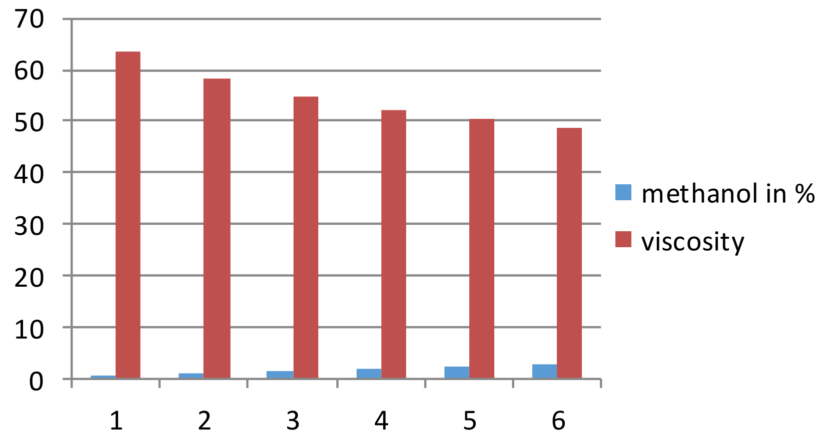

figure 4. x-axix methanol & y-axis viscosity

2.1.2 EFFECT OF METHANOL AT 80℃

In this condition mixing the 0.5% of methanol into heavy oil and obtain the viscosity 63.13 SUS. The additive concentration increasing from 0.5%vol to 3%vol viscosity reduced to 40.70 SUS were minimum value and at more concentration of additive 3%vol of methanol and high value were observed at 63.13 SUS at 0.5%vol methanol. It is observed that the effect of temperature and methanol reduce the viscosity, further more increasing internal spacing of structure, to increase flow behavior, the methanol acts as reducing agent and further more temperature also playing important role in this scenario for reducing viscosity as trend is declining viscosity by increasing the additive concentration, at temperature condition of 80℃ as shown in table 5.

Table 5. Reduction of viscosity by addition of methanol

Methanol in %	Viscosity in SUS
0.5	63.13
1	57.10
1.5	46.30
2	44.88
2.5	42.90
3	40.70

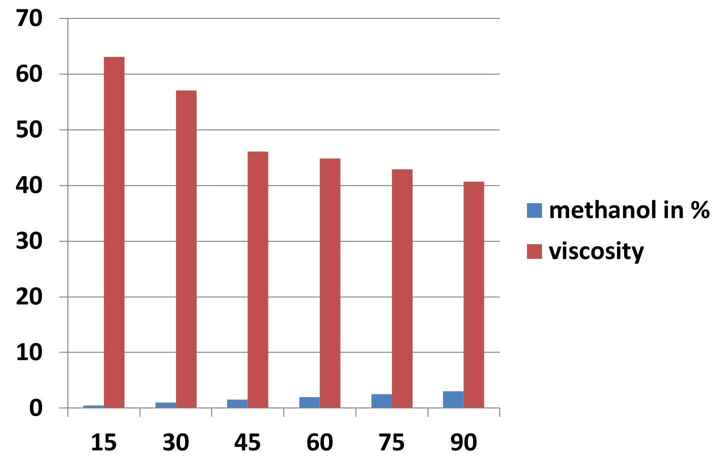

Figure 5. X-axis methanol & y-axis viscosity

2.1.3 EFFECT OF METHANOL AT 100℃

Considering the temperature of **100℃**, mixing 0.5% methanol to increase the concentration of methanol from 0.5%vol to 3%vol and observed as reduction in viscosity of heavy crude from minimum 38.41 SUS at 3%vol and maximum were observed 51.68 SUS at 0.5%vol concentration of methanol. It shows the effect of methanol and reduces viscosity and it reduces to 38.41 SUS by increasing the concentration of methanol up to 3%vol of methanol at temperature at 100℃, in such condition temperature and additive highly effect its rigidity to decrease viscosity, as mentioned in table 6.

Table 6. Reduction of viscosity by addition of methanol

Methanol in %	Viscosity in SUS
0.5	51.68
1	49.1
1.5	46.35
2	44.21
2.5	41.27
3	38.41

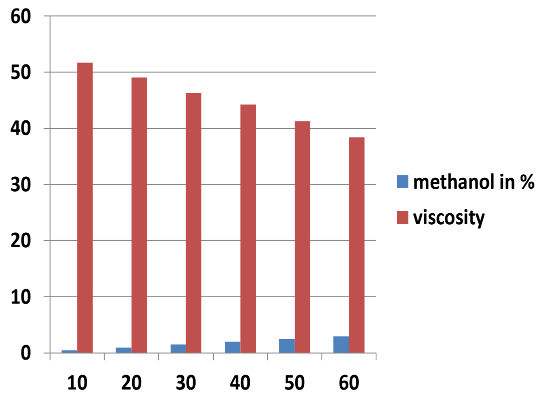

Figure 6. X-axis methanol & y-axis viscosity

2.1.4 EFFECT OF METHANOL AT 120℃:

In this condition at temperature 120℃ abating viscosity value were achieved 35.51 SUS at the additive concentration of 3%, and maximum value were achieved 47.86 SUS at 0.5% methanol, further more with increasing of concentration of methanol by reducing the viscosity at temperature 120℃, as mentioned in table 7.

Table 7. Reduction of viscosity by addition of methanol

Methanol in %	Viscosity in SUS
0.5	47.86
1	44.07
1.5	41.33
2	39.29
2.5	37.70
3	35.51

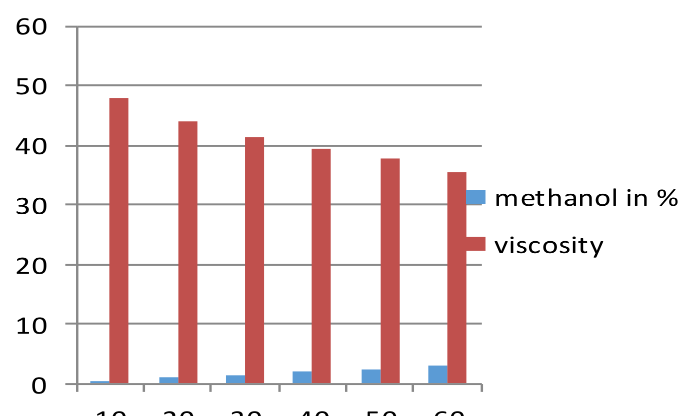

figure 7: x-axis methanol & y-axis viscosity

3. REFERENCES

1. Aske N., K. H. (2001). Determination of Saturate, Aromatic, Resin and Asphaltenic (Sara)Components in Crude Oils by Means of Infrared and Near-infrared Spectroscopy.*Energy and Fuels vol.15 issue.5*, 1304-1312.
2. Christophe Dicharry, David Arla, Anne Sinquin, Alain Gracia, Pattrick Bouriat. (2006), "stability of water/oil emulsions based on interfacial dilatational rheology," Journal of colloid and Interface Science, 297(2), 785-791.
3. Dusseault, M.B. (12-14 June 2001). Comparing Venezuelan and Canadian Heavy Oil and Tar sands (PDF) Calgary, Canada: Canadian International Petroleum Conference. Retrieved 5 May 2008.
4. Johnsen E.E and Ronningsen H.P., Viscosity of live water-in-crude-oil emulsions:experimental work and validation of correlation. Journal of petroleum science and Engineering, (2003), 23-36.
5. Langevin D., Poteau s., Henaut l. and Argillier J.F., Crude oil emulsion properties and their application to heavy oil transportation., Oil and Gas Science and technology-rev. IFP , (2004), 59 (5), 511-521.
6. Langevin D., Poteau s., Henaut l. and Argillier J.F., Crude oil emulsion properties and their application to heavy oil transportation., Oil and Gas Science and technology-rev. IFP , (2004), 59 (5), 511-521.
7. Mai:j. Bryan: N. Goodarzi: A. Kantas (2006). Insights into Non-Thermal Recovery of Heavy Oil. World Heavy Oil conference (WHOC) (2006-553). Alberta.
8. The ocular Vitreous humor is subject to rheologic observations, particularly during studies of age-related vitreous liquefaction, or synaeresis. *Baskurt OK, Meiselman HJ; Meiselman (2003). "Blood rheology and hemodynamics". Seminars in Thrombosis and Haemostasis* ***29*** *(5): 435–450. doi:10.1055/s-2003-44551. PMID 14631543.*
9. Nikolaev L.K., Nikolaev B.L., "EXPERIMENTAL STUDY OF RHEOLOGICAL CHARACTERISTICS OF MELTED CHEESE «MILK»", Processes and equipment for food production, Number 4(18), 2013.
10. Paso, K., Kompalla, T., Oschmann, H.J., Sjoblom, J. (2009), "Rheological degradation of model wax-oil gels", *J. Dispersion Sci. Tech.,* **30,** 472-480.
11. Pedersen, K.S, Ronningsen, H.P. (2000), "Effect of precipitated wax on viscosity – a model for predicting non-Newtonian viscosity of crude oils", *Energy and Fuels*, **14,** 43-51.
12. Schulmberger. (2014). *Plastic Viscosity*. Retrieved from Schulmberger official site: http://www.glossary.oilfield.slb.com
13. Schuller, R.B., Tande, M., Amundsen, L.(2010), "Experimental determination of time dependent yield properties", *Annual Transaction Nordic Rheol. Soc.,* ***18,*** *25-29.*
14. The ocular Vitreous humor is subject to rheologic observations, particularly during studies of age-related vitreous liquefaction, or synaeresis. *Baskurt OK, Meiselman HJ; Meiselman (2003). "Blood rheology and hemodynamics". Seminars in Thrombosis and Haemostasis* ***29*** *(5): 435–450. doi:10.1055/s-2003-44551. PMID 14631543.*
15. Yu y, Li K. Method for calculating temperature profile in heavy oil wells with injection of light oil diluent. J Pet Sci Technol: 2012, accepted for publication.
16. Zhilin, Y ., Sannaes, B.H., Johnson, G.W., Sjovoll, M., Schulkes, R. (2012), "OIL/WATER flow experiments with a real, viscous crude: The influence of ESP and flow behavior", *OTC* paper 22988, *Offshore tech. conf.,* Houston, US.

SOLAR AND EXERCISING MECHANISM FOR WASHING CLOTHES

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Abstract

Washing machine is a very good solution for time consuming, tedious and unhealthy washing. In the developing countries, washing laundry is a difficult and time-consuming task. Several researchers have worked on washing machines and tried their best to modify these machines which will be independent of electricity and will be easy to operate with minimum cost. So they developed washing machines which have bicycle like mechanism. All these projects have their own advantages. However, in some machines the rotating cylinders were damaging the clothes while in others, the power produced was not up to the required mark. To get high power and smooth wash, washing machine was designed by us which has bevel gears operation after rear sprocket revolutions**.** Solar and exercising mechanism for washing clothes has been developed by us. Main goal was to devise more than one mechanism for washing in this project which would remove deficiencies of machines which are operated by electricity as well as pedal powered and would focus on the health care of females. Solar and exercising mechanism for washing clothes generates up to maximum 110 watt through padaling and provides a smooth wash in less time.

Keywords: Washing Machine, Solar Mechanism, Exercising Mechanism, Power, Bevel Gears**.**

1. Introduction

Washing machine is a very good solution for time consuming, tedious and unhealthy washing. In the developing countries, washing laundry is a difficult, time-consuming task that falls only on women. Individuals typically spend eight hours each week in washing each piece of clothing and remove the harsh washing solution by hand. Powered washing machines exist. However, they are not in use in rural areas because running water and electricity are very expensive or unavailable.

Remya was the first girl who designed a washing machine which is run by peddles (Gupta 2007). The design was so much simple and consists of an aluminum cabin in which there is a horizontal cylinder made of iron net wire. The cylinder is connected to a pedaling system which consists of a cycle chain, pedal and a seat. In appearance it looks like a gym exercise cycle usually seen in gym centers which is connected to a cabin. Clothes are put in the cylinder and the cabin is filled with water to the level of clothes, washing powder is added and left to soak for at least ten minutes. Then pedal for three to four minutes. The cylinder rotates at a very high speed with the clothes inside, washing them thoroughly. Soap water comes out through an outlet, the tank is refilled and the process repeated. By pedaling, the washed clothes are rotated and are washed.

Although this project was good enough. However, the possibility of main deficiency in Remya's project was that rotating cylinder may damage the clothes and the washing was not as smooth as it can be seen in this project that the cleaning process is highly smooth and good enough.

Adarsh Ranjan designed a pedal powered washing machine which has a similarity with my project(Ranjan, Sharan et al.). However, difference is that rotor of the tub of his machine was connected to the belts and in my case it is connected to the gears which produce more power and the jerks of the gear drive are also eliminated. Ajay designed and fabricated manually driven pedal powered washing machine which produce maximum of 100 watt and in this project it even produce more power than 100 watt(Ajay and Choudhary).

Neel K Rude fabricated a simple washing machine. However, there was no clear idea that how much power will be produced through peddling system(Rude, Ruikar et al.). Gaurang Bhatawadekar designed pedal washing machine. However, there was no clear calculation of power which is needed to run the machine smoothly and efficiently(Bhatawadekar, Salman et al.). Biciliwadora with the help of “maya pedals” generated 50-75 watts for washing clothes which is not very much enough like this project which produces upto 110 watt(Leary 2010).

Further research work can be studied in literature like in (1956, Pakula and Stamminger 2010, Megalingam, Veliyara et al. 2012, Pitale and HatwalneNovember 2012, Singh, Singh et al. 2015) but in one way or the other all these research work have some deficiencies.

To remove these deficiencies we designed a washing machine which has bevel gears operation after rear sprocket revolutions**.** This project has got both exercising and solar mechanisms which are independent of electricity.

2. Methodology

2.1. Working

After several changes we came to know that we can make the design better and simple. So at last we were able to make final design of the project. It is given below.

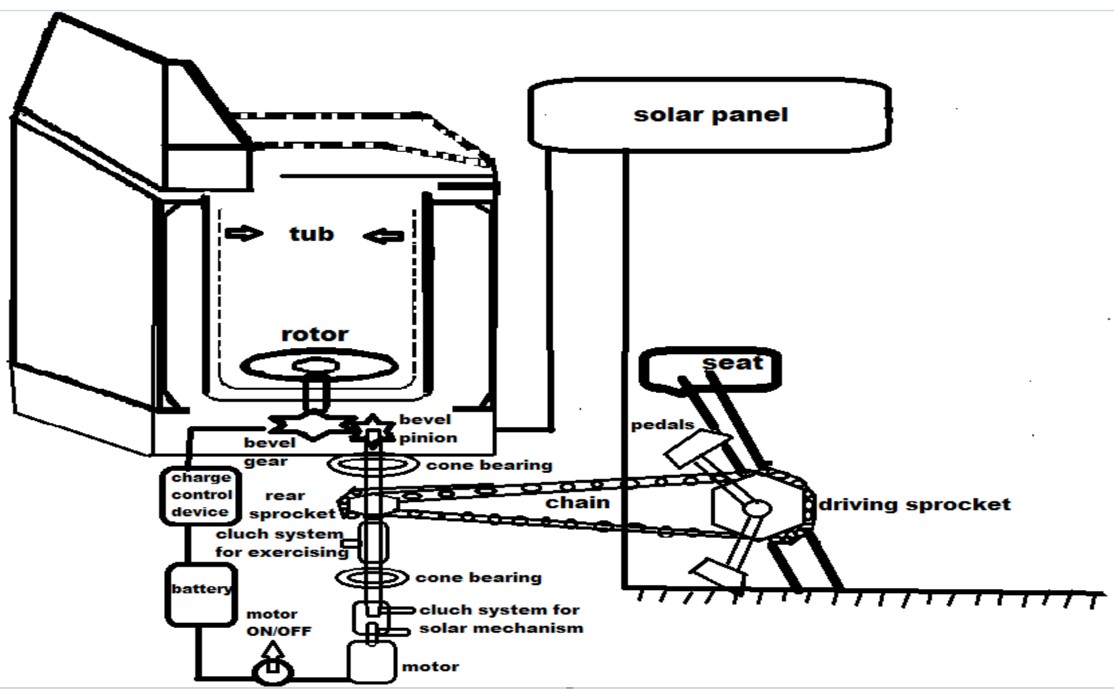

Figure 1. Final drawing of the project

Figure 2. Final design of the project

The user will start the pedaling/exercising and driving (main) sprocket will drive the rear sprocket mounted on the main shaft inserted into the right side of the washing machine. Bevel gears would transform the power to the rotors shaft and ultimately the rotor would receive the power and will perform the washing. The user also can do shoulder exercising for washing the clothes.

Simply one should sit on the comfortable seat and start the shoulder exercising through available moving handles in front of the user. Once you started this, your legs on the pedals will automatically move without any force applied by legs on the pedals and thus the rotor would get the required power for washing clothes.

Energy from the Sun can be utilized by the solar mechanism using a solar panel, following charge controller, battery, motor and consequently driving the main shaft and again the bevel gears will transform the power to the rotor for washing clothes. Here also the ultimate aim of spinning the washing rotor can be achieved.

Although we designed a best mechanical design but the biggest problem we faced in this design was the small diameter of the shaft because for measuring torque the dynamometer shaft was relatively more in dia. So for that purpose we made a flexible shaft in our university workshop for measuring torque easily and accurately. We can then find the rotor torque by using the gear ratio value. The torque value proved to us that this mechanism can be used for efficient cleaning.

To understand the basic physics of this project here are some terms defined.

2.2. Torque

Torque is a measure of the turning force on an object such as a bolt or a shaft. For example, pulling or pushing the handle of a wrench which is connected to a bolt or a nut produces a torque (turning force) that loosens or tightens the bolt or nut. The magnitude of torque depends on three quantities: the force which will be applied, length of the lever arm connecting the axis to the point of force application, and the angle between the force vector and the lever arm. In symbols:

$$\tau = r \times F$$

$$\tau = r \times F\sin\Theta \tag{1}$$

Length of the lever arm is particularly important; choosing this length appropriately lies behind the operation of levers, pulleys, gears, and many other.

2.3. rpm

Revolutions per minute (abbreviated rpm, RPM, rev/min, r/min, or $r \cdot min^{-1}$) is taken as a measure of the frequency of a rotation. It is generally used as a measure of rotational speed of a mechanical tool or component.

2.4. Power

Basically power is equivalent to energy amount which is consumed per unit time. We calculated the power which it generates by pedalling. It generated up to 110 watt from pedalling.

Formula for getting power in watt is below.

$$P=2\pi/60*N*T \tag{2}$$

Table 1.Parts used in project

Parts	Quantity
1) Bevel Gears	2
2) Exercising System	1
3) Solar Panel	1
4) Shafts	3
5) Chains	1
6) Tub	1
7) Charge Controller	1
8) Motor	1
9) Battery	1
10) Cone Bearings	2
11) Socket with key mechanisms	2
12) Metal Stands	4

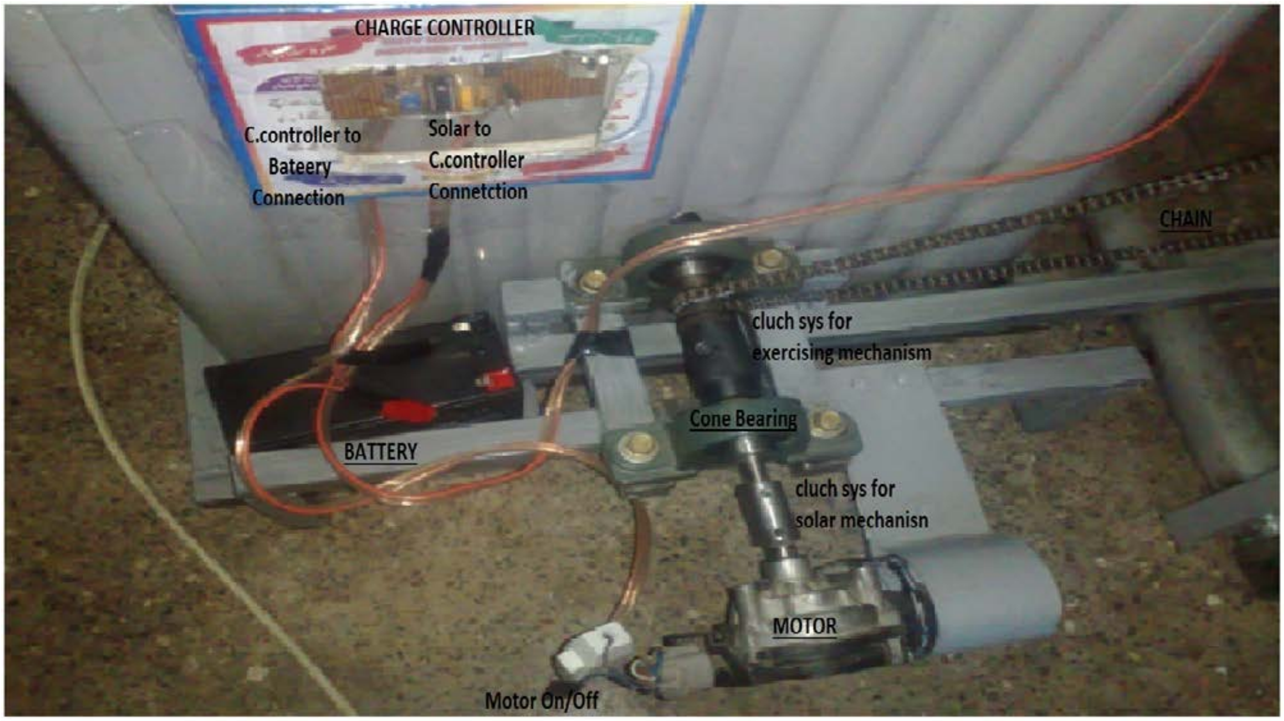

Figure 3. Final assembly of the main shaft

3. Results and discussion

In this phase we used two instruments known as techometer and dynamometer for calculating the power generated through pedaling. Through tachometer we did rpm test and through dynamometer we conducted torque test.

3.1. rpm test

Figure 4. rpm test

For measuring rpm of our rotor we used a device known as digital techometer. Using a digital techometer for measuring rpm is an easy job. Just attach the pointed end of tachometer with revolving shaft or rotor and press the side button continuously for taking the rpm readings on different speeds of pedaling.

3.2. Torque test

Figure 5. Torque testing

For using the dynamometer we had to connect and align both the rotor shaft and measuring instrument i.e. dynamometer shaft. For that purpose we made a flexible shaft in workshop, which connected rotor shaft with the apparatus shaft. Alignment was done by a table and set of wooden straps available in that lab. After setting all this, we took different readings of torque at different rpm. The software which we used for measuring torque was Dynomax, we recorded that readings and are given in the table below.

Table 2. Final readings of exercising mechanism

Reading	ROTOR TORQUE (Nm)	ROTOR RPM	Power (watt)
1	2.81	305	90
2	2.98	320	100
3	1.91	550	110

Note that the torque values we got in the table has been multiplied with 1.6 before inserting them into the table because we found the torque of the main shaft during testing via dynamometer and for finding the rotor shaft torque we multiplied the readings of the main shaft with 1.6 because we were using bevel gears of the gear ratio 1.6 .

Now to calculate the power of the rotor we just put the values of different rpm with the corresponding torques values in the formulae:

3.3. Power (watt)

Power =rpm*torque*2*3.14/60

We got the power value round about 90 watt upto 110 watt.

So the power that we got from the rotor is enough for a smooth and healthy wash. In testing we also noted the timings of the washing as for washing machine this is the clear indicator of performance. We filled the tub from water in a typical way. We used the detergent and recorded the timing of a good wash, which was 10-15 minutes for 4 number of clothes.

3.4. Solar test

Solar panel is of 100 watt, charge controller 40 amp, 12 volt battery, 4 amp motor and consequently the motor drives the main shaft provided that the exercising mechanism is disengaged using clutch system via keys.

Timing of solar mechanism depends greatly on what watt of solar panel we are using, what ampere of battery and motor we are using for this mechanism. During solar wash test , on a sunny day we recorded that our project battery took almost 5-7 hour to charge fully. On a normal day it took 7-9 hour because 40amp battery is a high capacity battery. Motor was capable of smoothly rotating the rotor for 30-60 minutes. We can increase the amp of battery for more timing and similarly we can increase the wattage of solar pannel for taking less time to fully charged the same battery.

4. Conclusions

Following results can be concluded from this project:

1. 90 degree power transformation can easily be done through bevel gears and spur bevel gears produces less noise as compared to straight tooth bevel gears.
2. Strength of spur bevel gears for the same power generation is greater than straight tooth bevel gears.
3. Up to 110 watts can be generated easily through paddling mechanism.
4. Exercising mechanism converts the boring washing into a joyful wash.
5. Thinking of having a slim body motivated many users/females for washing.
6. Solar system can be used for washing clothes very easily by using panel, charge controller, battery and motor provided having the further bevel gears mechanism.
7. Smaller diameter rear sprocket having less number of teeth increases our main shaft rpm, some of which can be easily converted into torque by using bevel gears of 1.6 or some gear ratio.
8. Washing can also be made possible by doing shoulder exercise.
9. Common washer-men just have to use bevel gears between their cycles rear wheel shaft and rotor shaft to achieve washing without electricity.
10. Charge controller prevented the battery from overcharging.

References

(1956). Drive mechanism for clothes washing machine and the like, Google Patents.

Ajay, R. and S. K. Choudhary "Design & Fabrication of Manually Driven Pedal Powered Washing Machine."

Bhatawadekar, G., B. Salman, N. Chiplunkar, S. Devrukhakar and S. Akashdeep "Design and Fabrication of Pedal Powered Washing Machine."

Gupta, A. K. (2007). "Conundrum of Creativity, compensation, conservation in India: How can intellectual property rights help grassroots innovators and traditional knowledge holders?" Biodiversity and the Law: Intellectual Property, Biotechnology and Traditional Knowledge.

Leary, J. (2010). Putting Research into Practice: From a Steel City Drawing Board to the Heart of the Maya. The University of Sheffield-EWB-UK National Research Conference.

Megalingam, R. K., P. S. Veliyara, R. M. Prabhu and R. Katoch (2012). "Pedal Power Generation." International Journal of Applied Engineering Research **7**(11): 2012.
Pakula, C. and R. Stamminger (2010). "Electricity and water consumption for laundry washing by washing machine worldwide." Energy Efficiency **3**(4): 365-382.
Pitale, A. and P. HatwalneNovember (2012). "A Review on-Flywheel Motor." International Journal of Engineering Science and Innovative Technology (IJESIT) Volume **1**.
Ranjan, A., K. Sharan and S. Mazumdar "Pedal Powered Washing Machine (PPWM)."
Rude, N. K., A. A. Ruikar and T. S. Mithare "HUMAN POWERED WASHING MACHINE."
Singh, S. K., D. P. Singh and A. S. Gaur (2015). "Pedal Powered Washing Machine (PPWM)."

A CASE STUDY OF OVERRUNS OF A COAL POWER PLANT PROJECT AND ITS CAUSE ANALYSIS USING EARNED VALUE MANAGEMENT

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Abstract: The purpose of this study is to analyze the overruns in term of cost and schedule of coal power plant project carried out by Descon Engineering Ltd, Karachi. For the case study, we obtained data from the progress reports of contractor, through performed surveys and interviews of project team. Earned value management (EVM) tool is mainly used for the analysis of the project data. In addition, the critical factors of delays are identified in order to analyze the reasons to formulate the necessary recommendations to overcome it in future. The study shows that scheduled performance index (SPI) is 0.86 which means that 14% extra time wasted during the project. The CPI of the project was 0.67 which shows 33% of total budgeted amount has been wasted during the project execution. It was also found that the greatest reasons for the delay in the project was unavailability of materials, bottleneck in civil section, extensive revisions in design of substructures, and lack of skilled man power. At the end some recommendations for the contractor have been suggested to avoid overruns in future projects.
Keywords: Earned value management, delays, Schedule performance index, and Cost performance index.

1. INTRODUCTION

Project overruns result into very harsh consequences both for the owner and the contractor. The contractor and the owner pays extra charges for the completion due to delay in large projects. When the completion time of the project exceeds the agreed completion time, it is known as project delay (International journal of project management).The world wide trends in project performances shows that 65% of the projects having cost more than 01 billion USD fail to achieve its objectives. Similarly, 35% of the projects having cost less than 1 million USD lead to failure in getting the set objectives. The study shows that 25% projects suffer from over budget while 50% of them suffer from over schedule [1].

The history of trends in project over runs show that it has been a very common problem for project managers. J.l. Narayan observed in his study that infrastructures projects in India undergone some extensive changes in the trends of cost overruns in the period from 1991 to 2010. He find out that cost overrun in projects with respect to the original approved cost have come down from 62% in March, 1991 to 12% in March, 2008 and then increased to 21% in September 2010 [2].
He further indicated that time overruns in terms of percentage of projects running behind their original schedule show a mixed trend during his period of study. He showed that percentage of projects behind schedule declined from 62% in 1991 to lowest ever 31.72% in March 2001, it then increased up to 34.13% in March 2007 and continued up to 52.10% in September 2010 [2].
There are numerous causes of overruns in projects. The causes of project delays fluctuate according to and due to the faults and weaknesses of the owners and the contractors. It is needed to conduct detailed investigation and identification of delay factors and then selecting the right actions to counter them [3].
In Pakistan the various causes for delay in projects identified in previous studies are mainly due to late payment of bills, possible changes to design, unclear perception of demands, inefficient property time decision, previous working relationships, and missing details in drawing [4].
Aedwin Regi Varghese1 and Shibi Varghese classified the delay reason on the basis of their relation to the contractor, owner, consultant, labor and equipment. He further enlisted the External factors for the delays. The Contractor related delays were identified to be occurred mostly due to the late payments. They also occur due to poor site management, supervision and reworks. Owner related delays frequently occur due to the slow decision making from owner side .Labor & equipment related delays were identified to be occurred due to Shortage of materials, low productivity level of labors and delay in obtaining

permits. External Factors can be identified mostly as delays in commissioning [5]. To identify delays in project at different point of time, different tools are being used. One of the project management tools, Earned value management (EVM), is used to evaluate the project. EVM is a project control methodology that originated in the 1960s at the US Department of Defense. EVM aggregates the progress of individual activities to a higher level of the work breakdown structure (WBS) and provides the project manager with an indication of the overall health of the project. Because of the aggregation of information at a low level to a higher level of the WBS structure, EVM is known as a top-down control method [6].

EVM is based on three basic variables: Planned Value (PV), Actual Cost (AC), and Earned Value (EV). From the basic variables, four indexes are defined; Cost Variance (CV = EV-AC), Schedule Variance (SV = EV-PV), Cost Performance Index (CPI = EV / AC), and Schedule Performance Index (SPI = EV /PV). Whenever CV<0 and CPI<1, it shows that the project is over cost. Similarly, if SV<0 and SPI<1, then the project is delayed. Positive values of SV and CV mean the project is in advance from plan and under budget respectively [7].

According to (PMBOK® Guide) Third Edition, the Earned Value Method (EVM) is recommended as the global standard for project performance measurement. It integrates scope, cost, and schedule measures. It could give good picture of current project status at the date of control. The concept of implementation the EVM into the cost control and even to overall performance measurement of construction projects have been presented by many authors. [8, 9, 10, 11].

In a nutshell, we say that EVM is an effective tool to analyze the project status and the first step towards the recognition of the facts which are involved in bringing the project out of track and setting up the remedies for them in order to ensure a uniform project flow.

The case study is an implementation of EVM tool on a project of Descon Engineering limited. The study has been organized in separate sections to recognize and highlight the issues and statistics related to delays and over cost. We started with the introduction of problems with a thorough literature review. This is followed by describing the data and the tools used for data analysis. Then we provided the results and discussed in detail with possible reasons and solution in the recommendation section. In the last section, we concluded our study after putting recommendations for the contractors, owner, industrialists and researchers etc.

2. METHODOLOGY

2.1 METHODS OF DATA COLLECTION

We obtained data from Descon Engineering Ltd for the period of January 2015 to August 2016. The project was started at January 2015 and was planned to be completed till August 2016. The data was collected in the form of monthly reports, through our own surveys and interviews with the concerned Expertise of different departments of the organization. The main source of our data are company monthly progress reports. The company's reports indicated the performance and effectiveness of the project. The reports also portray the progress of the project, delay time if there is any, detail information about the reasons for delay in the project, and future forecasted and updated plan for the project. We also collected data from 25 employees, working in various departments of the organization on various positions, through specified surveys forms. Our survey was to identify severe reasons due to which maximum number of activities affected. The survey further covered the information regarding cost based severe activities. The survey also had two open ended questions to get suggestions from the participants about the overruns in the project and for suggesting the alternate strategy, through which we can avoid the overruns in future project. We also conducted interviews with the concerned authorities of the three core department's i.e. Civil, Mechanical and Electrical departments to identify delay reasons.

In the desired project the study of the reports for the month of April, 2016 and August, 2016 were the main focus. Both reports of April, 2016 and August, 2016 provided data from the very start of the project to the latest possible date of the last months; March 31, 2016 and July 31, 2016 respectively. The reports show the overall progress of the project and the progress of each of three departments namely Civil, Mechanical, and Electrical and instrumentation departments. The progress was shown in term of Planned Values (PV), Actual Values (AV), and Earned Values (EV) of man hours for each department. The progress was depicted with the help of S curves. The reports also contain man hour analysis for each month in addition to all the required data. The Man hours analysis consist of Planned Values (PV), Actual Values (AV), and Earned Values (EV) for the cost centers (Group of inter related activities) of the project. We further calculated schedule and cost variances for the project. However, Schedule variances (The difference between planned value and Earned value) were calculated for the whole project and for each month as well. Although due to some constraints in term of access to the cost data, we were only able to calculate cost variance (The difference between Actual value and Earned value) for the whole project rather than monthly wise. The data regarding Planed, Earned and Actual values was extracted from the reports for the study and delays were identified through these data values.

As the project is a mega project and contains very large number of activities, so it was difficult to deal with such big data of the project activities. Therefore, the company have grouped the interrelated activities in hundred (100) different units known

as cost centers. These cost centers cover the whole project activities. We grouped these cost centers in two classes; cost centers which have positive man hour variance and cost centers which have negative man hour variance. It was our first step for analysis to specify the delay reasons. There were sixty one (61) cost centers, which showed negative variances, while the remaining thirty nine (39) cost centers showed positive variances. So our study focuses on the sixty one (61) cost centers. The remaining thirty nine (39) cost centers is out of the scope of the project.
The 61 cost centers identified as causing over runs in the project were focused for further data collection. As these cost centers were related to three departments that are Civil, Mechanical and Electrical departments. Interviews with the concerned authorities of each department were conducted and delay reason for each of the sixty one (61) cost centers were identified through these interviews.
The reports also highlighted the causes of negative variances and flaws in the project performance. It consists of seven (7) main reasons due to which project performance was affected. They also discussed the mitigation strategies applied to compensate the problems.

2.2 TOOLS & TECHNIQUES

The selection of right tools and techniques is necessary to perform a successful study. This study includes the application of the EVM used to identify project overruns and its causes. EVM evaluate projects in term of its cost and schedule variances and performance indexes. Variances identify delays of the project and over cost if there is any. The cost performance index measures the efficiency of the project in term of cost. Similarly, schedule performance index measure the efficiency of the project in term of time.

2.2.1 Cost variance

Cost variance is the algebraic difference between the value of the work accomplished in terms of the baseline (EV) and the amount spent to accomplish the work (AC). The cost variance tool has been used in the study to calculate the variance of coal power plant project in terms of cost.

EV-AC = Cost variance (CV)………….(1)

The negative value of cost variance shows that project is over cost. The positive value of cost variance shows that expenses of the project is less than what was planned. In other words, greater the positive variance shows that the project is running more economically than what was plan.
As given in the equation (1) Actual Value (A.V) and Earned Value (E.V) are the prerequisites for cost variance. These values have been calculated from the values extracted from the monthly progress reports of the company. The reports consist month wise project progress in percentages. These percentages have been used to calculate the Actual and Earned values of man hours.
In this study, the Actual values and Earned values calculated from the start of the project i.e. January, 2015 to August, 2016

2.2.2 Schedule variance

Schedule variance is the algebraic difference between the value of the work accomplished in terms of the baseline (EV) and the amount of work that was planned (PV).The schedule variance tool has been used in the study to calculate the variances in the coal power plant project on monthly basis.

EV-PV= Schedule Variance (SV………… (2)

The negative value of the schedule variance show that the project is behind the deadline and there are some delays. Similarly, the positive value shows that project is going ahead of the planned value.
As show in the equation (2) Planned Value (P.V) and Earned Value (E.V) are the prerequisites for schedule variance. Similarly to the values of cost variance, these values also have been calculated from the values extracted from the monthly progress reports of the company. The reports consist month wise project progress in percentages. These percentages have been used to calculate the Planned and Earned values of man hours.

The Plan values and Earned values also have been calculated from the start to the latest possible date for us i.e. January, 2015 to August, 2016

2.2.3 Cost performance index (CPI)

Cost performance index (CPI) is a project management key performance indicator that answers the question "Is your project behind or ahead of the schedule until now, in terms of cost?" This CPI shows the rate of actual cost consumed for work done so far.

Cost Performance Index (CPI) = EV/AC…………(3)

Cost performance index measure the efficiency of the project in term of its cost. CPI smaller than one shows that the project behind the planned budget. Similarly, CPI greater than 1, although is very unusual in practical world, shows that project is ahead of the planned value.

2.2.4 Schedule performance index(SPI)

Schedule performance is the ratio of the value of the work accomplished in terms of the baseline (EV) and the amount of work that was planned (PV).

Schedule Performance Index (SPI) = EV/PV………….. (4)

An SPI equal to or greater than one indicates a favorable condition and a value of less than one indicates an unfavorable condition
We presented month wise schedule variances of the coal power plant project and cumulative costs in S curve to make it more obvious and noticeable.

To graphically show the frequency and weightage of the delay causes, the data was put into a tabular form. The most prominent delay causes were highlighted and distinguished it from normal causes. We used it to find out that which delay reason highly affects the project. Further, cause and effect diagram is applied to identify the root causes of overruns in the project.

2.2.5 Man hour vs time S Curve

It can be defined as “A display of cumulative man hours plotted against time." The name derives from the S-like shape of the curve, flatter at the beginning and end and steeper in the middle, which is typical of most projects.
In this study the man hours achieved against each month is depicted in the form of S Curve in order to understand the variances in the project performance against the baseline.

2.2.6 Histogram

A bar graph merely depicts the data by presenting different categories in separate bars. The bars of a histogram, on the other hand, represent continuous data for a specific range that are measured in terms of frequencies and intervals; thus, the bars are connected to each other.
The histogram is used to show the frequency and weightage of the causes of delays identified through the surveys.

2.2.7 Fishbone Diagram:

A fishbone diagram, also called a cause and effect diagram or Ishikawa diagram. This diagram-based technique, which combines with a type of mind map Brainstorming, pushes you to consider all possible causes of a problem, rather than just the ones that are most obvious.
The tool is applied in the study to identify that what are real time problems behind the over runs in the project???

3. RESULT AND DISCUSSION

We have three set of results from different analysis. These are results from schedule analysis, cost analysis, and overruns causes analysis. Each set of results used to evaluate a specific component of Earned value management. We discuss each set of result in the proceeding section.

3.1 Schedule Analysis:

As show in Table No. 1, the schedule variance and schedule performance index have been calculated and presented in column number 5 and column number 6 of the table respectively. The positive values of Schedule variance show that the project is ahead of the plan while the negative values indicate delay in the project i.e. the project is behind the plan. Similarly the data values greater than 1 for the schedule performance index indicate the better efficiency in work progress while the data values less than 1 indicate the poor efficiency of work progress. The table also have plan values and earned values shown in term of man hours, which are prerequisites for the schedule variance. We see from the table, the data values for the initial two months is zero. Actually, the work progress in these were very small and so negligible. Therefore, we rounded up the values to zero for the first two months. The later values show the different numbers of man hour values as the project heads towards the progress in corresponding months. The trend in schedule variance is mixed, but predominantly negative. It can be observed from the table that fourteen (14) months among 20 months show negative variance, only four (4) months show positive variances. The initials months of the project show positive variance from January to July, 2015 except April 2015. The overall progress is satisfactory in these months because the project was in its starting phase. In starting phase the project is less complex, so it is easier to manage. Later when the project gets more progress, it becomes more complex and gets out of scope due to changes in plans and designs by the stakeholders. As a result, we observe from the table that the Schedule variances are negative during the month of August, 2015 up to May, 2016. During these months the negative schedule variance (S.V) values were in its peak. The variances for the months June, 2016 to August 2016 show lesser negative values. The decline in the negative variance values shows the project is heading towards completion.

Table 1. Schedule Variance analysis

S.No	Months	Planned Man-hrs. value (P.V)	Earned Man-hrs. Value (E.V)	Schedule Variance (S.V)	Schedule performance index (SPI)
01	Jan-15	0	0	0	0
02	Feb-15	0	0	0	0
03	Mar-15	22371.19	37023.19	14652.00	1.65
04	Apr-15	83891.96	50335.17	-33556.78	0.60
05	May-15	190155.98	206933.49	16777.51	1.09
06	Jun-15	302011.04	341160.62	39149.58	1.13
07	Jul-15	486573.34	814510.14	327936.80	1.67
08	Aug-15	743842.00	710285.22	-33556.78	0.95
09	Sep-15	1096188.21	950775.49	-145412.72	0.87
10	Oct-15	1560390.36	1286343.31	-274047.05	0.82
11	Nov-15	2091706.08	1560390.36	-531315.72	0.75
12	Dec-15	2757248.92	1907143.78	-850105.14	0.69
13	Jan-16	3406013.73	2214747.61	-1191266.12	0.65
14	Feb-16	4032406.64	2522351.45	-1510055.19	0.63
15	Mar-16	4658799.90	2975368.00	-1683431.90	0.64
16	Apr-16	5083852.47	3417198.97	-1666653.51	0.67
17	May-16	5413827.50	3383642.19	-2030185.31	0.63
18	Jun-16	5083852.47	4239340.13	-844512.35	0.83

19	Jul-16	592797.00	4602871.93	-989925.07	0.82
20	Aug-16	5592797.00	4938439.75	-654357.25	0.88

It can be understood from the table that the project is seriously suffering from schedule delay as measured by the parameters of Schedule variance and Schedule Performance index. This data will be the key for the analysis for getting into the roots of the delay in project and identifying the flaws which resulted into this condition of delay. The results from the above data can be observed and better understood through the S curve as given in figure 1.

The S curve is statistical model of the variances on the basis of the Planned values (P.V) and earned values (E.V). On the S curve the x-axis shows the names of the months and year for which the data values being considered. The Y axis shows the Planned values (PV) and Earned values (E.V) for the corresponding months. The blue line represents the trend in the Planned values (PV) for each month while the orange line represents the trends in Earned values (E.V) for each month. The dots in the blue and orange lines show the exact location of data values on the X-Y plane. The gap between the two lines depict the variances of the project from its track at corresponding months.

The graph shows that the project is in a proper flow in the initial months of the starting of the project and even shows a better trend in July, 2015. The project detracted from August, 2015 as depicted by graph. The variance continuously increased till it reaches its peak value at May 2016. It further depicts that in coming months there is a decline in the value of variance but the variance still continues.

In a nutshell it is obvious from the graph that the current statistics show that the project is suffering from overruns in terms of time and that the project is far behind its completion date, which was expected to be completed on Augus2016 in accordance to the baseline schedule data of the relevant organization and also as depicted in the S curve.

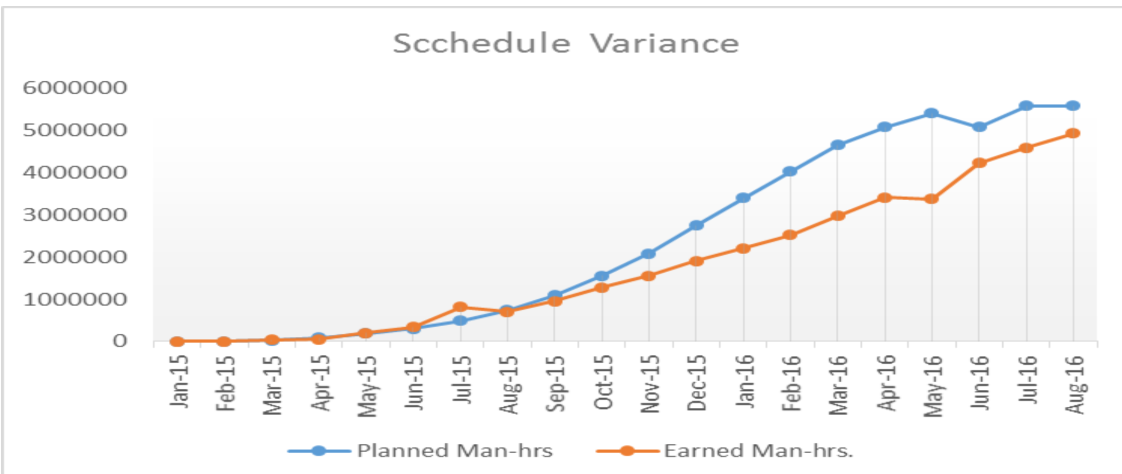

Fig 1. Statistic model of Schedule variance

3.2 Cost Variance Analysis:

As mentioned in the earlier section, Earned Value (E.V), and Actual Value (A.V) are the prerequisite for cost vaiance and cost performance index. These values are based on the man hours instead of cost. Because of certain constraints in access to the cost data. Therefore, to convert man hour's values into cost values, the following assumption was made to perform cost variance analysis. The Earned values (E.V) and Actual values (A.V) of man hours available up to the month of August, 2016 are interpreted in the following way to proceed further.

Let's assume "X" is cost/Man-hr.
Then Cost=Number of man-hrs. * X
So from the available Earned Man-hours, which is 5,202,129 hours up to August 2016.
Similarly, calculated actual Man-hrs and so actual cost.
So the values of Cost Variance and Cost performance index can be calculated as shown in the table 2.

Table 2. Cost variance analysis

The negative cost variance (C.V) and decimal cost performance index (CPI) parameters show that project is suffering from cost overruns. It means that extra money has been spent on the project as compared to the budgeted values of money allocated for the project.

The cost and schedule variance analysis performed indicate that it is an alarming situation for the stakeholders of the project as the project is suffering both in terms of cost and time. The statistics also depict that the project management is not being applied in an effective and efficient manner in the current project. It stimulates us to study and sort out the causes for such worse condition in order to avoid these problems in future projects and make project management more effective and efficient in the relevant organization

3.3 PROJECT OVERRUNS CAUSE ANALYSIS:

For project overruns cause analysis, we reviewed the monthly progress reports of the organization thoroughly as our first step to analyze the causes for delays mentioned in the reports. We extracted currently on going and real time issues with the project affecting its progress. To check the delays more closely, we conducted surveys on specifically designed questionnaires to records the perceptions of employees about the causes of delays. As discussed in data collection section, the interviews were conducted to know more about the causes of delays from the expertise of each department's i.e. Civil, Mechanical and Electrical and Instrumentation departments. They were asked to mention the reasons behind negative variances of man hours in the cost centers related to their respective departments. The causes identified and got more focus from all sources are as enlisted in Table 3.

Table 3. Causes of delays frequency

S.No.	Causes of delays	No. of CCTRS affected	Weightage
1	Unavailability of material	16	26.23
2	Bottlenecks due to civil department	7	11.48
3	Issues due to vendors/Sub Contractors	7	11.48
4	Re-work and revision of design	7	11.48
4	Due to Mechanical department	6	9.84
5	Shortage of Manpower	5	8.2
6	Space Availability Problem	4	6.56
7	other	9	14.73
	Total	**61**	**100**

The details of the number of cost centers affected and the frequency of cause's identified through interviews are shown in the table. 3. There are 61 cost centers which suffered out of which 16 cost centers suffered due to unavailability of material, 7 cost centers suffered due to delays in civil works. The mentioned 6 causes are responsible for 87.26% of the delays in the project. The on time delivery of material at the site was not efficient due to this reason. The second most prominent reason is delays due to civil works. The project work was planned in such a way that the most of the departments were dependent over the fulfilment of the civil works. The delay in this civil department lead to delay in other departments also. In addition to this the delays occurred due to unavailability of sub contactors and their in efficient performance. The modifications in the designs of the sub structures was also one of the major problem.

The table can be better understood through the Histogram. The histogram shown in figure 2 depicts the causes of reason for the delays on X axis. The Y axis show the frequency of cost centers affected by the corresponding cause on axis. The purple bar depicts the frequency while the red area in each bar depicts its weightage.

Earned Value E.V	Actual Value A.V	Cost Variance C.V=E.V-A.C	Cost Performance Index CPI=E.V/A.C
5,202,129x	7,695,786x	-2493657x	0.675

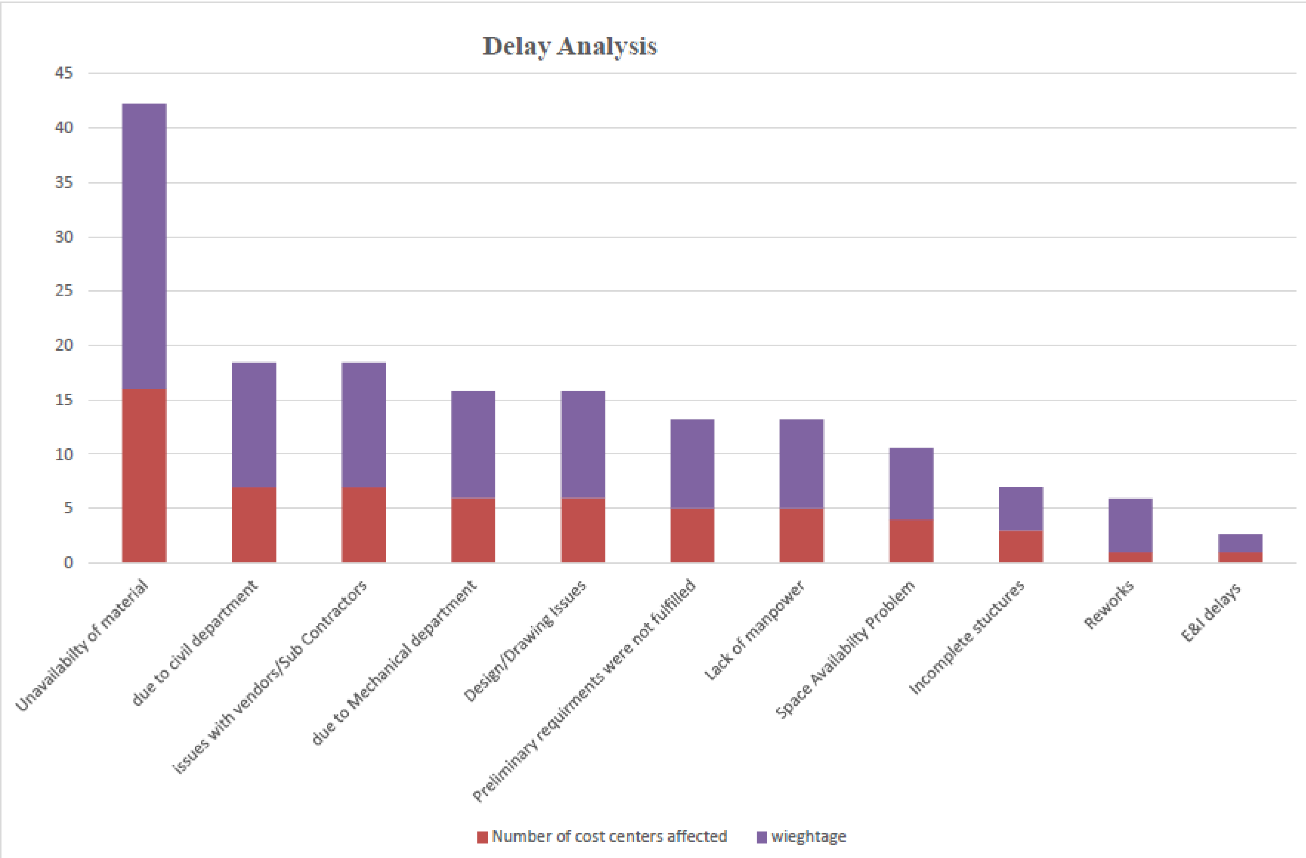

Fig 2.Histogram of Cause Analysis

The cause analysis is further elaborated through fishbone diagram in figure 3. The fishbone diagram classifies the delay causes in five groups on the basis of Man, Machine, Method, Environment and Material. The rectangular box at the right side depicts the problem statement and the lines above and below the straight line depict the causes of problem. It can be observed that the most of the delay causes are related to the method and material. The availability of material is again the most prominent cause having frequency 14. The other main causes are lack of labor, delay in civil works, issues with sub-contractors and delay in mechanical works etc.

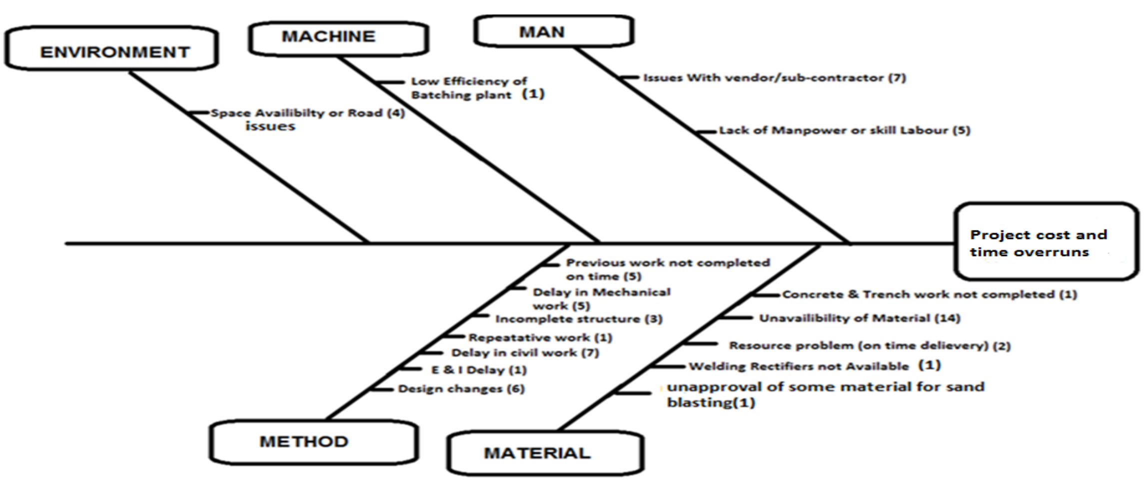

Fig 3. Fishbone Analysis

4. CONCLUSION

The study is based on the tools of earned value management. The tools i.e. Schedule variance (S.V), cost variance (C.V), schedule performance index (SPI) and cost performance index (SPI) are the main drivers of the case study. It concludes that the results of these parameters portray that the coal power plant project is suffering from both time and cost overruns.
The major delay causes identified were unavailability of material, bottlenecks in civil departments, and issues due to vendor/Sub-contractor.
The issues mostly arouse due to the location of the project. The project location was 46 km away from the urban area causing both deficiency of material and manpower. Furthermore, the planned work content was mostly concentrated with the activities of civil department due to which other departments suffered. The delay in the civil works caused the delay in mechanical and electrical departments. Inefficient design of the sub-structure was also a big problem. The repetitive modifications in design suffered the project the most.
The project could have been managed better through the consideration of certain dynamics i.e. by timely creating alarms regarding unavailability of material, active monitoring and maintaining efficiency of project activities, timely completion of predecessor activities, provision of design at the start of the respective activities, provision of error free designs, timely issuance of material, and integrating design with activities.

5. REFERENCES

[1] Speed Kills Ali Klaver, 2012 Project Management Magazine

[2]*J.l Narayan NBMCW January 2011Available from http://www.nbmcw.com/project-mgmt-arbitration-consultant/20898-time-and-cost-overruns-in-implementation-of-infrastructure-projects.html*

[3] R.D. Arditi, G.T. Akan, S. Gurdamar. Reasons for delays in public projects. *Construction management and economics*. Vol. 3, Turkey (1985), p. 171-81.

[4] Haseeb Muhamad, et al. "Problems of projects and effects of delays in the construction industry of Pakistan". *Australian Journal of Business and Management Research* September-2011 Vol.1 No.5:41-50.

[5]Varghese Regi Aedwin and Shibi Varghese. "Analysis of delays in construction projects." *International journal of Engineering and General Science.* 3(2015):108-112.

[6] M. Vanhoucke, on the dynamic use of project performance and schedule risk Information during project tracking, OMEGA: International Journal of ManagementScience 39 (2011) 416–426.

[7] Acebes Fernando, et al. "Beyond Earned Value Management: A graphical framework for integrated cost, schedule and Risk monitoring." *Procedia-Social and Behavioral Sciences.* 74 (2013):181-18.

[8] Burtonshaw-Gunn S.A., Risk Financial Management in Construction, Gower, 2009.

[9] Code of Practice for Project Management for Construction and Development. Fourth edition, Blackwell Publishing, 2009.

[10] Fewings P., Construction Project Management. An integrated approach. Taylor & Francis, 2005.

[11] Levy S.M., Project Management in Construction, McGraw Hill, 2012.

PRACTICAL INVESTIGATION FOR THE SELECTION OF BEST STRUCTURE AS LIGHTNING PROTECTION

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Abstract: Building protection against lightning is an enlarging issue for electrical engineers. Lightning can affect any building structure and therefore, it can damage electronic equipment and can cause human casualties. A competition test between different building structures is taken place in this paper. The structures have different shape and all the structures are scaled. The arrangement of lightning air terminal on each building structure is according to American standard NFPA780. The best structure has been selected. The best structure has the ability to receive the least number of lightning flashes under the ambient weather condition.

Key words: *Lightning, Probability, Lightning strike, Lightning protection system*

1. INTRODUCTION

In this paper the scaled model of building structures are selected for a competition test. All the work done is totally practical. High voltage impulse generator is used for high voltage impulse generation.

With increasing technology and global warming, particularly for the last 10 years lightning is effecting human life and building structures irregularly. Direct and direct lightning strike effects the human life whether it is inside the houses or outside in the open area (R.L.Holle, 2010). Lightning can be divided to into positive and negative lightning mainly while the intra cloud, cloud to cloud and cloud to air lightning is not affecting anything on the earth (Donald 2001). In modern research, the researchers have adopted different methods and techniques for the building protection. But Franklin rod is still in use for the lightning protection after 250 years. Franklin rod is still use by the latest international standards (IEC62305 1-2), NFPA780).

2. LIGHTNING RODS INSTALLATION ON BUILDING STRUCTURE

Capturing of lightning by lightning air terminal having three main methods explained in different international standards. The basic concept for the lightning protection is rolling sphere method which has the basic of electro geometrical model (Kern, Schelthoff, & Mathieu, 2012).Lightning rod is a very important parameter use in lightning protection. Lightning rods are used for the effective protection of building against lightning therefore, the position of lightning rod on the building structure is very important. For the correct position of lightning Monte Carlo technique is very helpful for any building structure. It makes sure the building structure to be safe inside and outside as well(Srivastava & Mishra, 2015) . For the protection of structure the rod protection zone and the electric filed calculation can also be done with the Monte Carlo technique(Srivastava & Mishra, 2013). For the protection system rolling sphere method is also used. The base for rolling sphere method is electro geometrical model. To make sure the rolling sphere method for the effective protection still the use of the rod is very important(Nassereddine & Hellany, 2009)

3. PROBABILITY OF LIGHTNING STRIKE ON STRUCTURES

The process of lightning flash on the structure has been analysed extensively. During some condition during lightning the lightning discharge is created form the head of a lightning rod. This discharge is associated by the upward streamer which is taken place during the lighting strike on the structure. In this way the protection system against lighting acts as to protect any structure from the effect of lightning. Lightning rod along with the down conductor and earth wire grounds the current and it is dispersed by the grounding electrode(Mikropoulos & Tsovilis, 2008). The capturing of lightning strike depends on the probability of lightning stroke current and on the upward discharge which is created at the tip of lightning rod. For the capturing capability of lightning rod a proper model needs to be developed. The attractive radius is more important for the capturing and for the protection design (Mikropoulos & Tsovilis, 2009).

4. METHODOLOGY

Work performed in this paper is totally experimental. HV91500 high voltage impulse generator is used for the impulse voltage. The generator used in this process is high voltage and low current. A top electrode is used which gets the applied voltage and produce high voltage in order to get break down voltage. The air terminals are of identical height in order to get equal distribution of lightning voltage. Standard height of the building is 3m. The 3m height is scaled to 10 cm. The height of structure is scaled according to (Kern, Schelthoff, & Mathieu, 2011) and(Bermudez et al., 2003). The equation for scaling the building given as

$$\text{Measure Scale} = m_i = \frac{M_P}{M_M} = \frac{\text{Prototype measures}}{\text{Model measures}} \quad (1)$$

$$\text{Model measures} = M_M = \frac{M_P}{m_i} = \frac{\text{Prototype measures}}{\text{Measure Scale}} \quad (2)$$

Where M_P is the characteristic height in the real-world prototype and M_M is the corresponding height in the model (subscript M). The simple structures are scaled as $3m = 300cm \sim 10cm$, hence

$$m_i = \frac{300}{10} = 30 \quad (3)$$

The inverse of equation (3) shows the scale factor 1:30. Therefor from equation (2) we can calculate the height of a single story building as

$$\text{Model height} = \frac{M_P}{m_i} = \frac{300cm}{30} = 10cm \quad (4)$$

After scaling the building according to every structure is provided different number of air terminal according to NFPA780. Every structure is provided different number of air terminal. For competition test 50 flashed are applied to all the structure. Four different structures have been selected having same height also identical height of the lightning rod. The air gap is also the same. Impulse voltage is applied and the structures are analysed closely. The structure which receives the least number of the lightning flash is the best design as it not allowed the lightning stroke to strike the structure. All the experiments are performed under the Malaysian weather conditions which is explain in the next section.

5. RESULTS

The obtained results including the competition test among four geometrical structures. Table 1 shows the number of strike on the geometrical shape while figure 1 shows the lightning strikes on the given structures.

Table1. Lightning strikes on geometrical shapes

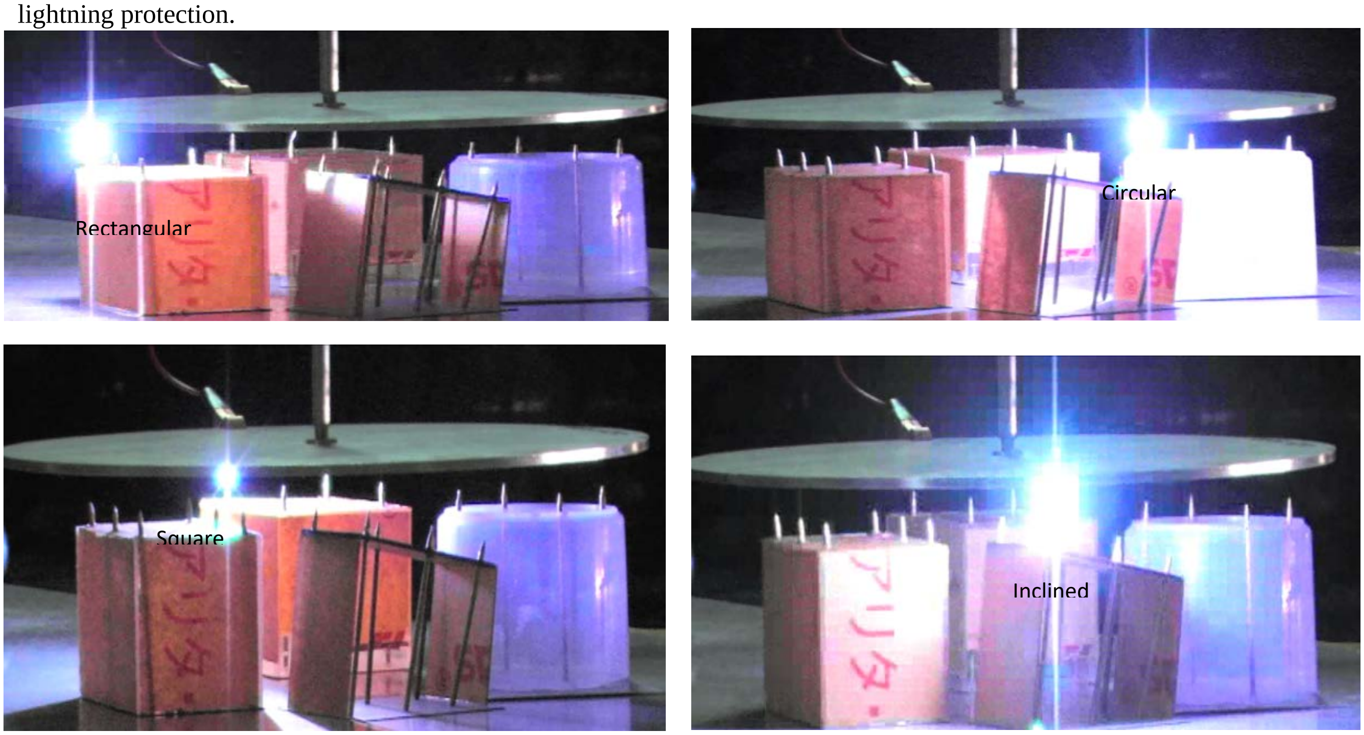
Temperature, 30.30C^0 Pressure, 1.03 Pa Humidity 69.20 % D.C Voltage, 87.50 kV Impulse, 82.30k V Current 1.7 A				
Shape	Rectangular	Square	Circular	Inclined
No. of strike	16	10	15	9

Table 1 shows the number of lightning strikes on different geometrical shapes when 50 flashes are applied to all the objects. Similarly after the test among all four square and inclined shape have selected the best while among these two inclined shape is the best. Table for inclined and square shape is given below

Table2. Lightning strike on square and inclined shape

Temperature, 30.30C^0	*Pressure*, 1.03 Pa	*Humidity* 69.20 %
D.C Voltage , 87.50 kV	Impulse , 82.30k V	Current 1.7 A
Shape	square	inclined
No. of strike	35	15

Table 2 represents the number of strikes square and inclined shapes. This shows that the inclined shape has the best quality of lightning protection.



(a)

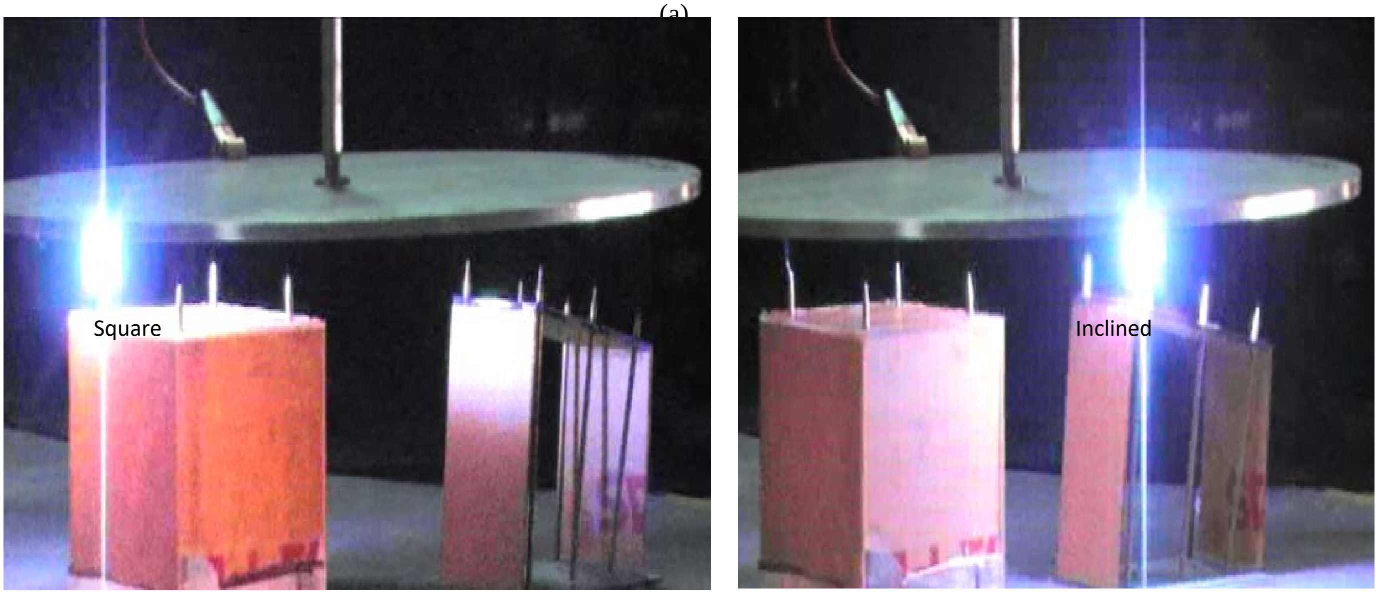


Fig.1 (a) ,(b) Lightning strikes on different structures during competition test

From figure 1 (a) it is clear that the lightning strikes all the four structure. Rectangular structure has been hit the most .In figure 1 (b) the competition test is among square and inclined shapes. The incline shape has been struck only 15 times among the 50 different flashes. It means that inclined shape does not allow lightning strike to hit it and therefore it has the good quality regarding lightning protection

6. DISCUSSION

The work carried out in this paper is an experimental investigation of the lightning strike on different structure. This work makes sure the best structure design for the lightning protection. The applied voltage is within the limits of 100KV as the impulse generator specification is 100KV. A number of flashes are applied are applied. The air gap between lightning rod tip and the top electrode is the same. For all the experiment the ambient weather condition are in the consideration. The numbers of air terminals are different for different shape. Among the four structures first all four structure are kept for the competition under the top electrode. Among all four the two best designs are selected and again a competition is performed which as a result select the best deign. The selected design is the best regarding lightning protection. The selected design can protect the equipment and the human being inside.

7. CONCLUSION

Form the experimental results it can be concluded that the best design among all four has been selected. The tested designs are square, rectangular, circular and inclined structures. The height of all the structure kept the same in order to get the voltage distribution the same. Among all four structures inclined shape is selected as the best design regarding lightning protection .During the experimental process the inclined shape received the least number of lightning flashes. This shows that although the geometry of the structures and the lightning rods are the same still inclined shape has the best performance regarding lightning protection. Humidity, temperature and pressure are the most important weather parameters therefore all the experimental work is performed under these condition. The weather conditions were under Malaysian conditions.

For the selection of best design more different structure can be included. The competition can be performed for the complex building structures as well as these tests were for the simple structures. Simulation and statistical analysis of the given experimental work can be more effective and can validate the results more effectively.

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8. REFERENCES

Holle, R.L. (2010). Lightning- Casualties in and near Dwelling and other building. *International Meteorology Conference*, Orlando, Florida, USA.

Donald, W. Zipse. (2001). Lightning Protection Methods: An Update and a Discredited System Vindicated. *IEEE transaction on industry application, vol. 37, No. 2*

Bermudez, J. L., Rachidi, F., Chisholm, A., Rubinstein, M., Hussein, M., & Chang, S. (2003). On the Use of Transmission Line Theory to Represent a Nonuni- form Vertically-Extended Object Struck by Lightning, 501–504.

Kern, A., Schelthoff, C., & Mathieu, M. (2011). Calculation of Interception Efficiencies for Air- terminations Using a Dynamic Electro-geometrical M odel, 25–30.

Kern, A., Schelthoff, C., & Mathieu, M. (2012). Probability of lightning strikes to air-terminations of structures using the electro-geometrical model theory and the statistics of lightning current parameters. *Atmospheric Research*, *117*, 2–11. doi:10.1016/j.atmosres.2011.01.009

Mikropoulos, P. N., & Tsovilis, T. E. (2008). Striking Distance and Interception Probability, *23*(3), 1571–1580.

Mikropoulos, P. N., & Tsovilis, T. E. (2009). Interception Probability and Shielding Against Lightning, *24*(2), 863–873.

Nassereddine, M., & Hellany, A. (2009). Designing a Lightning Protection System Using the Rolling Sphere Method. In *2009 Second International Conference on Computer and Electrical Engineering* (pp. 502–506). Ieee. doi:10.1109/ICCEE.2009.140

Srivastava, A., & Mishra, M. (2013). Lightning modeling and protection zone of conducting rod using Monte Carlo technique. *Applied Mathematical Modelling*, *37*(24), 9858–9864. doi:10.1016/j.apm.2013.05.026

Srivastava, A., & Mishra, M. (2015). Positioning of lightning rods using Monte Carlo technique. *Journal of Electrostatics*, *76*, 201–207. doi:10.1016/j.elstat.2015.05.029

Factors contributing Delay in Highway Projects of Pakistan

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Abstract: In Pakistan construction industry is creating many job employments and also it plays role to improve economy of it. The construction projects are facing problem of delay particularly in highway projects of Pakistan. Delay is known as serious problem because it shows negative sign to stakeholders and investors of construction projects. Hence, the aim of this study to find out most serious factors which causes delay in highway projects of Pakistan. From interviews and literature review 73 factors were found of delay in construction projects. Questionnaire was designed and dispersed among 90 randomly selected respondents from contractors, client and consultants. The respondents were asked to rank each factor which causes delay in highway projects. By using statistical approach of Average index most serious factors were inadequate planning, cash flow problem faced by contractor, rapid design changes, late delivery of materials at site and poor site management. This study can help stakeholders to control serious factors of delay in highway projects.

Keywords
Serious factors, Highway Projects of Pakistan, Delay

1. Introduction

Successful project is known as which is finished within time, cost and with standard quality (Frimpong et al, 2003). Successful project can be defined as a project which is completed within approved time, approved budget and with high quality (Oberlender, 2003). According to (Aziz et al., 2016) mostly highway projects take time to complete, if any highway project is complete in particular time is known as successful highway project.

Transportation sector is known as important sector in Pakistan which contributes about more tha 10% to gross domestic production and also 17% to gross capital foundation. (Javied and Hyder, 2009). The Pakistan government is nowadays is trying best for good and standard quality of highway system (ESP 2014-2015).

Many researches have been conducted to identify factors of delay which causative delay in construction industry worldwide. However, only few studies have been conducted to find critical and serious factors of delay in highway and transportation system globally. Less researches has been found also to find these serious causative factors in highway projects of Pakistan

2. Previous Studies

A research carried out by Mezher et al., (2006) causative factors of delay in highway projects at Lebanon from designer, owner, and contractors . It was determined that client has the concern with financial problems and contractors contractual association among parties where the consultant shows that project management as most important factor of delay in highway projects. According to researcher Mahamid et al., (2012) carried out questionnaire survey and found that government influence in construction projects, procedure of lower bidding, payment delay by the client and lack of experience consultant officers and staff, and incomplete and errors in design were most significant factors of delay in projects.

Ejaz et al., (2013) found total 26 factors of delay in highway projects of Pakistan. A questionnaire was developed and distributed to the consultant, client, contractors, and client, to identify critical factors which cause delay in projects. The results of survey were (a) fluctuation of items and material and (b) problem in cash flow from the owner. However, Haseeb et al., (2011) identified most critical factors which causative factors delay in construction projects in Pakistan were the lack of funds, change in orders by client and consultant , shortage of equipment and materials, lack of planning and improper management at site.

Choudhry et al., (2012) identified critical factors of delay which causes in highway projects of Pakistan, identified factors were the interruption in cash flow, weather effect, financial problems, buying of land, change in scope of project and inexperienced management and lack of planning by the contractor. Another research conducted by (Santoso and soeng, 2016) through questionnaire survey and point out critical factors of delay were poor site arrangement, slow process of payment, low productivity labor, the award of the contract on low bid and weather affect.

3. Objectives of Research

The objectives of the research are

(i) to find out the causative factors which delay in highway projects at Pakistan

(ii) to find out most serious factors of delay in construction of highway projects

4. Research Methodology

In this study quantitative method is adopted to know the awareness of investors towards factors causative delay in construction of highway projects. To achieve object of this research a study was through two phases. The first phase comprises of conducting interviews and literature review. From this phase, 73 factors were found causative the delay in different projects. At the second phase, questionnaire was developed which comprises of two stages, stage A and stage B. Stage A contained bio-data, company profile, experience, qualification of respondents were asked. Stage B contained causative factors of delay from which respondents were asked to give score each factor and rank each factor respectively.

5. Data Analysis

Data was evaluated by using formula of average index (AI)

$$AI = \frac{\Sigma(1X1+2X2+X3+4X4+5X5)}{\Sigma\ X1+X2+X3+X4+X5} \quad \ldots\ldots\ldots(1)$$

Where,

N= Overall number of respondents

X1= indicates number of respondents for “Not important”

X2= indicates number of respondents for “slightly important”

X3= indicates number of respondents for “moderately important”

X4= indicates number of respondents for “important”

X5= indicates number of respondents for “very important”.

In this research, evaluation values to assess significant level is used as follow:

Value of AI from 5.0 to 4.00	Very important
Value of AI from 4.0 to 3.0	Important
Value of AI from 3.0 to 2.0	moderately important
Value of AI from 2.0 to 1.0	slightly important
Value of AI from 1.0 to 0	Not important

All the respondents were asked to rank factors which cause the delay in highway projects.
Before data collection, a preliminary study was carried out by conducting interviews from 7 experienced persons who are involved in highway projects. This study was done to validate the questionnaire relevancy in highway projects of Pakistan. Table 1: shows the profile and experience of respondents interviewed.

Table 1: Profile of respondents interviewed for questionnaire validation

No	organization	Position	Academic Qualification	Experience in highway projects
1	Client	Project Director	Masters in Civil Engineering	26 years
2	Client	Deputy Director	Master in Project Management	25 years
3	Contractor	Project Manager	Bachelors in Civil Engineering	20 years
4	Contractor	Project Manager	Bachelors in Civil Engineering	16 years
05	Contractor	Managing Director	Masters in Civil Engineering	15 years
6	Contractor	Site Engineer	Bachelors in Civil Engineering	14 years
7	Consultant	Chief Resident Engineer	Bachelors in Civil Engineering	21 years
08	Consultant	Resident Engineer	Masters in Construction Management	20 years

Table 1: indicates that interviewed respondents have more experience in highway projects from 26 to 14 years. Overall experience of the 08 respondents is 157 years (average approximate experience of 20 years). Respondents were senior in their respective organizations and having good positions. Hence, aim of conducting interviews was to validate the factors of literature review.

6. Results and discussions

The survey was carried out by dispersed a total number of 90 questionnaire sets. Questionnaires were dispersed randomly to 27 consultants, 32 contractors, and 31 client personnel. From 90 questionnaires, 76 questionnaires were received back. From 76 few questionnaires further cannot be analyzed due to incomplete information. Facts of the survey are shown as in table 2.

Table 2: Facts of surveys

Parameters	**Values**
Total no: of questionnaire distributed	90
Total no: of questionnaire received	76
Total no of incomplete information	05
Total no of valid questionnaire	71
% of questionnaire received	84.4
% of questionnaire valid	78.8

Collected data was analyzed by statistical method of average index. The factor whose score is more than 3.6 is selected as serious factors in highway projects. Results of serious factors show as in table 3. The serious factors delays are presented in table 3:

Table 3: Serious Factors of Delay in highway projects

Identified Serious Factors	Score	Rank
Inadequate planning	4.10	01
Cash flow problem faced by contractor	4.03	02
Rapid design changes	3.91	03
Late delivery of materials	3.87	04
Political influence	3.81	05
Financial difficulties by owner	3.77	06
Inexperienced staff	3.71	07
Poor site management	3.62	08

Table 3: shows that inadequate planning ,cash flow difficulties faced by contractor, rapid design changes design changes, political influence ,late delivery of materials, financial difficulties by owner, inexperienced staff and poor site management with their average index value 4.10, 4.03, 3.91, 3.87, 3.81, 3.77, 3.71 and 3.62 respectively are the serious factors of delay in highway projects.

7. Conclusions

This study explores causative serious factors the delay in highway projects of Pakistan. 73 factors were found from literature review and from interview which causes the delay in the construction industry. A preliminary study was carried out to validate delay factors then questionnaire was developed and dispersed to experienced experts of highway projects to rank each factor carefully. Each factor was statistical analyzed by average index, 8 factors were found as serious causative factors which delay in highway projects. The serious factors which were identified were poor planning, cash flow problem faced by the contractor, rapid design changes, late delivery of materials, political influence, and financial difficulties by owner, inexperienced staff and poor site management.

The results of this study are beneficial to control serious factors which the delay of highway projects.

8. Future Research

This study have found serious factors which cause the delay in construction of highway projects of Pakistan but similar kind of research can be carried out on different type of projects are also recommended.

9. References

A. Sullivan, F.C. Harris, Delays on large construction projects, Int. J. Operat. Product. Manage. 6 (1) (1986) 25–33.

Choudry, R., Nasir, A., & Gabriel, H. (2012). Cost and Time Overruns in Highway Projects in Pakistan. *Pakistan Engineering Congress, Centenary Celebration Proceedings* (pp. 353-369).

Ejaz, N., Ali, I., & Tahir, M. F. (2013). Assessment of delays and cost overruns during construction projects in Pakistan.

Frimpong, Y., Oluwoye, J., & Crawford, L. (2003). Causes of delay and cost overruns in the construction of groundwater projects in developing countries; Ghana as a case study. *International Journal of project management*, *21*(5), 321-326.

Haseeb, M., Bibi, A., & Rabbani, W. (2011). Problems of projects and effects of delays in the construction industry of Pakistan. *Australian Journal of Business and Management Research*, *1*(6), 41.

Javied, Z., and Hyder, A. (2009). “Impact of training on earnings: Evidence from Pakistani industries.” Asian Social Science, 5(11), 76-85.

Mahamid, I., Bruland, A., & Dmaidi, N. (2011). Causes of delay in road construction projects. *Journal of Management in Engineering*, *28*(3), 300-310.

Ministry of Finance. (2014). *Economic Survey of Pakistan 2010-11*. Government of Pakistan.

Santoso, D. S., & Soeng, S. (2016). Analyzing Delays of Road Construction Projects in Cambodia: Causes and Effects. *Journal of Management in Engineering*, *32*(6), 05016020.

Trost, S.M. and Oberlender, G.D. (2003). Predicting accuracy of early cost estimates using factor analysis and multivariate regression. *Journal of Construction Engineering and Management*, 129(2): 198–204

CAUSES OF DELAY IN CONSTRUCTION OF DAMS IN PAKISATN

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Abstract: It is fact that if any project is finished in approved time is known as successful project but unfortunately because of many reasons construction projects of Pakistan are failed to complete on approved time frame. Delay in construction projects is serious problem which gives negative indication to investors because projects are taking long time to complete. The aim of this research is to find out most significant factors which cause the delay in construction of dam projects in Pakistan. From extensive literature review and interviews 70 factors were found which causes delay in construction projects. A questionnaire was designed and distributed among 100 experts who were working in construction of dam projects and were asked to rank each factor. After using RIW method and analysis mitigation measures of each significant factor were also found from experts. This study will help to construction experts to reduce significant factors by using mitigation measures of each significant factor in construction of dam projects.

Keywords
Construction of Dam projects, Delay causes, Pakistan.

1. Introduction

Construction industry plays a fundamental part in the economic growth of any country as it stimulates the development of other industries too (Rum and akash, 2011). Delay can be defined as when project exceeds the time frame which was mentioned in contract on which all parties agreed for time period of the project (Ahmed et al.,2002).Delay in construction projects can be defined as when the project is not completed within given time. Construction projects are facing problem of delay worldwide. This problem varies from country to country and project to project (Aziz et al.,2016). According to Hasan et al.,(2014) that delay in construction can be defined as postponing the project completion time due to predicted and unpredicted causes. Construction industry is not well reputed in terms of completion of projects within time. Ignorance of delay analysis resulted many projects fail to complete on given schedule (Duran, 2006). According to Trigunarsuah (2004) that in Indonesia only 47% of projects were completed within time frame, 38% of projects were behind time frame and 15% of projects were completed ahead of time frame.

Many researches have been carried out on identifying factors which causes delay in construction industry of Pakistan but no any single study has been found to identify factors which cause delay in construction of dam projects in Pakistan.

2. Previous studies

Various studied has been conducted on delay in construction projects. Fugar et al., (2010) conducted survey from 130 engineers of contractor, consultant and client. From survey results the critical causes of delay in construction projects were delays in honoring certificates, shortage of materials, change in price of raw materials, lack of site management, problem in bank credit. Chan and kumaraswey (1996) Identified 83 potential factors of delay and he arranged factors in 8 groups. By using relative importance index he five causes of delay which were (i) Poor supervision and site management (ii) Late in decision making (iii) Owner interference in project (iv) Change in ground conditions (v) necessary variation of owner. Another study conducted by Mansfield et al., (1994) in which 16 critical delay factors were found (i) Financial and payment faced by contractor of completed work (ii) poor contract management (iii) site situation (iv) Improper planning and (v) delay in materials.

(Ogeno,2016) design questionnaire and distributed to experts of construction industry in Nigeria after analysis the critical factors which causes delay were lack of skills of sub-contractors, shortage of skilled labor, poor site management, shortage of materials and defective in works.

3. Research Methodology

To achieve aim of this research, study is divided in two stages. In first stage of research the main factors which causes delay where identified through deep literature review and unstructured interview. A questionnaire was designed in which identified factors were shaped and experts were asked to give rank to each factor. In second stage, the questionnaire of mitigation were designed which were found from literature review and unstructured interview of experts. The data of this step were analyzed by using RIW method.

4. Data Collection and analysis

Questionnaire was floated among 100 professional engineers of consultant, contractors and client (only related to dam projects). 76 questionnaires were received from respondents. Hence, respondents experience in dam projects has been considered for this study. Table (1) indicates the experience of respondents.

Table 1: Details of conducted survey

Parameter	Value
Total no: of questionnaire distributed	100
Total no: of questionnaire received	76
Total no of incomplete information	01
Total no of valid questionnaire	75
% of questionnaire received	76
% of questionnaire valid	98

Experts were asked to rank each factor on a five point Likert scale. RIW method is successfully used in previous studies which give good and accurate result (Ballard et al., 2001). The weight in RIW was calculated by using following formula.

$$\text{RIW}=\frac{\sum ai\, xi}{\sum xi} \quad (1)$$

Where ai conveys a constant which expresses the weight given to I, xi is a variable denoting the frequency of the response for; i is 1,2,3,4 and demonstrated as, x1 is Least importance and equivalent to a1 is 1, x2 is the Less important and illustrated as, a2 is 2, x3 is the important and corresponding to a3 is 3, x4 is Very important and equivalent to a4 is 4, x5 is the Most important and corresponding to a5 is 5.

Results showed that delay in supply of materials, natural disaster, financial difficulties faced by contractor , disputes at sites, poor site management, inexperienced contractor, rapid changes in design, error in time estimation and shortage of skilled labor with average mean score 4.218, 4.205, 4.187,4.113,4.098, 4.091, 4.088, 4.087 and 4.081 respectively are the critical factors which causes delay in dam projects. Results are shown in table 2.

Table 2: Critical Factors of Delay

Rank	Identified Critical Factors	Score
01	Delay in supply of material.	4.218
02	Natural disaster.	4.205
03	Financial difficulties faced by contractor.	4.187
04	Disputes at sites.	4.113
05	Poor site management.	4.098
06	Inexperience contractor.	4.091
07	Rapid changes in design.	4.088
08	Error in time estimation.	4.087
09	Shortage of skilled labor.	4.081

1. Delay in supply of material

After analysis the delay in supply of material was found one of the critical factors from among all factors which cause delay in construction of dam projects. Delay in supply of different material at construction site creates gap in construction activities at site which causes delay in construction projects (Faridi et al., 2006)

2. Natural Disaster

Natural disaster like heavy rains, floods and earthquake can stop the construction activities at site which causes delay in construction of dam projects. Sometimes weather impact can also delay time duration or approved time of the project (Al-Momnai, 2000).

3. Financial difficulties faced by contractor

Many contractors delayed or stopped the construction activities at site only because of delay or shortage of funds. It is true that main contractor plays role for from initial stage to final stage of the project and it is also true that only contractor plays role in execution of the project (Frimpong et al., 2003).

4. Disputes on site

Disputes between labors and sometimes disputes between management and labors delay the approved time frame of the project. Many projects are delayed because of disputes at the construction sites which takes time to resolved and with this project time duration exceeds from approved one (Alaghbari et al.,2007).

5. Poor site management

Poor site management factor delays the construction projects because daily routine activities or work is not properly managed at sites and this factor includes poor management by project engineers and contractors (Le-Hoai et al.,2008). Mostly this factor take place when the project engineer quit his job and that post remain vacant for long period.

6. Unexpereinced contractor

Appointment of unexperienced and incompetant contractor factor causes delay in consttruction of dam projects because contrcators is not well experineced in construction of dams as well as he has no compitetant staff and skilled labour. Appoitment of contractor on favoustism basis also can causes the delay in consruction projects (Alaghbari et al., 2007).

7. Rapid changes in design

For rapid and frequent changes in design which causes delay in construction of dam projects for that client and consultant are responsible. Frequent design changes delay the project activities which can causes delay in completion of project within time frame (Aziz et al., 2013).

8. Mistake in Time estimation

Mistakes in estimation of project duration causes because of lack of experineced enginners or planners of consultant and improper estimation of completion period of project. Estimation of project length is based on resources and their output (Sweis et al., 2008).

9. Shortage of skilled labor

Pakistan is develping country and many projects are on going at a time so construction industry is facing problem of shortage of skilled labour. Construction of dam projects are mostly in hilly and remote areas so it availibilty of skilled labour is cruicial problem and which causes delay in completion of project in given specific time period (Sambasivan et al.,2007).

The second part was questionnaire was mitigation measures which were found from literature review and unstructured interview from experts. The respondents were asked to highlight the relative importance of mitigation measures on Likert scale. The data was analyzed by using RIW method. Table 3 shows the analyzed results of mitigation measures of critical delay factors in dam projects of Pakistan.

Table 3: Mitigation measures of Critical Factors

S.NO	Mitigation Measure	Score
01	Sufficient material should be stored on site	3.0
02	Proper arrangements in floods and heavy rain areas.	2.97
03	Sufficient funds should be allocated for project.	2.94
04	Coordination between labor and management.	2.91
05	Qualified and experienced engineers should be appointed.	2.90
06	Contract should be awarded on merit & experience basis.	2.89
07	Frequent design changes should be avoided	2.88
08	Sufficient field data should be investigated.	2.86
09	Skilled labor should be hired by giving good rates	2.85

5. Conclusion

This research was carried out to find the critical factors which cause delay in construction of dam projects and mitigation measures of critical factors. The factors were identified from literature review and unstructured interview and after statistical analyzes the critical factors which causes delay in dam projects were delay in supply of material, natural disaster, inaccurate time and cost estimate, disputes at site, high transportation cost, inexperienced contactors, rapid changes in design and change in specifications found. The significant mitigation measures to control critical factors which cause delay were identified as below:

I. Sufficient material should be stored on construction site to overcome causes of delay in supply of material
II. Natural disaster cannot be controlled but few mitigation measures can be taken like proper arrangement in floods and heavy rain areas should be taken.
III. Sufficient funds should be approved and allocated for each project to avoid financial difficulties faced by contractor.
IV. It is necessary that coordination between labor and management should be good to overcome disputes on site
V. Well experienced and qualified engineer should be appointed for proper management at site.
VI. Contract of construction of dam project should be allotted on merit and to experienced contractor.
VII. Frequent and rapid design changes should be avoided to overcome rapid changes in design.
VIII. To overcome the wrong time estimation it is necessary to keep sufficient data of site and sufficient data should be investigated.
IX. Skilled labor should be hired by paying them good rates to avoid shortage of skilled labour problem.

Finding of this research will not be only helpful to control the factors which causes delay in dam projects but also be helpful for improvement of environment because all dam projects of Pakistan are facing delay problem.

6. References

1. Alaghbari, W. E., Razali A. Kadir, M., Salim, A., & Ernawati. (2007). The significant factors causing delay of building construction projects in Malaysia. *Engineering, Construction and Architectural Management*, *14*(2), 192-206.

2. Al-Momani, A. H. (2000). Construction delay: a quantitative analysis.*International journal of project management*, *18*(1), 51-59.

3. Aziz, R. F. (2013). Ranking of delay factors in construction projects after Egyptian revolution. Alexandria Engineering Journal, 52(3), 387-406.

4. Aziz, R. F., & Abdel-Hakam, A. A. (2016). Exploring delay causes of road construction projects in Egypt. *Alexandria Engineering Journal.*

5. Ahmed, S. M., Azhar, S., Castillo, M., & Kappagantula, P. (2002). Construction delays in Florida: An empirical study. *Final report. Department of Community Affairs, Florida, US.*

6. Ballard, G., Koskela, L., Howell, G., and Zabelle, T.,“Production System Design in Construction”,Proceedings of 9th Annual Conference of International Group for Lean Construction, Singapore, August, 2001

7. Chan DWM, Kumaraswamy MM. (1996). The delay in Civil Engineering projects. Hong Kong. 2(3): 1-8.

8. Duran, O. (2006). “Current risk management applications in Turkish construction industry.” Master’s thesis, Univ. of Gaziantep, Gaziantep, Turkey.

9. Faridi, A. S., & El-Sayegh, S. M. (2006). Significant factors causing delay in the UAE construction industry. *Construction Management and Economics*,*24*(11), 1167-1176.

10. Fugar, F. D., & Agyakwah-Baah, A. B. (2010). Delays in building construction projects in Ghana. *Australasian Journal of Construction Economics and Building, The*, *10*(1/2), 128.a (pp. 272–280).

11. Kumaraswamy, M.M. & Chan, D.W.M. 1998. Contributors to construction delays. Construction Management and Economics, 16(1), pp. 17-29.

12. Le-Hoai, L., Y.D. Lee and J.Y. Lee, 2008. Delay and Cost Overruns in Vietnam large construction projects:A comparison with other selected countries. KSCE J. Civil Eng., 12: 367-377.

13. Mansfield NR, Ugwu O & Doran T. (1994). Causes of delay and cost overruns in Nigerian Construction project . Int J project manage. 12 (4): 254-60.

14. Ogeno, D. O. (2016). *Factors influencing completion of construction projects in Kenya*: a case of government buildings construction projects in Nairobi County, Kenya.

15. Rum, N. A., & Akasah, Z. A. (2011). Implementing Life Cycle Costing In Malaysia Construction Industry : A Review. In International Building & Infrastructure Technology Conference Vistana Hotel, Penang, Malaysia

16. Sambasivan, M., & Soon, Y. W. (2007). Causes and effects of delays in Malaysian construction industry. *International Journal of project management*, *25*(5), 517-526.

17. Sweis, G., Sweis, R., Hammad, A. A., & Shboul, A. (2008). Delays in construction projects: The case of Jordan. *International Journal of Project Management*, *26*(6), 665-674.

18. Tumi, S. A. H., Omran, A., & Pakir, A. H. K. (2009, November). Causes of delay in construction industry in Libya. In *The International Conference on Economics and Administration* (pp. 265-272).

Product and Performance Analysis of Islamic and Conventional Banks in Pakistan: A Comparative Study

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ABSTRACT: This study is conducted to find out product differentiation and financial performance of Islamic and conventional Banks working in Pakistan for the year 2009-2014.The difference between Islamic and conventional banks evaluates its past derivation, assembling of financial resources, and methods for making profit, employed values, product constructing and scheming and capital structure. Financial Performance is compared through average values of different ratios of both Islamic and conventional banks. Thirteen Financial Ratios are estimated to measure the performance of both banking system in terms of Profitability, Assets Quality, Liquidity and Risk and Solvency.M-ANOVA is used to determine the significance of mean value of these ratios between and among the banks. The study concluded that product of Islamic banks are not similar to conventional banks as islamic banks are operating on Shariah principles where transactions are Riba Free, and avoid any unethical practice and participate actively to achieve goals and objectives of Islamic economy. Financial Performance reveals that Islamic banks are less profitable, less riskier with less liquidity ratios, where Assets Quality is maintained at equally at both banking system.

Keywords – Islamic Banks, Conventional Banks, Product, Financial Performance

1 INTRODUCTION:

Banks plays key role in mobilizing funds for channeling public saving into productive investment activities which invigorate to maintain the healthy economy. Banks make a getaway between spare and scarce units for promotion of trade and business. In Pakistan banking sector comprises of both Islamic and conventional banks. Conventional banks have been working subsequent to the foundation of Pakistan while Islamic banking is a rising part.[1]Islamic banks have been expanding rapidly and growing at 10-12% annually. This sustained development momentum throughout the most recent 10 years gives strong confirmation of the growing acceptability of Islamic banking as a sustainable and a substitute to the conventional banks. Islamic banks differ from its conventional counterparts both in terms of assets and liabilities. Islamic banks holds deposits from its customers on the basis of current account based on islamic contract of Qarz-e Hasna and saving accounts are opened on the Musharika and Mudarbaha.On the other hand islamic banks offer three types financing facility firstly sale based financing facility i.e Murabbaha, Salam and Istisna.Secondly by offering participatory modes of financing facility Musharika, Mudarbah and Diminishing Musharika Thirdly by islamic leasing mode Ijarah. Pakistan has taken genuine efforts for foundation Islamic banks in January 2000 when State Bank of Pakistan (SBP) established a Commission for Transformation of Financial System (CTFS) to present Sharia consistent methods of financing, as a result of which in September 15, 2003, the State Bank of Pakistan (SBP) formulated special department for Islamic Banks. January 2002, made a land mark for establishment of sharia based framework in Pakistan by inauguration of Meezan Bank Limited as a first full-grown Islamic Bank. Now most of the conventional banks are running islamic branches parallel to

[1] http://www.worldbank.org/en/topic/financialsector/brief/islamic-finance

their conventional banking business.[2]Total Islamic banks branches network comprises of 2075 branches as on December 2015 and captures 15% of total financial market share in Pakistan.
This study aims to compare the product and performance of islamic banks from year 2009-2014, financial performance is compared for 6 years on the basis of different ratios i.e. Profitability, Liquidity, Risk and Solvency and asset test ratio. The study is important as there are many stakeholders who are interested in viewing the performance of islamic banking sector on the basis of which future corrective measures can be established and potential investment can be made. On the basis of aims and objective following research questions have been answered to present the study.

- To compare the products structuring of Islamic banks with conventional banks.
- To compare profitability of Islamic banks with conventional banks.
- To compare the liquidity of Islamic banks with conventional banks
- To determine the risk and solvency of Islamic banks with conventional banks
- To determine asset quality of Islamic banks with conventional banks

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2 Literature Review

In 1963 Islamic banks appeared on a trial grounds on a small scale in a residential community of Egypt. The achievement of this trial opened the ways for operational working of Islamic banks. As a result of which Islamic banks appeared at a moderate scale and various full-fledge Islamic banks was introduced in 1970 in most of the Islamic countries. Islamic banks are working in more than 60 nations with asset base of over $166 billion with yearly development rate of 10%-15%. Islamic banks of Muslim nations have ascended from 2% in the late 1970s to around 15 percent today in a credit market
Samad (2004) compares the Islamic and conventional banks in Bahrain from year 1991-2001. The study shows that credit performance of both banks is different however there is not much difference in profitability and liquidity measures of both of these banks. Iqbal(2001) has carried out performance analysis of both these banks using trend analysis from year 1990-1998 by taking 71 commercial banks in GCC countries. The results revealed that conventional banks are more efficient than Islamic banks. Kaleem and Isa (2003) have carried out their study regarding the return earned on deposit procurement of both Islamic and conventional banks using econometric techniques. The results reveals that Islamic banks contributes significantly in developing economies and earns the trust of the people by offering various sharia based deposit products. Akhtar et al. (2011) has made comparative analysis of Islamic and conventional banks which shows that liquidiy risk and net working capital to assets have positive relationship also capital adequacy of conventional bank and return on assets of islamic banks have positive and significant relationship with liquidity risk.
Wasiuzzaman and Gunasegavan (2013) have investigated the performance of Islamic banks in Malaysia where results favors the Islamic banks in terms of efficiency, capital adequacy, assets quality and operational efficiency. Hassan (2005) has used interest free banks from 22 countries by taking multiple efficiency techniques. Where it has been found out that Islamic banks are less efficient in containing operating cost than their conventional counterparts in the world whereas they are efficient in generating profit.it has been revealed in the study that reason of less efficiency of Islamic banks is that they have to face regulation which are not favorable to Islamic transaction in most of the countries. Fayed (2013) have conducted the comparative study of Islamic and conventional banks in Egypt. This empirical study analyzes the performance of three Islamic banks and six conventional banks working in Egypt. The study collected the data between years 2008-2010, the study also elucidated that Islamic banks still have to face many challenges in order to perform better in the financial market. Some of these challenges includes operational contrast between theoretical base and real operation of Islamic banks in Egypt along with it they donot have clear implementation for profit and loss sharing concept with their clients.

There are several studies carried out in Pakistan which also compares the performance of Islamic and conventional banks in Pakistan. Jaffar and Manarvi(2011) have used CAMEL test for comparing the performance of Islamic and conventional banks performance for the years 2005-2009.The results reveals that the conventional banks have better liquidity management and earning ability where both banks share similar asset quality. Moin (2013) have also carried out similar study for different time period i.e year 2003-2007 which also reveals the similar result that conventional banks are performing better due to its working operations since many years.

Islamic banking industry becomes a reality and proved to be strong alternate system to the existing financial problems of the world. Researches carried out on the subject matter do not show the similar result due to different period of times, geographical areas, cultural and economic perspective and analytical tool. But as far as product structuring is concerned

[2] http://www.customstoday.com.pk/islamic-banking

almost all studies shows unanimous results with the core differentiating values i.e.1)-Prohibition of interest (riba) 2)-Financing is linked to real assets (materiality) 3)-Engagement in immoral or ethically problematic business not allowed (e.g, arms manufacturing or alcohol production) 4)-Returns must be linked to risks

3 Methodology

This study is expected to look at the product and financial performance of Islamic and conventional banks in Pakistan. Research data is collected from secondary information which includes financial reports, research journals and papers issued by SBP as guidelines for their operations. Data for product structuring is taken from already available material, i.e. books and articles research journals its differentiating point with each other is compared. Financial data is collected from annual reports, Published Financial Statements of the banks for the years 2009 to 2014.Ratio analysis technique is used to determine the performance of Islamic and conventional banking. The study assesses interbank performance of Islamic and Conventional banks in terms of profitability, liquidity, risk and solvency and assets test ratio. The study uses thirteen financial ratios to evaluate bank performance. These ratios are grouped under four broad categories.

3.1 PROFITABILITY RATIOS

Profitability ratios measure the managerial efficiency of the business. Profitability ratios measure return on Assets, deposits investment and equity where higher the profitability ratio better is the performance. There are following three ratios which are calculated in the shade of profitability

1. Return on Assets (ROA) = Profit/(Loss) after taxation/Total Assets
2. Return on Equity (ROE) = (Profit/(Loss) after taxation/Total Equity
3. Earnings Per Share (EPS) = (Profit/(Loss) after taxation/No.of Ordinary Shares

3.2 LIQUIDITY MEASURES:

Liquidity ratios measure the ability of the bank to meet cash requirement and other short term financial obligation. Banks may face liquidity problem by excess withdrawal from current and saving account.

1. Current Assets ratio = Cash and Cash Equivalent/Total Assets
2. Investment to total Assets=Investment/Total Assets
3. Deposits to Assets=Deposits and other Account/Total Assets
4. Advances to deposits ratio =Gross Advances/Deposits

3.3 RISK AND SOLVENCY RATIOS:

Risk and Solvency ratio depict the picture of how much bank is relying over its debt financing and its ability to meet all due debt obligation. It carries out that details of how much bank owes than it owes.

1. Debt to Equity Ratio = Total Debt/Shareholders Equity
2. Debt to Assets Ratio = Total Debt/Total Assets

3.4 ASSETS QUALITY MEASURES:

These ratios defines the quality of loan that bank disbursed and on the basis of which income in the form of markup is earned. It reflects productive and effective utilization of resources. Higher the loan loss ratio will affect the quality of advances.Asset quality measures following ratios:

1. Nonperforming loan to Gross Advances =Classified Advances/Gross Advances
2. Provision against NPL to NPLs =Provision against NPLs/NPLs
3. Non-Performing Loan to Deposit Ratio = Classified Advances/Total Deposits
4. Non-Performing loans to Shareholders Equity=Classified Advances/Shareholders Equity

3.5 Sample:

Shariah based banking products are offered by 5 full-fledge Islamic banks and 14 Conventional Banks in Pakistan. Up to June 2013, around 1115 branches of IBIs were working in Pakistan. Following Six banks are selected on the basis of their size, assets, deposits, loans, and financing of banks according to KPMG Banking Survey 2007.

ISLAMIC BANKS:

Meezan Bank
Bank Islami
Burj Bank

CONVENTIONAL BANKS:

Bank Alfalah
Askari Bank
Bank Alhabib

3.6 Descriptive analysis:

Descriptive analysis includes operational methodology of Islamic banks along with its product structuring with respect to its underlying contracts which is thoroughly compared with conventional bank.

3.7 Quantitative Analysis:

Quantitative Analysis is measured by ratio analysis. Ratios are guiding financial analysis tool in order to compare financial and operation position within same industry by comparing its increasing and decreasing trend in a given study period .It also open further room for those areas which requires further investigation.

3.8 Data Analysis:

Performance of both banks is compared by interbank comparison. Multivariate Analysis of variance (M-ANOVA) is a simple ANOVA with several dependent variables as it determine the covariance between the outcome variable arises from mean difference of financial ratios of the bank. The decision criteria is Significant value; if sig value is greater than 0.05 null hypothesis will be rejected if and if it is less than 0.05 research hypothesis will be rejected. The equality of means among banks is tested empirically through compared means to find mean differences among the banks.

4 Data Finding and Analysis

4.1 DESCRIPTIVE DATA ANALYSIS

Islamic financial framework provides a road way amongst SSUs (savings-surplus units) and SDUs (savings-deficit units) by offering variety of financial products and services according to Islamic moral standard.

4.1.1 FINANCING SIDE PRODUCTS

There are variety of services that may likely be offered by both Islamic and conventional banks so long as it does not enter into debtor and creditor relationship because such a relationship may bring out the possibility of existence of riba.Islamic law allows trade and exchange transaction on the basis of profit and loss arrangements. Financing products are the uses of funds, out of these financing products some are debt or debt based while others value based or equity based financing.

4.1.1.1 EQUITY BASED FINANCING PRODUCTS OF ISLAMIC BANK

Equity based offered financing products have some prevalence over conventional banks on the ground of morality and efficiency. Equity based financing under Islamic banks are carried out by;

1. Musharaka
2. Mudaraba
3. Diminishing Musharaka

The difference between Conventional bank's financing and Musharakah:

Conventional banks charged fixed rate of interest/return over the amount of loan advanced irrespective of profit/loss earned by the borrower. Whereas Musharika facility does not claim for fixed rate of return rather it is adjoined with the amount of actual profit/loss earned. Which is ideal alternative to interest based financing. Here in conventional Banking system bank do not suffer the portion of loss incurred by the borrower in his business whereas under Musharika facility financer bears the loss. On the whole Musharaka, involves unlimited liability, as both both share decision making authority. Therefore if liabilities exceed the value of assets upon liquidation then all liabilities will be bore by both sharing partners on pro rata basis. Such equity-based banks are superior to conventional banks as the former has the power to external shocks absorption. Equity based financing proves to be better than conventional bank on the ground of moral view, decency and social equality.

The difference between Conventional bank's financing and Mudaraba:

The principle highlights which recognized Islamic value financing with conventional financing is that Equity based financing products involves the sharing of profit and loss. Value of assets may either change positive or negative by accumulation of returns as periodic profit. An important feature of Mudaraba financing is ruling out of profit in absolute terms other than pre agreed proportion of benefits that are to share between financer banks and customers unlike conventional Bank. In Mudaraba financing losses are completely bear by the bank but customer shall be liable to pay the lessees if such losses are occurred due to administrative carelessness or misconduct. Where under traditional banking system banks do not bear the loss of capital in any case.Mudaraba financing provides limited obligation for financing bank as level of bearing risk is limited to the amount of capital investment which is quite rational and reasonable as bank is not participating in administrative operational decision making.

The difference between Conventional bank's financing and Diminishing Musharaka.

Conventional banks finance its customers to earn profit through markup payments where borrower is charged with interest at fixed or variable rate but in diminishing Musharaka islamic bank and customer share joint ownership of the venture with determination of payment of future rentals and profit share of the capital investment. Since Shariah does not permit forward sale and purchase commitment from both parties but allows unilateral promise which binds the customer to purchase and redeem the share of the bank at specific future date.

4.1.1.2 DEBT-BASED FINANCING PRODUCTS OF ISLAMIC BANK

Subsequent to Equity Based financing models which have robustness to bear external shocks Islamic bank have extended framework of debt based financing mechanism which includes;

1-Murabaha
2-Salam
3-Istisna

The difference between Conventional bank's financing and Murabaha

A state of contrast between Murabaha and conventional financing is its lending rates.Murabaha is such financing products with high degree of volatility and mostly offer floating rate financing product. Where Murabaha structure offer fixed rate product here rate is determined once for a given period of contact and is not allowed to float where fixed financing facility may be converted into debt rollover where new lending rate is fixed for other contracting period by replacing the old one. Here debt rollover means another Murabaha is booked for the same merchendize.It is trusted that conventional lending has an implicit disincentive against defaults and delinquencies and incentive for early repayment. Borrower is punished with added penalties in case of late payments or default and granted discount if he pays his debt earlier then booked period. Since this compensation is due to time value of money which can be constituted with the fact of existence of riba where in contrast to Murahaba financing cost price cannot be increased or decreased and becomes fixed for the booked contracting period.

The difference between Conventional bank's financing and Salam.

Commercial Bank provides agricultural financing through State Bank of Pakistan and earned interest by charging fixed rate of markup which is generally higher than value of its commodity and does not bear any kind of price risk which is against Shariah principal.

The difference between Conventional bank's financing and Istisna

The concept of charging interest whether it is fixed or variable makes the Islamic banking contract different from Conventional product structuring. Where the concept of earning profit is to get financial gain in the name of Gharar but here it relates with societal gain for uplifting of business entities which comes up with economic prosperity.

4.1.2 DEPOSITS SIDE PRODUCTS:

It is analyzed while reviewing liability side products that conventional Bank raises its funds by offering fixed deposit products with fixed and predetermined return in the form of interest and in case of floating rate deposit interest rate is linked with bench mark i,e KIBOR which varies with value of benchmark. Under both situation rate of return can never be negative and nominal value is guaranteed and depositor is entitled to an excess amount than deposited.

Conventional banks also raises funds by borrowing from the central bank or from interbank money market which also involves interest payment in the form of riba.Whereas Islamic banks does not offer any product that trade off the shariah compliance. Islamic bank mobilize and procure savings from the depositors by offering shariah compliant products that also vary with different rate of return, risk, liquidity, maturity and safety. Islamic law deals the deposit amount as amana of the investor toward the bank where conventional bank seeks deposit for its own interest i.e. not for safe keeping only but its utilization thereof and paying it back with added amount.

4.2 QUANTITATIVE DATA ANALYSIS

Financial performance of Islamic bank is compared with Islamic bank over the period of six years from 2009 to 2014.This study carries 13 different financial ratios to know the performance measures. Multivariate Analysis of variance (M-ANOVA) is a simple ANOVA with several dependent variables as it determine the covariance between the outcome variable arises from mean difference of financial ratios of the bank. The decision criteria are significant value; if sig value is greater than 0.05 null hypotheses will be rejected and if Sig. value is less than 0.05 research hypothesis will be accepted. The equality of means among banks is tested empirically through compared means to find mean differences among the banks.

Profitability of bank is analyzed by using three ratios i.e. ROA, ROE and EPS. ROA, (Return on Assets) tend to measure how well business is using its assets to generate income. Higher ROA can be attributable for higher profit margin or rapid turnover of assets or combination of both. ROA of Islamic bank is lower than conventional Bank indeed it becomes negative by -2.93% in year 2010 and shows unstable trend over the period of review. But same decline to negative also occurs as far as conventional bank is concern in year 2013 by -0.21%. This negative trend could be attributed to the decline in quality of assets, particularly in the form of loan portfolio as substantial provision is made against nonperforming loan. It is shown from the data that ROA has both increasing and decreasing trend for both banks. ROE measures business returns on equity as what has been earned over the investment. where the fluctuating position of CB during the period and went into red zone in year 2013 which mainly occurs as Askari bank reported loss in year 2013.IB shows increasing trend over the years and does not cross the danger zone which yield more promising and predicting positive side for shareholders of Islamic bank in near future. Since ROE and EPS are weighted by the owners and shareholders because higher the values of these ratios higher will be the dividend and payout in near and future. Investors pay much value to these ratios when the decision is to be made for buying the shares of any listed company. This ratio shows positive and stable trend over the years whereas CB shows decreased average ratio of 16.94% in year 2013 and covers up in the following year i.e. 2014 by 23.94% in the trend line.

Table:1 M-ANOVA of Return on Assets (ROA)

Banks	Ratios	2009	2010	2011	2012	2013	2014	Mean	SD	f-value	Sig.
IB	ROA	1.23	-2.93	1.74	1.47	0.66	1.17	0.36	1.399		
CB	ROA	0.77	0.98	2.16	1.63	-0.21	2.11	0.89	0.644	3.148	0.085

Table:2 M-ANVOVA of Return On Equity (ROE)

Banks	Ratios	2009	2010	2011	2012	2013	2014	Mean	SD	f-value	Sig.
IB	ROE	18.8	13.64	25.84	28.19	16.94	23.94	17.23	12.023		
CB	ROE	15.3	21.26	45.14	33.88	-7.91	42.28	17.95	13.94	1.975	0.169

Table:3 M-ANOVA of Earning per Share

Banks	Ratios	2009	2010	2011	2012	2013	2014	Mean	SD	f-value	Sig.
IB	EPS	2.66	2.37	4.37	4.43	3.69	5.23	2.92	1.924		
CB	EPS	3.6	3.96	8.54	6.79	0.91	9.18	3.97	2.491	5.904	0.021

By looking at the overall average figure of profitability measures of Islamic and conventional bank in relation to ROA,ROE and EPS which shows that profitability performance of Islamic bank is not significantly different as M-ANOVA shows for two variables i.e ROA and ROE that performance ratio of two banks is not significantly different at 5% level of significance. Where for EPS sig value is less than 5% whereas mean value of CB in all ratios are greater than IB therefore research hypothesis is rejected that Islamic banks are more profitable than conventional banks.

The Liquidity position of Islamic and conventional banks is analyzed by Current Assets ratio, Investment to total Assets, Deposits to Assets, Advances to deposits ratio. Higher value of CAR measures that bank has higher liquid assets to pay back it depositors. Current Assets ratio of bank measures Cash and account with banks to Total assets.Islamic bank is ahead of conventional bank till year 2012 and even becomes equal in year 2013 and declines in year 2014 by 16.54%. Investment to Total assets ratio appears for SCB is higher than Islamic Banks except for year 2012, but still shows consistent growth over the period of time whereas Islamic bank shows inconsistent increase and decrease trend after year 2012.which is mainly due to the reason that conventional banks offer more interest profit margin than Islamic bank. Therefore, people are reluctant to invest in less profitable investment. Some people avoid risk and invest in safe securities where they can share the risk of loss as in case of Islamic banks. Islamic banks have fewer opportunities toward investment portfolio as they are bound by sharia compliance and due to lack of lending opportunities and more relying on equity based loaning.LDR (Loan to deposit Ratio) measures the degree of reliance of bank over borrowed funds. The higher is the value of LDR leads to illiquidity of the bank over borrowed funds. Results are showing in conjugation with CR, that SCB values are higher but not significant than Islamic banks. This is confirming with statement that SCB are less liquid and relying more on borrowed funds than Islamic bank, as already said that due to sharia bound Islamic banks have less lending opportunities. This had risen with 146.27% in year 2014.Deposit to total Assets ratio shares the amount of the portion of deposit liability that contributes to the generation total assets. This ratio has decreasing trend as far as SCB are concern whereas it is increasing timeline in Islamic bank over the period of study, but comparative figures are lesser for Islamic bank on average and become equal in year 2013 with 198.83% and becomes ahead in year 2014 with 194.77%. Increasing figurative values in deposits are mainly due to the fact that SCB are working in the financial market since long then SIBs, with the time people are more aware with Islamic deposit products and save their fund in Riba free and sharia compliance deposit model.

Table:4 M-ANOVA of Current Assets Ratio (CAR)

Banks	Ratios	2009	2010	2011	2012	2013	2014	Mean	SD	f-value	Sig.
IB	CAR	29.25	34.61	23.23	26.26	27.22	21.33	26.99	3.056		
CB	CAR	28.29	24.63	26.58	27.15	27.22	16.54	25.07	3.36	0.302	0.586

Table:5 M-ANOVA of Investment to Total Assets Ratio (InvTA)

Banks	Ratios	2009	2010	2011	2012	2013	2014	Mean	SD	f-value	Sig.
IB	InvTA	34.73	59.95	87.98	101.26	82.95	52.04	69.82	12.479		
CB	InvTA	66.61	75.19	93.77	94.85	95.32	111.3	89.5	10.205	10.05	0.003

Table:6 M-ANOVA of Loan to Deposit Ratio (LTD)

Banks	Ratios	2009	2010	2011	2012	2013	2014	Mean	SD	f-value	Sig.
IB	LTD	143.57	140.28	129.8	114.29	124.21	146.3	133.06	13.397		
CB	LTD	151.4	144.64	123.4	122.43	124.44	115.6	130.31	8.133	2.384	0.132

Table:7 M-ANOVA of Deposit to Total Assets Ratio (DTA)

Banks	Ratios	2009	2010	2011	2012	2013	2014	Mean	SD	f-value	Sig.
IB	DTA	176.44	187.29	189.2	192.97	198.83	193.8	79.191	8.126		
CB	DTA	202.79	194.86	196.7	197.11	198.82	193.8	82.791	3.816	2.893	0.098

Liquidity ratios revealed the results that Islamic bank average current ratio is more than SCB with 26.99% and 25.07% respectively. Which defines that Islamic bank owns more liquid assets than SCB.Which confirms with the fact of loan to deposit ratio as it higher with average value of 133.06% for Islamic bank and 130.31% for SCB, As more avenues have been opening up for Islamic lending products and shows effective result in year 2014 as compares to SCB with ratio of 146.67% to 115.61% respectively .As deposit have grew with 29% during the period of study. Investment to total assets ratio and deposit to total assets ratio is higher and favoring SCB at its average. Thus overall result based on M-ANOVA reveals that liquidity performance of Islamic bank is not significantly different from Conventional Bank. Therefore research hypothesis is rejected that Islamic banks are more liquid than conventional bank.

Risk and Solvency ratio depict the picture of how much bank is relying over its debt financing by calculating Debt to Equity Ratio and Debt to Assets Ratio. DER (Debt to Equity Ratio) measures the bank's ability to bear external financial shocks. Comparison of this ratio between the two banks indicates the credit worthiness and financial risk of the bank. The lower risk and solvency ratios are shows lower riskiness of bank. In such a case islamic banks shows lower results than SCB.whereas values are volatile for SCB over the period of study showing increasing and decreasing trend. DAR (Debt to Assets Ratio) indicates the financial strength of the bank to pay its debtors or the percentage amount of assets supported by debt financing. Bank undergoes higher financial risk if debt to asset ratio is higher. The stated figures shows that SCB are more exposed toward financial risk than Islamic banks. Whereas SCB remains consistent over the selected period and Islamic bank shows increasing trend.

Table:8 M-ANOVA of Debt to Equity Ratio (DEQ)

Banks	Ratios	2009	2010	2011	2012	2013	2014	Mean	SD	f-value	Sig.
IB	DEQ	17.17	20.02	22	27.33	28	32.04	24.42	4.926		
CB	DEQ	46.13	49.25	46.18	45.46	48.97	39.02	45.83	1.778	68.869	0

Table:9 M-ANOVA of Debt to Assets Ratio (DTA)

Banks	Ratios	2009	2010	2011	2012	2013	2014	Mean	SD	f-value	Sig.
IB	DTA	195.71	202.86	206.5	211.44	215.57	215.9	207.99	8.123		
CB	DTA	220.02	221.23	220.9	220.29	221.57	220.1	220.69	0.295	14.899	0

Average DEQ, DTA for Islamic bank are 24.42% and 207.99% as compared to 45.83 and 220.69% for their Conventional counterpart. Overall risk and solvency ratios shows positive results for Islamic bank and figures revealed that Islamic banks are less riskier than conventional bank and they have the ability to absorb the financial shocks and are more solvent as becomes more financial enabled to pay its debtor-ANOVA also supports the result as mean difference of DEQ and DTA is statistically different at 5% level of significance. The lower risk and solvency ratio are good for investor to invest their funds. It is analyzed from the figures that that hypothesis is accepted that Islamic banks are less risky and more solvent than conventional banks on the basis of their financial strength.

Assets quality ratios define the quality of loan that bank disbursed and on the basis of which income in the form of markup is earned. It reflects productive and effective utilization of resources. Higher the loan loss ratio will affect the quality of advances. NPL to gross advances shows the quality of financing of the bank. It evaluates impact of classified loans over quality assets based on loan portfolio.NPLs to gross advances ratio of Conventional Banks for the selected period is higher with average increasing trend of 67% percent comparing to selected Islamic Banks. Although series of Islamic bank data shows increasing and decreasing trend but overall it is lower than CB which reflect the careless lending practice of conventional bank. Assets quality of both banks shows that CB are not funds are not properly utilized therefore aggregate amount of net non-performing loans stands at Rs.15.920 billion. Higher NPL amount reflect imprudent lending and inefficient recovery policy adopted by Conventional Bank. It can also be assumed that loan financing are not diversified which record in loan losses for the bank. In contrast classified advances of Islamic banks is Rs.2.724 million which is just 0.171% of SCBs' NPLS which confirms that loan portfolio is healthy ,credit allocation is diversified with prompt recovery in classified loan. Provision against NPL to NPLs Islamic Bank is 29.03% as against 15.86% of conventional Bank, provision in a banking system is the cushion amount that bank reserves to bear its loan losses; higher amount of provision for classified loans depict healthier and transparent picture of balance sheet. While comparing the figures of the two banks average provisioning of SCB is higher than IB due to the size of loan portfolio and ratio of defaulted amount.NPLs to deposit ratio of Islamic bank is lower than CB, additionally both sector undergoes toward declining trend. This determines increase in deposits as well as strict lending practices followed. As, increase in this trend depicts reckless lending practices but looking at trend line of both sectors shows vigilant approach toward lending practice as it ultimately impact the liquidity position of the banks. Shareholder's equity calculates share capital, reserves and unappropriated profit (Loss).The ratio between NPLs to Shareholders equity indicates exposure of shareholder to classified loans. Whereas, increase in trend leads to the amount of equity at stake. This ratio is a way ahead for conventional bank then Islamic bank which is due to amount of equity invested and lending rate.

Table:10 M-ANOVA of Non-Performing loan to Gross Advances Ratio (NPLTGA)

Banks	Ratios	2009	2010	2011	2012	2013	2014	Mean	SD	f-value	Sig.
IB	NPLTGA	16.56	20.8	17.42	15.94	12.63	11.11	15.66	3.878		
CB	NPLTGA	20.57	21.71	24.05	26.01	24.49	23.05	23.31	5.362	0.317	0.577

Table:11 M-ANOVA of NPLs to Deposit Ratio (NPLsTD)

Banks	Ratios	2009	2010	2011	2012	2013	2014	Mean	SD	f-value	Sig.
IB	NPLsTD	3.78	4.19	3.41	2.67	2.3	2.26	3.1	2.501		
CB	NPLsTD	4.91	4.91	4.62	4.75	4.39	3.88	4.58	3.229	0.071	0.791

Table:12 M-ANOVA of NPLs to Shareholders Equity Ratio (NPLsSHE)

Banks	Ratios	2009	2010	2011	2012	2013	2014	Mean	SD	f-value	Sig.
IB	NPLsSHE	54.16	79.95	74.89	74.89	75.65	73.37	72.14	8.558		
CB	NPLsSHE	231.64	255.14	233.7	242.64	265.03	180.8	234.83	58.575	14.193	0.001

Table:13 M-ANOVA of NPLs to Provision against NPLs to NPLs Ratio (PNPLsTNPLs)

Banks	Ratios	2009	2010	2011	2012	2013	2014	Mean	SD	f-value	Sig.
IB	PNPLsTNPLs	131.85	136.88	219.75	167.89	196.64	203.62	176.11	31.517		
CB	PNPLsTNPLs	165.88	170.20	191.58	187.43	213.91	207.08	189.35	35.865	4.186	0.049

Overall conventional banks are ahead of Islamic banks in reviewing these ratios. Where aggregate amount of NPL of IB for selected period is 2.72b to conventional bank i.e. 15.92b.NPLs to advances ratio of Islamic bank is 15.66% as compare to 23.31% of SCBs.This ratio of SCBs is 7.65% more than Islamic Banks. Provision to NPLs of Islamic Bank is 176.11% as against 189.35% of Conventional Bank. Results interpreted through M-ANOVA that 2 variables i.e. NPLsTA,NPLsTD of assets test ratio of two banks are not statistically different at 5% level of significance and other two variables i.e. PNPLsTNPLs,NPLsSHE are sig at 5%level of significance. Whereas the mean values CB are also greater than IB.

5 Conclusion

Development of Islamic Bank in lined with conventional Banks during 2009-2014 has recorded a steady growth in term of assets development and procurement. Assets have expanded around 27.12% for every year which can be quickly contrasted with conventional banks as 20.16%.Advances and investment of Islamic bank recorded 46.75% and 30.43% as against 26.77% and 9.04% of conventional bank. Branch banking network also reached at a cumulative number of 1314 by the end of December 2014, which is not less than a wonder in the financial history of Pakistan. Market Share of Islamic Banks with respect to deposit was expanded by 26.15% over the year. This expansion of Islamic banks is a strong proof that Islamic banking has risen as an alternate financial system to meet financial requirement of the customers and business community under the shariah standards.

This research reveals that Islamic banks offer products which are not similar to those offered by the conventional banks because products of Islamic banks are designed as per Shariah principals. On the other hand conventional banks product and policy framework is based on the ruling principal of earning profit by the way of interest and cash based financing. Major fundamental difference is that Islamic banks offered financing product based on asset capitalization formation. Conventional Banks offer variety of products which still Islamic banks lag behind due to shariah restriction but still Islamic bank‘s Mudarabah,Musharaka financing are very famous and yield good income for both investor and lender.

The results based on comparing the financial performance of Islamic versus Conventional Banks research analysis reveals that the hypothesis tests accepted in one area, that is Islamic Banks are less riskier and more solvent than conventional Banks, hypothesis were rejected which belongs with profitability and liquidity of Islamic Banks. Where assets Quality ratio shows equal results.

6 References

1. Akhtar, M.F., Ali, K., Sadaqat,S.(2011),Liquidity risk management: A comparative study between conventional and Islamic banks of Pakistan. Interdisciplinary Journal of Research in Business, 1(1), 35-44.
2. Akkas,A.(1996),Relative Efficiency of Conventional and Islamic Banking System in Financing Investment Unpublished Ph.D. Dissertation, Dhaka University.
3. Fayed, M.E. (2013), Comparative Performance Study of Conventional and Islamic Banking in Egypt, Journal of Applied Finance & Marketing, 3(2), 1-14.
4. Hassan (2005), An Empirical test of association between production and financial performance: The case of commercial banking industry. Applied Financial Economics, 4(1), 55-60.

5. Iqbal, M. (2001), Islamic and conventional banking in the nineties: A Comparative study, Islamic Economic Studies, 8(2), 1-28.
6. Jaffar, M.,Manarvi, I.(2011), Performance comparison of Islamic and conventional banks in Pakistan. Global Journal of Management and Business Research, 11(1), 59-66.
7. Kaleem, A., Isa, M.M. (2003), Casual relationship between Islamic and conventional banking instruments in Malaysia, Islamic Journal of Islamic Financial Services, 4(4), 1-8.
8. Ashraf, M., I, (2002), Meezan Bank’s Guide to Islamic Banking.
9. Moin, M.S. (2013), Financial Performance of Islamic Banking and Conventional banking in Pakistan: A comparative study, International Journal of Innovative and Applied Finance, 3, 2-5.
10. Samad,A.(2004),Performance of Interest-free Islamic banks Vis-à-vis interest-based conventional banks of Bahrain.IIUM Journal of Economics and Management,12(2),1-15.
11. Wasuzzaman, S., Gunasegavan,U.N.(2013), Comparative study of performance of Islamic and conventional banks: The case of Malaysia,29(1),43-60.

SUPPLY CHAIN LINKAGE AND PERFORMANCE CONTAGION: A PANEL THRESHOLD APPROACH

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Abstract: The aim of this paper is to investigate the non-linear relationship between the strength of the supply chain linkage and the financial performance of the linked organisations. Through literature review and based on empirical evidences, it has been observed that the individual organisation's financial performance within a supply chain is contagious with each other. A firm's performance oscillation due to the exogenous factor such as an economic shock event may be rippled out to other firms demonstrating a performance contagion effect. And how much is the level of contagion between the linked firms in a supply chain appears to be dependent on the linkage strength - a structural factor. This research hypothesises that the organisations' financial performance contagion is non-linearly associated with the supply chain linkage strength; and the non-linear relationship between the linkage strength and the financial performance contagion can be influenced by the exogenous factor - the economic shock event in the business environment. Based on a set of real-world supply chain data, panel threshold method is used to test the hypothesis. As a result, one significant threshold on the dimension of the degree of shock has been identified; and a consequent non-linear relationship model between the linkage strength and performance contagion has been established. It is concluded that the panel threshold analysis and modelling reveal two performance contagion models that fit to the lean and agile supply chain paradigms respectively. The linkage strength as one of the supply chain's key structural characteristics do have a non-trivial relationship with the degree of the financial performance contagion but only does so under a specific environmental circumstance.

1. INTRODUCTION

A supply chain's structural factors exert great influence to its financial performance in the market place (Gunasekaran, Patel & Mcgaughey, 2004; Randall & Ulrich, 2001). One of such structural factor is called linkage strength (Wang, 2014a; Tsouma, 2009), which is broadly defined as the level of transactions taken place between the supplier and buyer and the level of the embedded operational collaborations (Johnson & Grayson, 2005; Boles, Johnson & Barksdale Jr, 2000; Donaldson & O' Toole, 2000). It is usually measured in between a specific dyadic supplier-buyer linkage within a supply chain, and understandably the linkage strength could vary significantly across different links or echelons in a supply network. However, unlike some of the widely discussed topics such as supply chain integration (Reid, Ismail & Sharifi, 2015; Hsu & Li, 2011), strategic alliance (Yang, Lai, Wang, Rauniar & Xie, 2015), and partnership (Gallear, Ghobadian & He, 2014) and so on, linkage strength is both an economic measure and a managerial measure. Despite where it should be categorised taxonomically, it has a direct correlation, if not a causal relationship, with the firm's financial performance (Aobdia, Caskey & Ozel, 2014; Acemoglu, Ozdaglar & Tahbaz-Salehi, 2010; Hertzel, Li, Officer & Rodgers, 2008). There are enough evidences to support that a supply chain's economical and financial performances contagion can be, at least partially, attributed to its linkage strength as one of the structural factors in the supply chain.

Another factor that influences the firms' financial performance is the exogenous factor arisen from the business environment where the supply chain operates. It has been observed that an organisation's financial performance may take an uncontrolled dive or rise when an economic shock event (Chung, Hung & Yeh, 2012; Brenner, Pasquariello & Subrahmanyam, 2009) took place in the linked organisations; and as a consequence there will always be a shock-ripple-effect that passes to the neighbouring firms, which makes it appears to be contagious through the linkages of the supply chain. Moreover, empirical evidences Chung et al. (2012: and Liu and Cruz (2012: also suggest that the magnitude of such contagion in terms of organisation's financial performance appears to have directly and significantly related to both the supply chain linkage strength and the environmental disruption due to economic shock events.

For the convenience of the discussion, we first provide a working definition for the three key terminologies: "linkage strength", "performance contagion", and "economic shock". In a supply chain management context, we define the linkage strength as the amalgamated index of the transaction volume of the transformed-material purchased / supplied, the level of any other tangible and/or intangible resources exchanged between the linked firms; and the level of operational coordination and collaboration. Linkage strength, therefore, represents one of the supply chain's endogenous structural character. Thus, it is perceived and measured mostly at a tangible operational level for the convenience of modelling. Although, the level or the strength of such linkage in a supply chain is surely related to the supply chain strategies which may or may not be so easily measurable. As we will discuss later, one of the research implications is that the decision on the linkage strength will certainly have its strategic implications.

We define "performance contagion" as the co-movement of the linked firms' financial performances. The rise or fall of a firm's financial performance is mirrored to more or less degree in a linked neighbouring firm. Thus, performance contagion, is not mainly concerned about the firm's performance but about contagion. Supply chain performance is a whole lot different research topic that this paper tries to shy away with. Performance contagion represents one of the supply chain's behaviour factors, which shows how performance changes in organisations across the supply chain influence with each other. Furthermore, since firms survive in a connected structure of a supply network, any economic shock event therefore is unlikely to remain isolated to only one firm. It will be passed on to its adjacent firms like the ripple-effect (Feyen, 2013; Cohen & Frazzini, 2008; Hertzel et al., 2008). Thus, the performance behaviour of the firms in a supply chain is often appears contagious towards each other. Such a behaviour is defined in this paper as performance contagion.

We define "economic shock" as any sudden, unpredicted and uncontrollable events in the business environment where the supply chain operates that result in some immediate non-trivial financial performance changes in the associated firms of the supply chain. The term "shock" in a very similar definition has already been widely used in the research community in economics and econometrics (Carriere, Marshall & Binkley, 2015; Chakrabarti, 2014). Quality problem, safety disaster, major accidents, uncovered fraud, technological breakthrough and so on may be the sources of the economic shock. Economic shock, therefore, represents one of the supply chain's exogenous business environmental factors. It is usually measured by the number of the direct reporting, announcements, critiques, revelations, or news over the mass media to indicate the magnitude of the shock (Akhtar, Faff, Oliver & Subrahmanyam, 2013; Brenner et al., 2009). Undoubtedly the economic shock event will have consequences in the supply chain's financial performance.

This paper attempts to investigate the intricate relations in between those three constructs: linkage strength, performance contagion, and economic shock. So far, our literature review shows some limited findings as to how the supply chain performance contagion is positively correlated to the linkage strength (Cainelli, Montresor & Vittucci Marzetti, 2012) and how the economic shock event impacted upon the correlation between the linkage strength and performance contagion (Jinjarak, 2014; Bhattacharya, Geraghty, Young & Byrne, 2013). However, how much and in which way the linkage strength will influence the performance contagion remains largely unexplored, especially at the firm-level. Evidences in the literature, which are described in the next section, have unequivocally shown that most past and current researches have only addressed such correlation relationship at the market-level but not at the firm-level. This means that such relationship models developed so far in the literatures are mainly concerned by the marketers and investors, but not by the managers at the supply chain management level. Such research may be useful in understanding the stock movement in between the markets, but offers little help to the managers who make day-in-day-out managerial decisions at the firm-level.

To assist the decision making by the supply chain executives for purpose of understanding and managing the supply chain performance (or part of it), a research question arises. How the linkage strength may affect the performance contagion under the impact of economic shock events? The past researches have reported some encouraging understanding on the vertical linkages and how do they influence the performances co-movement in the supply chain (Aobdia et al., 2014; Cainelli et al., 2012). However, how the degree of performance contagion is influenced by the associated linkage strength under the economic shock event has never been properly investigated.

It must be clearly distinguished between the overall financial performance in general and a chosen specific financial performance under the circumstance of unexpected economic shock event. The latter forms the unit of analysis for this paper, not the former. The paper is concerned with the performance co-movement or the 'contagions' under the ripple effect of the economic shock events. In fact, it would be inappropriate to address the overarching financial performance of a firm by only associate it to one factor alone – the linkage strength. The level of business success and the general success factor analysis for financial performance obviously belongs to a much bigger and very different research subject. What we are interested here is largely about how one of the supply chain structural factor – the linkage strength might influence the degree of performance contagions subject to the different level of environmental shock events.

Therefore, the aim of this research is to investigate the non-linear relationship between the strength of the supply chain linkage and the financial performance contagion over the linked organisations in respect to different levels of economic shock event. In the process of pursuing this objective, and as the research contents unfolds in the sequel, a number of relevant captured research issues will also be addressed.

Research Questions
1. Is the relationship between the linkage strength and performance contagion linear or non-linear?
2. Would the external business environmental factor such as economic shock event has any bearing on the performance contagion?
3. What is the unique advantage of applying the panel threshold method in order to reveal the underlying relationship between the linkage strength and the performance contagion?
4. What are theoretical implication of the findings in terms of the existing supply chain management models such as lean supply chain management and agile supply chain management?

The remainder of the paper is arranged as follows. In section 2, a systematic literature review is presented to lay down the basis of the established concepts and theories, leading to two hypotheses. Then, section 3 discusses the methodological issues around the fundamental concepts of panel data regression and panel threshold analysis. Section 4 explains the data gathering from a real-world global supply chain and describes the computing processes that analyse the data set using STATA. In section 5, the key findings from the computing results were summarised and discussed. Finally, section 6 presents the major research conclusions followed by the discussion of the implications to both theoretical and practical spheres.

2. SYSTEMATIC LITERATURE REVIEW

The systematic literature review approach was based on the method originally proposed by Tranfield, Denyer and Smart (2003). It is applied in this research to address the following questions:
1. To what extent the concept of supply chain linkage has been so far developed?
2. What have been found in terms of the impact of the linkage strength on the firm's financial performance?
3. Why the firm-level relationship between the linkage strength and financial performance is important, and yet it has not been sufficiently explored?
4. What have been achieved in this area by using panel data and panel threshold methodologies?
This review is carried out based on two literature databases: Business Source Premier (EBSCO) and ABI/INFORMS (ProQuest). Our confidence in choosing just these two databases to represent the needed research population is based on the fact that first, they covers almost all the scholarly journals in the fields of corporate finance and supply chain management; and second, all the articles we reviewed have been published in the journals that are covered by the two databases. Given the focus on relationship between the supply chain linkage strength and the firm's financial performance, the search strings used were as follows:
- Supply chain or link* and strength*
- AND performance
- AND shock or contagion
- AND (data OR empirical OR test OR statistical OR finding* OR result* OR evidence OR case* OR stud*)

The keyword supply chain is there to aim at the supply chain management context of the research; link* was to include both link and linkage; and the strength* is to cover the strength and the strengthen; while performance was used to target financial performance; the keyword shock and contagion were selected to cover shocks propagation and performance contagion; the final line of keywords such as empirical and et. al. were used to select articles with empirical contents. No time restriction was used in this search procedure.

The search string identified 579 articles on EBSCO and 431 on ABI/ProQuest, in which 324 articles were found on both databases. The total number of non-duplicated articles identified in this search was 686. The abstracts of all 686 articles have been screened to decide whether they are appropriate or worthy for a further full text review. Based on the selection criteria (not included to avoid unnecessary lengthy text), 62 articles, in which 47 from EBSCO and 34 from ABI/ProQuest, were filtered out for further detailed full-text analysis, all of which appear to have made reference to economic shock effect and relationship between linkage strength and financial performance.

In view of the first literature review question, it is evident that the three key concepts of linkage strength, economic shock event and their impact on the financial performance, have been well established (Mizgier, Wagner & Holyst, 2012). Although our research concerns more specifically the performance contagion rather than general performance, the background of the discussion remains relevant and useful. Moreover, a number of articles related to the concept of performance contagion and performance alignment in the supply chain have also been brought to the attention of the researchers (Mizgier, Wagner & Jüttner, 2015).

Some consistent findings emerging from those literature appears to be that a closely integrated supply chain (high level of linkage strength in our definition) demonstrating more homogeneous performance across echelons of the supply chain; and that the degree of supply chain integration and collaboration with high level of engagement produce more aligned performance operationally and financially. This appears to be in line with the finding from other literatures (discussed below) that supply chain's linkage strength is positively correlated with the performance co-movement (we define it as performance contagion). However, the extant literatures fall short of proving whether such relationship between the linkage strength and performance contagion is subject to the influence of any environmental factors, which gives rise to the research gap discussed earlier.

As to the second literature review question, our review shows that the concept of linkage strength has been extensively explored by Friman, Gärling, Millett, Mattsson and Johnston (2002; Donaldson and O' Toole (2000; Kaj, Tore and Christian (1994:. Their attempts, however, were mainly to address the supply chain structural balancing issues. Since the OEM (original equipment manufacturer) is unlikely to have the equal linkage strength to all its first tier suppliers, balancing the linkage strength with different suppliers based on strategic importance of the supplied components become an issue. They have at least demonstrated that the linkage strength is one of the important constructs in their theoretical modelling, and in fact can be observed and measured quantitatively to the convenience of the researchers; and its influences on the buyer and supplier's performance as well as the supply chain's overall performance were also explored to various of degrees.
In particular, the quantitative measurement of the linkage strength has been specifically looked into by Meyricke (2013; Barry, Dion and Johnson (2008: in attempt to model it as an independent construct for the supply chain behaviour. Clearly, the research community has long come to realise that a supply chain's performance and its participating members' performances are determined partially but significantly by the associated linkage strength. Thus, based on the reviewed literature we could quite confidently hypothesis that the level of supply chain performance contagion, or the co-movement of firms' financial performances, in the perspective of a supply chain context correlates significantly with the level of the linkage strength.

The concept of economic shock event (sometimes shock in short) is originated from field of economics and econometrics (Rose & Mishler, 2010; Edelberg, Eichenbaum & Fisher, 1999) to address some business environmental events that have significant impact on the supply chain's performances. Shock has been discussed extensively by Chung et al. (2012; Brenner et al. (2009; Darrat and Zhong (2005: to reveal the substantive influence an environmental factor can exert on the fluctuating nature of the supply chain's financial performance. Shock as an important research construct in the modelling exercises has also been measured quantitatively by Akhtar et al. (2013; Brenner et al. (2009). Their researches are mainly on studying how shocks impact on the supply chain's operational behaviour and financial performance in the market places.

Out of the 62 filtered out articles 25 were focused on the research of how the economic shock events influence the financial performance. Some were making direct reference to the market-level research (Akhtar et al. (2013; Chung et al. (2012; Milani and Treadwell (2012). It is evident that the influencing power of the linkage strength on the overall supply chain financial performance at the market level have been studied quite extensively, but the evidence of the firm-level research remains elusive. To summarise, the findings from the literature may be categorised in three strands.

- First, there is a definitive and significant positively correlated relationship between the linkage strength and the co-movement of financial performance.
- Second, most of panel data analysis results in a converged linear regression between linkage strength and performance co-movement or performance contagion in our definition; in the meantime, the more sophisticated panel threshold analysis has led to non-linear relationships but only used data at the market-level.
- Third, since the relationship were mainly observed from the market level researches, such studies were only useful for the investors or economists (Díaz and Jareño (2013; Cheng, Quek and Mah (2007); they have little or no implication to the firm-level decision making with regards to improve the supply chain performance.

The third point above is also in line with the comment offered by Meyricke (2013), which basically states that most empirical studies of linkage effect have been done at the market-level and the importance of firm-level research has just begun to gain scholars' increasing attention in recent years.

It is our observation that the reason why there are more researches were conducted on market level than at the firms level is perhaps the lack of available data at the firm level, since some researcher have already pointed out that the lack of firm level research data is one of their limitations (Zhou & Gao, 2012; Phylaktis & Ravazzolo, 2002). The importance of firm-level analysis has been raised by Meyricke (2011). Based on Meyricke, the impact of linkage strength at the firm level will directly influence how an economic shock event propagate through the supply chain, thus demonstrating its effect on the performance contagion over the linkage. For an individual participating firm in a supply chain, the knowledge of the performance contagion will be critical for them to make educated decisions on how to weather the shock. Furthermore, it can help the members of the supply chain to avert the risks brought about by the shock waves (Longinidis and Georgiadis (2011).

However, in regards to the exact nature of the relationship between the linkage strength and performance contagion at the firm-level, we came to notice that for those limited number of researches reviewed at the firm-level (see Table 1), none of them so far has addressed or came up with a non-linear positive relationship model (nor the linear negative one). The interesting finding is that no one was denying or rejecting the possible existence of such non-linear relationship. It was simply not explored intendedly. Not to speculating why no one did that, at least it appears to be a valid research gap to cover. Based on the findings of the positive non-linear relationship at the market-level, it is intuitively appearing to contemplate that the same could exist at the firm-level. Thus, we hypothesis that the relationship between the supply chain linkage strength and the financial performance contagion is a non-linear one, and the non-linear status is influenced by the environmental factor of the economic shock.

	Positive/linear	Negative/linear	Positive/non-linear	Total
Market-level	5	1	4	10
Firm-level	8	0	0	8

Table 1. Classification of the selected articles based on the references to relationship nature

The fact that all the reviewed research at the firm-level appear to show a positive linear rather than non-linear relationship between the linkage strength and performance contagion does not necessarily lead to a logical conclusion that the relationship is always positively linear in all circumstance. In fact, the second hypothesis is formulated to ascertain whether the linear relationship is distorted under the different levels of economic shock. Table 1 confirms that no current research articles have ever addressed the possible non-linear relationships at the firm level.

Looking into the research methodologies that have been employed in those literatures, there are some interesting facts which could assisted us in deciding on an appropriate method for this research. The identified articles have applied one of the three different methods: time series method, cross section analysis, panel data regression. Out of the 18 selected articles, 14 (78%) used time series method, 3 articles (17%) applied a panel regression method, and only 1 articles (5%) used both time series and cross section method.

	Time series	Cross section	Panel regression
Positive/linear	12	1	0
Positive/non-linear	1	0	3
Negative/linear	1	0	0
Total	14	1	3

Table 2. Classification of the selected articles based on the research method and research finding

In regards to how those three methods were used to treat the linear and/or non-linear models, the table 2 illustrates the associations between the methods and model treatments. Apparently, the panel regression method appears to be solely associated the positive non-linear models. In fact, Hansen (2000: has pointed out that one of the advantages of panel regression method, especially the panel threshold method, is to model the non-linear relationship. Time series method looks quite popular, but it perhaps is more appropriate in dealing with the linear models. The unexpected negative relationship might arise due to an idiosyncratic nature of Asian's emerging markets that Wang (2014b: was focusing.

In terms of the quantitative measures for the key conceptual constructs: linkage strength, performance contagion, and economic shock events, the reviewed literature have some commonly adopted indicators, which have largely been followed in this paper without too much lengthy debate since they are not the key focus. 56% of the selected articles use the number of media reporting on the specific economic shock events to represent the magnitude of shock. The linkage strength is mostly measured by the level of supplier-buyer transactions and operational collaborations (Eapen, 2012) and the performance contagion is measured by the correlated movement of the assets performance across the linked firms (Wang, 2014a).

	Total number of articles	% of selected articles
News	14	56

US investor sentiment index	3	12
Reaction time	3	12
Long term/short term	1	4
Weight of current criese	1	4
Mutual fund net buying/selling	1	4
Auctions	1	4
Tax liability	1	4

Table 3. Classification of the selected articles referring to shock measurements

We summarise the two hypotheses developed through the literature review.

1. The level of supply chain performance contagion, or the co-movement of firms' financial performances, in the perspective of a supply chain context correlates significantly with the level of the linkage strength.
2. The relationship between the supply chain linkage strength and the financial performance contagion however is a non-linear one, which is influenced by the environmental factor of economic shock.

By employing appropriate methodologies, it is hopeful that we may be able to testify those two hypotheses rigorously.

3. METHODOLOGY

To test the hypotheses, this paper resort to the Panel Threshold Regression method instead of panel regression method which were used much more widely in such modelling processes. The choice of the methods is based on the fact that panel threshold method is capable of identifying the underlying thresholds that partition the data into the groups in order to form two or more different regression regions with different regression models. Thus it could and often result in an overall non-linear regression model. There are also evidences in econometrics that the panel threshold methods reveal more underlying nature of the data than others.

Panel data is a data set that typically mixes the characteristics of time series and that of cross-sections (across different organisations or people). It is therefore often seen as a three dimensional data. The data is usually collected over time for all the sections or individuals. Therefore, it captures both time variability and section variability. A regression analysis that runs on a panel data can reveal much more internal character relationships that sometimes cannot be easily observed through the two dimensional non-panel data.

Researchers have already discussed the issues of different coefficients for linkage strength over financial performance by using different data samples. (Bekiros, 2014; Wang, 2014a; Zhou & Gao, 2012; Phylaktis & Ravazzolo, 2002). Then, they tried manually to divide the data sample into different time scales or other regimes to explain the coefficient difference. In this research, we employ Hansen's Threshold Panel Model to avoid unnecessary errors caused by the subjective division (Hansen, 1999). One of the advantages of the panel threshold model is that it can divide endogenously the regimes based on the characteristics of the data, then the coefficients within each regimes can be estimated accordingly.

Over the last two decades, there have been many useful studies successfully conducted by using the panel threshold method. Some are concerned with the non-linear relationship between the financial performance and the structural linkage within the supply chain (Lee, Yen & Chan, 2014; Chen, Chen & Lee, 2013; Dungey, Fry, Martin & Gonzalez-Hermosillo, 2004). Their work shows the potential prospects of using the method for in-depth investigation into the impact of supply chain linkage strength on the financial performances. Hence, regarding the methodological choices, this study attempts to build the key method on a reduced form of the predictive panel regression model created by Meyricke (2013: and further develops it into a threshold model that allows for nonlinearity in the panel relationship set-up (Randall & Ulrich, 2001).

There are two reasons of using the reduced form of Meyricke (2013:'s model. Firstly, the assumption of fixed transmission probability within the Markov Chain is not accepted in major Markov Chain related literatures (Agrawal, Akshay, Genest & Thiagarajan, 2015; Beffy, Coudin & Rathelot, 2014), and finding a precise transmission probability along linkages is quite another research topic. Second, by including indirect linkages it makes the panel data sample less balanced. And it is a choice of either sacrificing the number of cross-sections or the number of time periods to balance the panel data sample. In this study, we employ a non-dynamic panel threshold model to test the asymmetric effect of economic shock effect on the relationship between linkage strengths and financial performance contagion. Given that the panel threshold model usually requires the data sample to be balanced, a reduced form of Meyricke (2013:'s model avoids the assumption of fixed transmission probability and releases the restrictions of obtaining a balanced data sample by excluding indirect linkages.

The linear panel fixed-effect model

To investigate how linkage strength affect financial performance contagion under the effect of economic shocks, we start with a linear panel fixed-effect model to test the relationship between linkage strength and performance contagion without considering the effect of economic shocks. The purpose of doing so is to make a comparison between the linear model and non-linear model and to see if there is an advantages for using the non-linear model. The linear panel fixed-effect model can be presented as:

$$PC_{cs,t} = \mu_{cs} + \eta LS_{ct} + e_{cs,t} \tag{1}$$

where PC represents performance contagion; □is the interception; e is the error term;

LS represents the linkage strength; cs=1,...,N; t=1,…,T; N represents the number of customers and suppliers; t is for time; $\eta$is the coefficient of LS . In order to avoid individual effect of□cs, a traditional method is to remove the individual-specific means (Hansen, 2000).

Empirical studies tend to support for positive relationship between linkage strength and performance contagion (Bekiros, 2014; Wang, 2014a; Zhou & Gao, 2012). In other words, the stronger the linkage the stronger the performance contagion becomes. Therefore, we would expect a positive coefficient of LS as $\eta>0$. However this fixed effect linear model is not useful until unless the panel threshold analysis results in no valid threshold.

The panel threshold model

The panel threshold model specified here concerns with the regression between the performance contagion PC as the dependent variable; and the linkage strength LS as the regressor. The critical difference here is that the degree of shock DS is now used as the threshold variable. For a single threshold scenario, following Hansen's (1999) study, the single threshold model should be constructed as:

$$PC_{cs,t} = \mu_{cs} + \phi_1 LS_{cs,t}\, I(DS_{ct} \le \gamma) + \phi_2 LS_{cs,t}\, I(DS_{ct} > \gamma) + e_{cs,t} \tag{2}$$

where DS represents the degree of shock; ϕ_1 and ϕ_2 are the coefficients of the regressor LS ; I( ) is the indicator function; γ represents the unknown threshold to be estimated during the computing process. Based on this model, the observations have now been divided into two 'regimes' depending on whether the threshold variable DS is smaller or greater than the threshold□γ. The regimes will then be distinguished by the two regression slopes ϕ_1 and ϕ_2. The essential condition for being able to identify the different regression slopes is that the regressor LS and threshold variables DS are not time invariant (Hansen, 2000). The residual term e sc,t are assumed to be independent and identically distributed with a zero mean and a finite variance of σ^2.

Dependent Variable: Performance Contagion (PC)

To measure the performance contagion in between the linked firms, we use the asset return correlation to observe the performance contagion. Such a measurement choice has been applied by Liu, Qi, Shi and Xie (2013) and Neaime (2012) in the past, and they all appear to have been satisfactory. The following equation illustrates the correlation between the customer and supplier's asset returns,

$$PC_{cs} \approx \frac{\sum_s R_{cs} R_{sc}}{\sqrt{\sum_s R_{cs}{}^2 R_{sc}{}^2}} \tag{3}$$

Where c represents customers; s represents suppliers; t is the time measured in month; PCcs,tis calculated by taking the sample correlation between Rc,tand Rs,t over the past 12 monthly observations; Rc,t and Rs,tare the asset return of the customer and supplier at time t. The results will then be used as the input data to model (2) for the estimation of coefficients.

Independent Variable: Linkage Strength (LS)

We only include the direct linkages, because the attempt of extending the dataset by including indirect linkages violates data balancing. The direct linkage LScs can be treated as a transition matrix of a Markov Chain (Nicolau, 2014) which describes the transmission path of shocks within supply chains. Thus, LScs represents the probability of a shock on customer that moves to the supplier s directly. Therefore the total weighted sum of linkage strength LScs determines how the transmitted shocks affect the asset returns. The measure of the linkage strength is the ratio of supplier sales to the customer's cost of goods sold (CGS) as has been used by Meyricke (2013:. Thus the independent variable of linkage strength can be represented by:

$$LS_{cs,t} = \frac{NSL_{s,t}}{CGS_{c,t}} \tag{4}$$

Where NSL represents the supplier's net sales to customer c; and CGSc represents the customer's cost of goods sold at time t. Suppliers whose net sale counts a large proportion of cost of goods sold have stronger linkage with the customers.

Threshold Variable: Degree of Shock (DS)

Many different methods have been tried in the past to measure the degree of shock. However, in view of our research focus at the firm-level, most market-level measures are not necessarily appropriate for this study, as they are too macro in observing the shocks for the firm-level networks. Instead of using the investor sentiment index, reaction time and so on, we use the number of media reports (NMR) at firm level as the measure of the degree of shock. In particular, a Log format of the measure makes the variable more sensitive to changes (Bartolotti & Edney, 1994) and hence, easy to manipulate in computing:

$DS_{ct} = Log(NMR_{ct})$

Thus, in order to establish the data required by the three variables discussed above, we set out to gather an appropriate set of data including the 5 required data: Rct, Rst, NSL, CGS, and NMR to form the basis for the three variables. First, we explored the Compustat Monthly database's Updates Segment in Customer Files to establish the exact number of firms in the identified global supply chain in the fast moving retailing industry (the name of global supply chain has been concealed for confidentiality). It turns out that there are 109 organizations involved in the direct linkages with each other within the supply chain. The 109 organizations are then dropped into another database CRSP to extract the organizations' full accounting data. We then use these accounting data to form the variables of PC and LS; however the data that forms the DS is obtained from a different database Lexis Nexis. As a result, our panel data sample spans over 84 months from 2007 to 2013, totalling 27,468 data entries. This data sample is also a balanced one, which satisfies the requirement of the panel threshold model computation.

4. EMPIRICAL RESULTS

The analysis process follows the threshold regression models described in section 3 and the coding / programme was done in STATA 14 SE, which is one of the most powerful statistics tools available in the market today.

Panel unit root test results

Levin, Lin and Chu (2002) and Westerlund and Breitung (2013) suggest a panel unit-root test of variables' stationary condition before running the panel regression. The problem of spurious regression could arise if the condition of stationary cannot be satisfied. Accordingly, we set the null hypothesis of non-stationary and the alternative hypothesis of stationary. Under the condition of balanced panel data, Levin et al. (2002) and Westerlund and Breitung (2013) employed two different unit-root tests, which are Levin-Lin-Chu (LLC) and Im-Pesaran-Shin (IPS) respectively, to test the stationary hypothesis. We repeated their testing procedure to investigate whether a unit-root exists in each of every variables. Table 6 reports the test results for both panel unit-roots. There is a clear rejection of the null hypothesis of non-stationary in both tests as their p-values are less than 0.01. Therefore, we have strong evidence to believe that all variables are now stationary. However, econometrically, our panel data is still likely to have the problem of heteroscedasticity (Vogelsang, 2012). We leave this problem to be tested in the following computation procedure. We can now step to the regression analysis below.

Variables	LLS		IPS	
	t-statistic	p-value	t-statistic	p-value
PC	-5.95***	0.00	-9.15***	0.00
LS	-64.41***	0.00	-63.50***	0.00
DS	-10.42***	0.00	-7.00***	0.00
Notes: LLC and IPS represents the Levin et al. (2002) panel unit-root test, respectively. ***, ** and * indicate significance at the 1, 5 and 10% level, respectively.				

Table 4. Panel unit-root test results.

Linear fixed-effect model results

	Model-A
	Fixed-effect with robust
η	1.51***
N	9156
t statistics in parentheses * p<0.1, ** p<0.05, *** p<0.01; N represents the number of observations	

Regression in column Model-A is running on fixed effect with robustness to avoid the potential effect of heteroscedasticity.

Table 5. Panel fixed-effect regression results of the relationship between linkage strength and performance contagion.

Table 5 reports the empirical results for the linear model of equation (3). In the Model-A, there is a positive and statistically significant relationship between the linkage strength and performance contagion, which is consistent with our prediction and other scholars' findings (Aobdia et al., 2014; Wang, 2014a; Alcock & Meyricke, 2013; Feyen, 2013). The estimated value of the coefficient is 1.501833, which means that a unit increase of linkage strength will cause 1.501833 unit rise of performance contagion. The Model-A is running with robustness to avoid the potential effect of heteroscedasticity.

Test of threshold effect

To do this, we use the bootstrap method to obtain an approximation of the F-statistics and then calculate the p-values. The F statistics in table-8 contains F1, F2 and F3 to assess the null hypotheses of one, two and three thresholds, respectively. Table 8 shows the tests for the single threshold, double-threshold and triple-threshold effects. The single-threshold F-statistics of 49.310 and p-value of 0.0000 are yielded respectively. They show that under 1% significant level the null hypothesis of no threshold effect is rejected. However, we do not have evidence to support the double and triple threshold models, since the p-value of effect is first tested to see if it exists. By using bootstrap to make 2000 times multiplication, double and triple thresholds models are 0.476, 0.733 respectively, which is greater than 0.1.

The estimated value of threshold is the value of γ when F-statistic's p-value of the likelihood ratio less than 0.1. The obtained threshold value is 0.213 in the model. The functional diagrams Figure 1 shows a clear estimated threshold and how the confidence interval is structured. The 95% confidence intervals of these threshold values are constructed by the likelihood ratio of 7.35 (dash line in figures) corresponding γ. Observations greater than 0.213 represent the degree of shock is high, whereas smaller than 0.213 shows the shock degree is low.

Threshold value	Critical value of F				
	F	p-value	1%	5%	10%
Single threshold					
0.21	45.31	0.00***	37.91	35.36	32.47
Double thresholds					
0.21					
0.85	12.95	0.47	46.33	41.74	36.02
Triple thresholds					
0.21					
0.58	14.25	0.73	34.15	29.76	26.10
0.85					
Notes: F-statistics and p-values are from repeating bootstrap procedures 2000 times for each of the three bootstrap tests. * p<0.05, **p<0.01, *** p<0.001 indicate significance at the 1%, 5% and 10% level, respectively.					

Table 6. Tests for threshold effects between linkage strength and performance contagion.

	Model-B	Model-A
ϕ_1	1043***	
ϕ_2	0.79*	
η		1.50***
N	9155	9155
F	14.10	7.04

Table 7. Threshold effect validation and comparison.

Table 7 presents the estimated results of coefficients of the single panel threshold model and fixed-effect linear model. Model-B regress on two regimes divided by the obtained threshold value with robustness. And the Model-A is a linear model that serves a comparison with the non-linear Model-B. The threshold value divided LS into two regimes, the coefficient □□ ϕ_1 is 10.43 (significant at 1% level) in the first regime as $\gamma<0.213$, and the coefficient ϕ_2 significantly drops to 0.797 (significant at 10% level) in the second regime as $\gamma>0.213$. Compare to the linear fixed-effect model, which has the coefficient of 1.501833 on LS , it is mainly a mixed fuzzy result of two regimes.

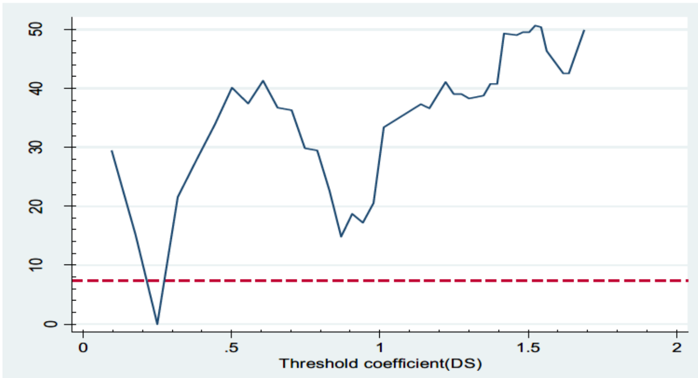

Figure 1. Structure of estimated threshold confidence interval.

The estimated result of equation (1): Model-A therefore is:

$\boldsymbol{PCcs_{,t} = 1.501833LScs_{,t}}$

And the equation (2): Model-B estimated above is:

$\boldsymbol{PC_{cs,t} = 10.43LScs_{,t}\ \mathrm{I}(DSct \leq 0.213) + 0.797LScs_{,t}\ \mathrm{I}(DSct > 0.213)}$

Note that we have took logarithm to threshold variable, DS, which means, in Model-B, when the increasing rate of number of news at time t (compare to time t-1) is smaller than 0.213, a one unit increase of LS causes a 10.43 unit increase of PC. Otherwise, when the increasing rate is greater than 0.213, a one unit increase of LS only causes a 0.797 unit increase of PC, ceteris paribus.

5. FINDINGS AND DISCUSSION

To summarise, what have we found through the computing above are:

- The single threshold model (Model-B) appears to fit to the data best.
- Because of the significance of the single threshold, the regression model will now take the resultant shape of:

$$PC^{*}_{cs,t} = \begin{cases} 10.43LS^{*}_{cs,t}, DS_{ct} \leq 0.213, \\ 0.797LS^{*}_{cs,t}, DS_{ct} > 0.213. \end{cases}$$

- Since the resultant ϕ_1 and ϕ_2 are significantly different, the null hypothesis is therefore rejected in favour of the alternative hypothesis.
- Therefore, the PC and LS regression is definitively non-linear.
- The two coefficients $\phi_1 = 10.43$ and $\phi_2 = 0.797$ have been specified quantitatively.

By interpreting the above computing results, we may be able to draw some quite profound findings of the relationship between the linkage strength and performance contagion.

First, the performance contagion is highly and positively correlated with the linkage strength when the shock is low or when the supply chain is running in a stable business environment. This means that when a supply chain is in a 'normal' operating status without too much of unanticipated disruptions from the market place, the supply chain's structural factor – the linkage strength will influence the supply chain performance contagion with an amplifying effect. In many ways, this finding is in agreement with some established lean concepts in supply chain management, such as: a close partnership in a supply chain tends to result in more coherent operational performance in the participating firms; highly integrated supply chain often leads to consistent financial performances across the network; to name just a few. On the other hand, the positive correlation also means that in a closely linked and well integrated supply chain, when one company's performance drops it will engender a strong ripple effect to the neighbouring firms, at least temporally. So, when the degree of the disruptive economic shock is low, the financial performances of the participating companies tend to be highly contagious.

Second, the performance contagion is positively but weakly correlated with the linkage strength when the degree of shock is high or when there are major economic shock events took place in the business environment that affects or directly related with the supply chain. This means when strong economic shocks take place, the business environment becomes volatile, which usually followed by the demand uncertainty, than, and the structural linkage strength will have less effect on the performance contagion. Thus, the supplier and buyer's financial performance is likely to be less contagious under the volatile market environment. This is true, when the supply chain is running in an "Agile Supply Chain model". When the general degree of shock event is relatively high, i.e. the business environment is rather volatile and uncertain, the supply chains tends to switch into the ″Agile Supply Chain” model. Comparing with the lean model, the same level of linkage strength will have less degree of correlation with the performance contagion. It can be argued that the performance change in the participating supply chain member of an agile supply chain is less (but still is) affected by the changes is the neighbouring members under the same linkage strength. Agile supply chain’s structural linkage tends to be ‘virtual’, so to speak.

It, therefore, can be concluded that the correlation between the linkage strength and performance contagion do exist, testifying the first hypothesis, but the correlation is in the meantime influenced by the environmental ‘shock’ factor. When the shock is lower than the identified threshold, the performance contagion level is highly correlated with the linkage strength, demonstrating a typical behaviour of a “Lean Supply Chain”. On the other hand, when the shock is higher than the threshold, the performance contagion is still correlated positively with the linkage strength but at a much lowered degree, demonstrating a typical behaviour of an agile supply chain with much more independent but ‘virtually’ connected suppliers. Thus, the effect of a supply chain structural factor – the linkage strength on the performance contagion can be reasonable believed to be a non-linear one, testifying the second hypothesis. The level of the positive correlation depicted by the magnitude of the coefficient is influenced, if not determined, by the degree of economic shocks in the business environment whereby the supply chain operates. Less shock environment leads to high level of the correlation, and vice versa.

6. CONCLUSIONS AND DISCUSSION

As can be seen from the regression results, there exist one threshold in the axis of the independent variable. This means, in fact, the data population can be and perhaps should be segregated into two regimes by the one threshold. Each group of data has its own somewhat unique characteristics that is different from that of the other groups. The significance of such grouping can be easily observed by the different value of coefficients (see table 5-4) in each of the data groups. Thus, the correlation modelling between the dependent and independent variables for each group of data will exhibit different regression coefficients, resulting in an overall non-linear relationship when the whole population of data is considered together.

It therefore can be concluded that the panel threshold regression analysis and modelling shows unequivocally that the linkage strength as one of the supply chain’s key structural characteristics do have a non-trivial causal relationship with the degree of the financial performance contagion in between the captured firms. More importantly the research, based on many years of a real-world supply chain data, reveals that the correlation model has a distinct threshold structure, whereby the correlation is no longer linear throughout as many have believed so previously. It is in fact non-linear and can only be shown through a proper panel threshold based regression analysis.

The findings from the research have also some profound implications in both theory and practice. The theoretical implication is that panel threshold approach discovers the underlying thresholds and the threshold segregated regression model reveals more intricate nature of the data set. Thus, a panel threshold model is arguably a better fit model than the panel data regression model given the thresholds are significant enough mathematically.

The managerial implication of this finding can be significant. It can help the supply chain manager to be able to mitigate the performance risks by carefully design the linkage strength in line with the environmental factor; and for a given linkage strength the managers and decision makers could foresee the forthcoming shock effect more precisely. It could be a major risk mitigation tool when it comes to consider how an organisation should attempt to protect itself from the down-ward contagion risk from its supplier or buyer.

7. REFERENCES

Acemoglu, D., Ozdaglar, A. & Tahbaz-Salehi, A. 2010. Cascades in networks and aggregate volatility. National Bureau of Economic Research,1977-2016.

Agrawal, M., Akshay, S., Genest, B. & Thiagarajan, P.S. 2015. Approximate Verification of the Symbolic Dynamics of Markov Chains. Journal of the ACM, 62(1):1-34.

Akhtar, S., Faff, R., Oliver, B. & Subrahmanyam, A. 2013. Stock Salience and the Asymmetric Market Effect of Consumer Sentiment News [2012]. Journal of Banking and Finance, 37(11):4488-4500.

Alcock, J. & Meyricke, R. 2013. The Influence of Customer-Supplier Linkages on Stock Returns. Available at SSRN 2476250.

Aobdia, D., Caskey, J. & Ozel, N. 2014. Inter-industry network structure and the cross-predictability of earnings and stock returns. Review of Accounting Studies, 19(3):1191-1224.

Bai, J. 1997. Estimation of a change point in multiple regression models. Review of Economics and Statistics, 79(4):551-563.

Barry, J.M., Dion, P. & Johnson, W. 2008. A cross-cultural examination of relationship strength in B2B services. Journal of Services Marketing, 22(2/3):114-135.

Bartolotti, L. & Edney, E. 1994. Investigation of the correlation between the energy of the highest occupied molecular orbital (HOMO) and the logarithm of the OH rate constant of hydrofluorocarbons and hydrofluoroethers. International journal of chemical kinetics, 26(9):913-920.
Beffy, M., Coudin, E. & Rathelot, R. 2014. For Whom are Permanent Jobs off Limits? A Markov-Chain-Based Analysis of Individual Labor Market Dynamics. GENES,315-342.
Bekiros, S. 2014. Nonlinear causality testing with stepwise multivariate filtering: Evidence from stock and currency markets. The North American Journal of Economics and Finance, 29(0):336-348.
Bhattacharya, A., Geraghty, J., Young, P. & Byrne, P.J. 2013. Design of a resilient shock absorber for disrupted supply chain networks: a shock-dampening fortification framework for mitigating excursion events. Production Planning & Control, 24(8/9):721-742.
Boles, J.S., Johnson, J.T. & Barksdale Jr, H.C. 2000. How Salespeople Build Quality Relationships: A Replication and Extension. Journal of Business Research, 48(1):75-81.
Brenner, M., Pasquariello, P. & Subrahmanyam, M. 2009. On the Volatility and Comovement of U.S. Financial Markets around Macroeconomic News Announcements. Journal of Financial and Quantitative Analysis, 44(6):1265-1289.
Cainelli, G., Montresor, S. & Vittucci Marzetti, G. 2012. Production and Financial Linkages in Inter-firm Networks: Structural Variety, Risk-Sharing and Resilience. Journal of Evolutionary Economics, 22(4):711-734.
Carriere, D.E., Marshall, M.I. & Binkley, J.K. 2015. Response to Economic Shock: Impacts of Rurality and Economic Recession on County-level Suicides in the US. Population (log), 1(1.024):1.067.
Chakrabarti, A. 2014. Organizational adaptation in an economic shock: The role of growth reconfiguration. Strategic Management Journal .. doi: 10.1002/smj.2309.
Chen, M.-P., Chen, P.-F. & Lee, C.-C. 2013. Asymmetric effects of investor sentiment on industry stock returns: Panel data evidence. Emerging Markets Review, 14:35-54.
Cheng, P., Quek, C. & Mah, M.L. 2007. Predicting the impact of anticipatory action on U.S. stock market-an event study using anfis (A neural fuzzy model). Computational Intelligence, 23(2):117.
Chung, S.L., Hung, C.H. & Yeh, C.Y. 2012. When does investor sentiment predict stock returns? Journal of Empirical Finance, 19(2):217-240.
Cohen, L. & Frazzini, A. 2008. Economic links and predictable returns. The Journal of Finance, 63(4):1977-2011.
Díaz, A. & Jareño, F. 2013. Inflation news and stock returns: market direction and flow-through ability. Empirical Economics, 44(2):775-798.
Darrat, A.F. & Zhong, M. 2005. Equity market linkage and multinational trade accords: The cast of NAFTA. Journal of International Money and Finance, 24(5):766-792.
Davies, R.B. 2002. Hypothesis Testing When a Nuisance Parameter Is Present Only under the Alternative: Linear Model Case. Biometrika Trust,484-489.
Donald, W.K.A. & Ploberger, W. 1994. Optimal Tests when a Nuisance Parameter is Present Only Under the Alternative. Econometric Society,1383-1414.
Donaldson, B. & O' Toole, T. 2000. Classifying relationship structures: relationship strength in industrial markets. Journal of Business & Industrial Marketing, 15(6/7):491.
Dungey, M., Fry, R., Martin, V. & Gonzalez-Hermosillo, B. 2004. Empirical Modeling of Contagion: A Review of Methodologies. International Monetary Fund, IMF Working Papers: 04/78.
Eapen, A. 2012. Social structure and technology spillovers from foreign to domestic firms. Journal of international business studies, 43(3):244-263.
Edelberg, W., Eichenbaum, M. & Fisher, J.D. 1999. Understanding the effects of a shock to government purchases. Review of Economic Dynamics, 2(1):166-206.
Feyen, E.H.B. 2013. Boardroom Networks and the Cross-Section of Stock Returns. Rochester: Social Science Research Network, Available at SSRN: http://ssrn.com/abstract=2257925.
Friman, M., Gärling, T., Millett, B., Mattsson, J. & Johnston, R. 2002. An analysis of international business-to-business relationships based on the Commitment–Trust theory. Industrial Marketing Management, 31(5):403-409.
Gallear, D., Ghobadian, A. & He, Q. 2014. The mediating effect of environmental and ethical behaviour on supply chain partnership decisions and management appreciation of supplier partnership risks. International Journal of Production Research, (ahead-of-print):1-18.
Gunasekaran, A., Patel, C. & Mcgaughey, R.E. 2004. A framework for supply chain performance measurement. International Journal of Production Economics, 87(3):333-347.
Hansen, B.E. 1999. Threshold effects in non-dynamic panels: Estimation, testing, and inference. Journal of Econometrics, 93(2):345-368.
Hansen, B.E. 2000. Sample Splitting and Threshold Estimation. Econometric Society.
Hertzel, M.G., Li, Z., Officer, M.S. & Rodgers, K.J. 2008. Inter-firm linkages and the wealth effects of financial distress along the supply chain. Journal of Financial Economics, 87(2):374-387.

Hsu, C.-I. & Li, H.-C. 2011. Reliability evaluation and adjustment of supply chain network design with demand fluctuations. International Journal of Production Economics, 132(1):131-145.
Jinjarak, Y. 2014. Supply Chains, Global Financial Shocks and Firm Behaviour towards Liquidity Needs. The World Economy: 38: 425–444. doi: 10.1111/twec.12202.
Johnson, D. & Grayson, K. 2005. Cognitive and affective trust in service relationships. Journal of Business Research, 58(4):500-507.
Kaj, S., Tore, S. & Christian, G. 1994. Managing Customer Relationships for Profit: The Dynamics of Relationship Quality. International Journal of Service Industry Management, 5(5):21.
Lee, J.-S., Yen, P.-H. & Chan, K.C. 2014. Investor Sentiment and Investment Behavior in the Chinese Mutual Fund Market. Chinese Economy, 47(1):38-52.
Levin, A., Lin, C.-F. & Chu, C.-S.J. 2002. Unit root tests in panel data: asymptotic and finite-sample properties. Journal of Econometrics, 108(1):1-24.
Liu, S., Qi, H., Shi, J. & Xie, Y.A. 2013. Inferring default correlation from equity return correlation. European Financial Management, doi: 10.1111/j.1468-036X.2013.12016.x.
Liu, Z. & Cruz, J.M. 2012. Supply chain networks with corporate financial risks and trade credits under economic uncertainty. International Journal of Production Economics, 137(1):55-67.
Longinidis, P. & Georgiadis, M.C. 2011. Integration of financial statement analysis in the optimal design of supply chain networks under demand uncertainty. International Journal of Production Economics, 129(2):262-276.
Meyricke, R. 2011. Diversification vs. Contagion in Inter-Linked Portfolios. 24th Australasian Finance and Banking Conference.
Meyricke, R. 2013. Theoretical and empirical evidence of the influence of economic linkages on stock returns. Thesis, University of Cambridge.
Milani, F. & Treadwell, J. 2012. The Effects of Monetary Policy 'News' and 'Surprises'. Journal of Money, Credit & Banking (Wiley-Blackwell), 44(8):1667-1692.
Mizgier, K.J., Wagner, S.M. & Holyst, J.A. 2012. Modeling defaults of companies in multi-stage supply chain networks. International Journal of Production Economics, 135(1):14-23.
Mizgier, K.J., Wagner, S.M. & Jüttner, M.P. 2015. Disentangling diversification in supply chain networks. International Journal of Production Economics, 162:115-124.
Neaime, S. 2012. The global financial crisis, financial linkages and correlations in returns and volatilities in emerging MENA stock markets. Emerging Markets Review, 13(3):268-282.
Nicolau, J. 2014. A new model for multivariate markov chains. Scandinavian Journal of Statistics, 41(4):1124-1135.
Phylaktis, K. & Ravazzolo, F. 2002. Measuring financial and economic integration with equity prices in emerging markets. Journal of International Money and Finance, 21(6):879-903.
Randall, T. & Ulrich, K. 2001. Product variety, supply chain structure, and firm performance: Analysis of the US bicycle industry. Management Science, 47(12):1588-1604.
Reid, I., Ismail, H. & Sharifi, H. 2015. A Framework for Operational Agility: How SMEs Are Evaluating their Supply Chain Integration, In: Managing in a VUCA World. Springer , New York, USA. ISBN 978-3-319-16888-3 (In Press).
Rose, R. & Mishler, W. 2010. The impact of macro-economic shock on Russians. Post-Soviet Affairs, 26(1):38-57.
Tranfield, D., Denyer, D. & Smart, P. 2003. Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review. British Journal of Management, 14(3):207-222.
Tsouma, E. 2009. Stock returns and economic activity in mature and emerging markets. The Quarterly Review of Economics and Finance, 49(2):668-685.
Vogelsang, T.J. 2012. Heteroskedasticity, autocorrelation, and spatial correlation robust inference in linear panel models with fixed-effects. Journal of Econometrics, 166(2):303-319.
Wang, L. 2014a. Who Moves East Asian Stock Markets? The Role of the 2007-2009 Global Financial Crisis. Journal of International Financial Markets, Institutions and Money, 28(1):182-203.
Wang, L. 2014b. Who moves East Asian stock markets? The role of the 2007–2009 global financial crisis. Journal of International Financial Markets, Institutions and Money, 28(0):182-203.
Westerlund, J. & Breitung, J. 2013. Lessons from a decade of IPS and LLC. Econometric Reviews, 32(5-6):547-591.
Yang, J., Lai, K.H., Wang, J., Rauniar, R. & Xie, H. 2015. Strategic alliance formation and the effects on the performance of manufacturing enterprises from supply chain perspective. International Journal of Production Research, 53(13):3856-3870.
Zhou, J. & Gao, Y. 2012. Tail dependence in international real estate securities markets. The Journal of Real Estate Finance and Economics, 45(1):128-151.

COMPETENCY FRAMEWORK DEVELOPMENT WITH AN ENGINEERING INTERVENTION

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Abstract: It has been since mid of seventies when competency made its appearance in professional literature; then psychologists and HR specialists started using competency framework for different phases of employment life cycle. Both employers and employees found substantial utility in competency framework. The available literature reveals that momentous amount of work has been done on behavioral side leaving a need of formal development on technical aspects of competencies. Few examples, available on technical competencies are either frameworks specific to a profession or are related to organizations. This leaves a gap to develop a widely applicable technical competency framework. This paper discusses the development of technical competency framework which could be applied on common jobs in business and industry. The model is exemplified by mapping a job of mechanical fitter by showing every detail of work and eventually concluding it to a weighted proficiency number. This work is stretchable to any jobs in any trade and is useful throughout the employment lifespan. For the purpose of demonstration, this paper has discussed its application in hiring and performance evaluation system only. As the work is being done for a particular organization, it was necessary to include behavioral aspects of competencies as well to make the framework complete and ready to implement as well as evaluate the relationship among various competencies.

Key words: Behavioral competencies, employment lifecycle, technical competencies, technical competency framework.

1. INTRODUCTION

The world has become a “global village”; communication is fast, transportation is improving and customers are demanding. This has brought the entire business on fast pace and strict competition. Fast Moving Consumer Goods industry has to struggle more to survive in a competitive market. Organizations must create “competitive advantage” which is unique for them. While every resource could be available on some fiscal parity or could be copied, human resource remains the clear competitive advantage. The human resource practices which are based upon competency modeling not only give this leverage but also a distinct understanding to hire external talent or to see if the organization has internally developed required set of competencies [1]. Therefore, growing organizations have a significant stress on enhancing personnel competencies. As a matter of fact, in modern human resource management, forming individuals’ competency framework is considered as an ingenious and vigorous tool [2]. In order to be successful in a business, an organization should have to look at the factors that influence its success and one of the factors is the employment of competent workforce.

As often cited, the founder of modern competency movement, David McClelland, argued to present competence as an alternative to intelligence testing [3]. Since then the use remained popular especially in performance management context.

Workplace competency is a thorough and specific account of the skills and attributes that employees need to be better performer in their jobs [4]. Competencies are put together in a framework which is constituted of a number of positions and the required abilities with varying proficiency level that the job holder should either have or attain in order to be effective in his job.

The objective of this project is to develop a technical competency framework for a specific organization with an intent that the same will be applicable to other organizations or industrial sectors as well. The "Technical Competency Framework" which is being suggested here is useful throughout the employment lifecycle. It helps identify and articulate job requirements and define work instructions. It may be used in establishing performance expectations, setting goals for accomplishing the work and assisting supervisors in providing the feedback.

So far published work is limited to few models conferring a narrow scope of technical competency but the proposed work has a wider scope. It is based on real-world system modelling to be followed by testing and validation.

2. TYPES OF COMPETENCIES

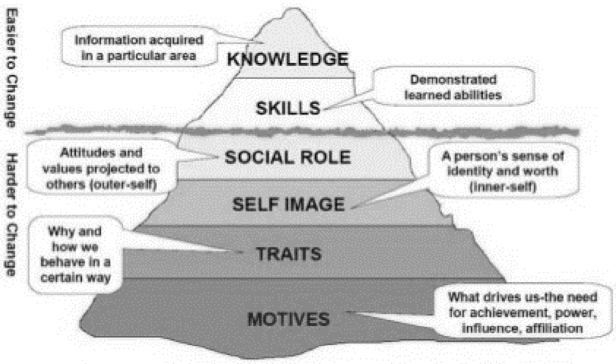

Figure 1 Competency Iceberg [11]

We will cover two types of competencies here: behavioral and technical with emphasis on technical side. Every job may include several of each. For example, a team leader may require to possess behavioral competencies like the ability to work in secrecy, motivate his team mates and produce monthly reports on time, while related technical competencies may be knowledge of procedures, communication skills, and report writing. Each competency must be attribute to a proficiency measure so the job holder knows what level of accomplishment he must reached to in order to fulfill the competency requirement.

Technical competencies are easy to judge as these are related to knowledge and skills, thus known to others. Behavioral competencies on the other hand are related to attitude and traits which are very difficult to estimate. The iceberg concept is found appropriate with this categorization. Figure 1 depicts the idea.

That appears very logical that the competency models must include technical skills but developers of initial competency models concentrated on the behaviors that emanate outstanding performers and assumed that technical skills were of less importance [4]. Since behaviors are situational and environmental based, therefore, their importance is differently felt and developments under competency framework is mostly found related to behavioral skills. Though under very technical jobs like information technology [5], technical competency is talked about but no model at par to behavioral competency has come to our knowledge.

Table 1 enlists some example of both behavioral and technical competencies.

Table 1: Competency categories with examples

Type	Example
Behavioral competencies	Courteous, motivator, supervision ability, punctuality, maintains confidentiality
Technical competencies	Can troubleshoot problems, Analytical, safety compliant, can fill out reports

3. LITERATURE REVIEW

The review of literature on the subject indicates that much of the work has been done either related to behavioral side of the competencies or to organization's technical competence. For example, Walsha and Lintonc, [6] published their work of technical competencies measurements about semiconductor silicon industry but these are competencies of the firm, suppliers, customers and competitors and not individual members.

Ennis [7] mentions a nine tier models where tier four and five are industry wide and industry specific technical competencies. However, competency model there is defined as behavioral job description and therefore, only considers technical competencies as building block or support to higher level behavioral competencies.

Mansfield [4] defines competency model as behaviorally specific description of skills and traits. The work compares various approaches of competency model development from HR perspective. He couldn't trace any work related to technical competencies. Under common set of building block competencies, he proposes that human resource staff should meet with technical people to develop set of specific technical competencies.

Further study also reveals the same outcome where practitioners are finding the need to develop technical competencies. For example, Wingreen and Blanton [5] has presented a model of person-organization fit based of social cognitive theory and suggests that this behavior modeling and modification theory should support research on the maintenance and development of technical competencies.

Gangani [8] et al in their 'Competency - Based Human Resource Development Strategy' have considered competency to be behavioral skills so all their work revolves around behavioral competencies.

Martone, [1] in his 'A Guide to Developing a Competency-Based Performance –Management System' also considers competencies to be behavioral and cultural skills. Two of his Exhibits mention some role specific skills but these are still managerial oriented.

Thompson [9] and two others have taken a long way to come up with a definition of competency as integrated sets of behavior which can be directed towards successful goal achievement within competence domain.

One work of Osika and Sharp [10] is however, related to technical competency which used survey method to match the faculty expectations with what pupils think of technical competencies required in distance learning students. The survey was of faculty at a midsize regional commuter campus in the mid-western United States. An inventory of technical competency was established which faculty members were of view students should exhibit to be successful in web-based instruction. Besides that, same university students were surveyed to determine how well they thought they met the minimum competencies outlined by the faculty. This study is specific to education sector, in particular with distance learning and may not be applicable to business and industry.

4. EXPECTED OUTCOME OF THE COMPETENCY FRAMEWORK

Competency frameworks give employees an explicit idea of what performance is expected from them. These specify which skills (and/or behaviours) are appreciated, recognized and compensated. The emphasis turns from formal qualifications and career past to 'standard capabilities' as proven through experience or tests designed to assess an individual's capabilities. Each identified competency must define a consistent set of levels (proficiency) to differentiate the degree to which a competency is required in various jobs [4].

So far, competencies have been discussed from the employers' perspective. While, competency models can also be used by the other side as well, such as an incumbent worker, a student or a new employees applying for a position. Competency models are alike useful for business planning purposes, individuals seeking employment and advancing or transitioning in their careers. [7].

5. COMPETENCY FRAMEWORK

A Competency Framework comprises of a set of some competencies, explicit to a particular job as extracted from the job descriptions [8]. The competencies should also define the levels to distinguish the extent to which a competency is required. For example, one job may require a basic level of skill while another job may require a much higher level. Levels could also enable the correct evaluation of individuals when there is a need to identify persons who possess particular competencies required for their job or project [4].

We have included an example of some **technical** (in bold) competencies related to a job of mechanical fitter. For the purpose of completing the map, we have to enlist some necessary behavioral competencies as well. Shown below are these fifteen competencies technical cum behavioral.

1 **Ability to communicate verbally,**
2 **Be able to fill out reports,**
3 **Analytical,**
4 **Be able to trouble shoot problems,**
5 **Can supervise workers,**
6 **Compliance to procedures,**
7 Courteous,
8 Develop workers,
9 **Guide workers in their job,**
10 Motivator,
11 **Performs as active technical support,**
12 Punctuality to work,
13 **Reliable,**
14 **Safety conscious; personal and property,**
15 Team worker

6. Competency Framework Development

The methodology for developing a Competency Framework starts with identifying jobs of considerable importance that a project leader, head of the department or an HR professional sees a need for. A universal list of competencies or library may not therefore, be purposeful for organizational achievement [9]. The preliminary collection of information may include a panel of HR professional, job expert and psychologist and at the same time a focus group of job holders and their managers to interview with jobholders. The stage of collecting data may also include interviews with customers and direct reports, surveys of additional job holders, and direct observation of jobholders at work [4]. After this is complete, the next step is scrutiny of data to extract it into a Competency Framework that would normally include ten to twenty skills, each with a list of specific task that describe what exactly is required of the job to do to be an effective performer. These are development phase steps which continue exactly as detailed below but there are two other distinct phases of validation which our project has to take. Details are following (Figure 2).

6.1 Development Phase:

Some technical jobs will be identified through experience and survey which are usually found in industry like fitter, fabricator, machinist, motor winder, AC technician, generator operator, wiring man, inspectors, lab technicians, forklift drivers, etc.

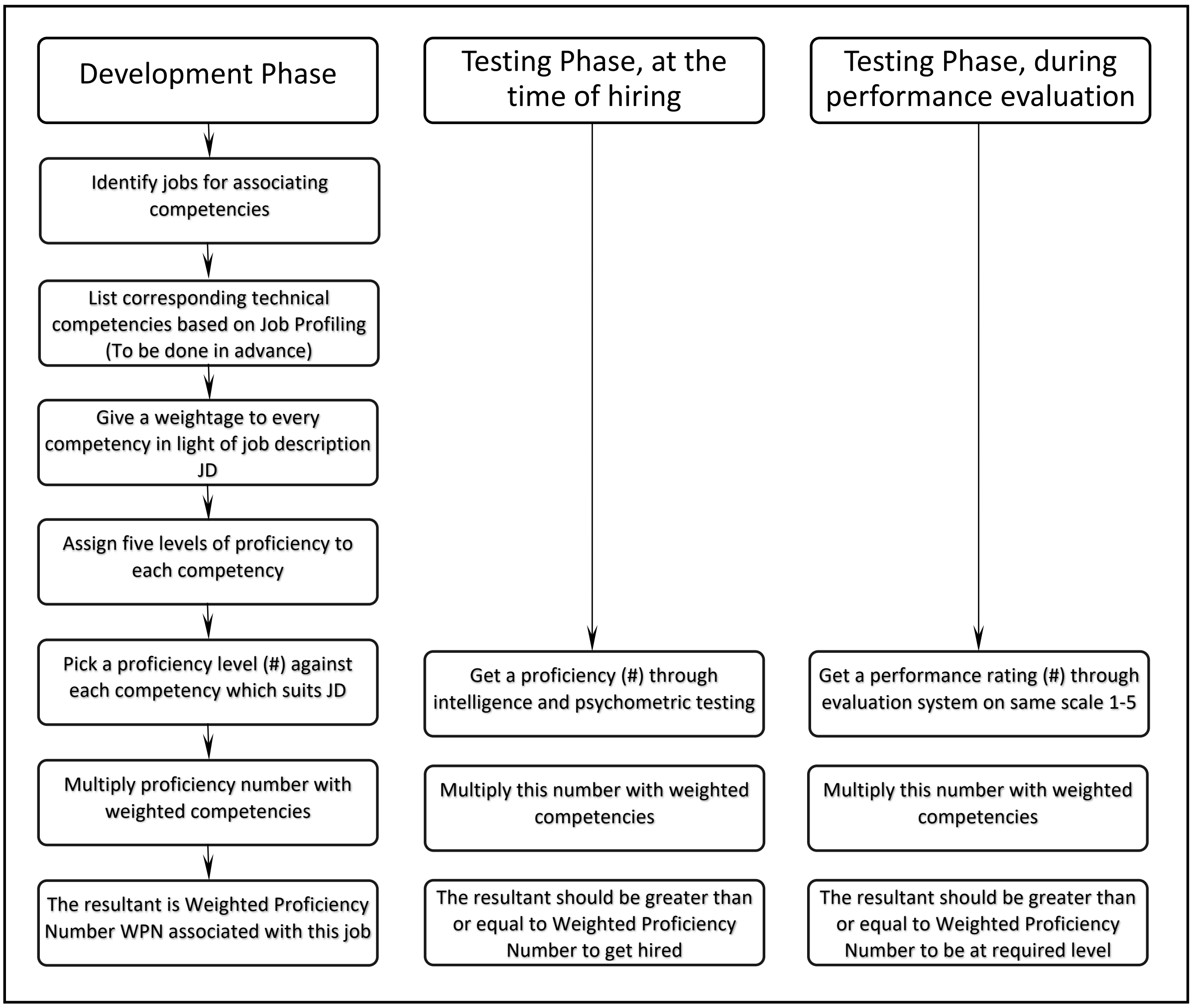

Figure 2. Process Flow of Competency Framework Development Methodology

- Technical competencies will be identified against each job based on Job Profiling which should exist or be prepared before any work on competencies should start . Under every competency, there will be five levels of proficiency defined. This will be done by literature survey, observation at work, expert opinion, brain storming and interviews.

- Weightages will be given based on the above work in each job.

- Based on already present job description, proficiency level will be picked and multiplied with weightage to get Weighted Proficiency Number – WPN. For example, ‘Ability to communicate verbally’ is a technical competency. For the job (mechanical fitter) we calculated WPN, its weightage is 7 on a scale of 100. Proficiency level we require for this job is ‘Is able to express and report work related issues’ which corresponds to level 4. So WPN will be 7x4 = 28.

- The same number against any job could vary from industry to industry and company to company based on their needs.

- Work thus done for different jobs will form a population. The whole work will be referred to as a “Competency Framework.”

- A pilot run will be made on a selected organization to verify that the process runs satisfactorily.

6.2 Testing and Validation Phase

6.2.1 <u>At the time of Hiring:</u>

This is future work and suggestions as how the framework could be tested for its effective working

- Specific questions for interview will be designed; relevant technical and psychological tests will be determined; and on-the-job testing will be framed out. These tools will be used to derive a Proficiency Level. This level (number) will be multiplied with the weightages to obtain WPN.

• This WPN could be statistically tested to confirm whether it belongs to the population derived in the Competency Framework. If this number comes out to be greater than or equal to WPN in the Competency Framework, then it is believed that the hiring has been done according to the required competency.

6.2.2. During performance:

Aforementioned procedure will be followed with an exception that "Proficiency Level" is replaced with "Performance Rating (number)." Here, WPN is the product of this rating and assigned weightages. If this number is greater than or equal to WPN in the Competency Framework, then it is concluded that the incumbent's performance is according to the required level of competency.

7. CONCLUSION

Original use of competency started some four decades ago. Since then it has not only been popularly used but has become a robust tool in modern human resource practices. Literature review of competency framework shows that much of the work has been done related to behavioral side of the competencies. Very limited work has so far been published related to technical competencies. This project has covered major and common technical jobs of the industry for drawing technical competency framework. A team of relevant staff was employed to identify required competencies for specified jobs and categorize five probable proficiency levels against each. Weightages were assigned to competencies and weighted proficiency number was calculated. This weighted proficiency number is useful for hiring and performance measurement.

For future research, validation of the framework can be made. There are HR tools which can test an individual during hiring process and during the course of performance if he meets the job criteria or is performing up to the standards. It is recommended that the framework is validated and more applications are employed other that hiring and performance evaluation like training need analysis and personal improvement programme.

8. REFERENCES

[1] Martone, David (2003). A Guide to Developing a Competency-Based Performance –Management System. Employment Relations Today, 30(3), 23-32.
[2] Collin, Jim A. (1997). Learning and Development, Brardwell, I. and Holdon, L. (eds). In Human Resource Management: A Contemporary Perspective. London: Pitman.
[3] McClelland, David (1973). Testing for Competence Rather Than for "Intelligence". American Psychologist, 28(1), 1-14.
[4] Mansfield, Richard S. (1996). Building Competency Models: Approaches for HR Professionals. Human Resource Management, 35(1), 7-18.
[5] Wingreen, Stephan C.; Blanton, J. Ellis (2007). A Social Cognitive Interpretation of Person-Organization Fitting: The Maintenance and Development of Professional Technical Competency. Human Resource Management, 46(4), 631-650.
[6] Walsha, Steven; Lintonc, Jonathan D. (2001). The Measurement of Technical Competencies. The Journal of High Technology Management Research, 13(1), 63-86.
[7] Ennis, Michelle R. (2008). Competency Models: A review of the literature and the role of the Employment and Training Administration. Pilots and Demonstration Team ETA, U.S. Department of Labour, 2-25.
[8] Gangani, Noordeen T.; McLean, Gary N.; Braden, Richard A. (2006). Competency –Based Human Resource Development Strategy. Performance Improvement Quarterly, 19(1) 127-139.
[9] Thompson, John E.; Stuart, Roger; Lindsay, Philip R. (1996). The competence of top team members. A framework for successful performance. Journal of Managerial Psychology 11(3), 46-65.
[10] Osika, Elizabeth Reed; Sharp, Douglas P. (2002). Minimum Technical Competencies for Distance Learning Students. Journal of Research on Technology in Education, 34(3), 318-325.
[11] http://www.managementstudyguide.com/ competency-iceberg-model.htm

PLANT DISEASES DETECTION USING CONTENT BASED IMAGE RETRIEVAL

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Abstract: Agriculture is major sector for generating revenue for any country. Agriculture is divided into Cultivation and Live Stock. Current researchers have mainly focused on Crop Cultivation problems like diseases identification of various plants caused due to virus infection known as Fungi and etc. Plant diseases has become a dilemma and its consequences has significant reduction of agricultural productivity, so agricultural production loss can be minimized by specific pathologies identification at early stages and control strategies can also be implemented. CBIR can be used as a remedy for these problems by complementary supportive system and used as control strategies for improved quality of agricultural products. Accurate detection of diseases can be done with the help of CBIR in field of agriculture. On the basis of experiments and result successful system is designed for Tomato Leaf Image Diseases Dataset (TLIDD) disease detection.
Keyword: Content Based Image Retrieval; Tomato Leaf Image Dataset; Gabor Feature Extraction

1. INTRODUCTION

Agriculture accounted for 20.9 percent of the Gross Domestic Product (GDP) in 2014-15 and is a source of income of 43.5 % of rural population of Pakistan. [13] Automatic detection of plant diseases is an essential research topic as it may prove beneficial in monitoring fields of crops.

The Research provide help to farmers to harvest more land and provide better quality food to consumers. Technology of Computer Vision/image processing can be applied for the development of agriculture field, and we can achieve so many advantages regarding crops/plants harvesting, diseases detection, monitoring and water level management etc. Farmers can save crops/plants from diseases by detecting them using Content Based Image Retrieval. If crops/plants are healthy then quality of product will also be improved. Computer Vision can also help to detect and monitor whether that crop is ready or not. Time and money can also save because it is main thing that matter a lot for farmer's social life. The quality of Crops/Plants can also be maintained by using Computer Vision that does matters a lot to farmer because no one would like to lose his market competitiveness just because of low quality.

Computer Vision can help farmers to cultivate more land than normally he/she does because machine can provide Artificial Intelligence and machine never get tired of. Machine can also be easily maintained and replaced with new machines. Computer Vision definitely increases total average of production or harvest etc. Computer Vision can simply give assistance to farmers and convert their efforts into productive certainty.

2. EQUATION

Expressed mathematical representation of 2D Gabor Filter below:

$$G_{\theta,f}(x,y) = \exp\left(-\frac{1}{2}\left[\frac{x^2{}_\theta}{\sigma^2{}_x} + \frac{y^2{}_\theta}{\sigma^2{}_y}\right]\right).\mathrm{Cos}(2\pi f x_\theta) \tag{1}$$

$$x_\theta = x\sin\theta + y\cos\theta$$
$$y_\theta = x\cos\theta - y\sin\theta$$

f shows the frequency on the x-axis at an angle of θ

σ_x and σ_y are used for the standard deviation of the Gaussian envelope along the x and y axes . Gabor Filter is a wavelets group all wavelets takes energy at particular frequency and direction from a digital image $G_{\theta,f}$ and its computes frequency information and local orientation. All image is filtered using at number of different standard deviations, orientation and frequencies.

3. Figures and Tables

3.1 Proposed System

Content Based Image Retrieval system architecture shown in figure 1 based on retrieval diseased leaves of plant CBIR system based on four steps i.e. In First step Query Image and TLIDD are Pre Processed followed by Second of Feature Extraction by using Gabor Feature Extraction Algorithm. Third Step Trained Models of Query Image and TLIDD match by using Classifier. In Last step Class Name is displayed as Resultant of Maximum Score of Query Image matched most similar class from TLIDD.

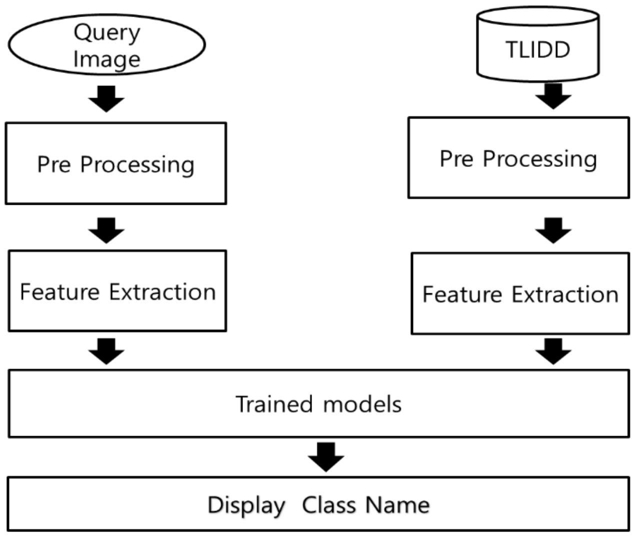

Figure 1: Plant Diseases Detection Methodology

3.2 Tomato Leaf Image Diseases Dataset (TLIDD)

Acquiring a suitable dataset appears to be a big challenge in the field of crop disease detection. Mr. David Hughes work has done immense in the field of crop disease detection. An open access repository of images on plant health to enable the development of mobile disease diagnostics by David. P. Hughes, Marcel Salathe. [11]

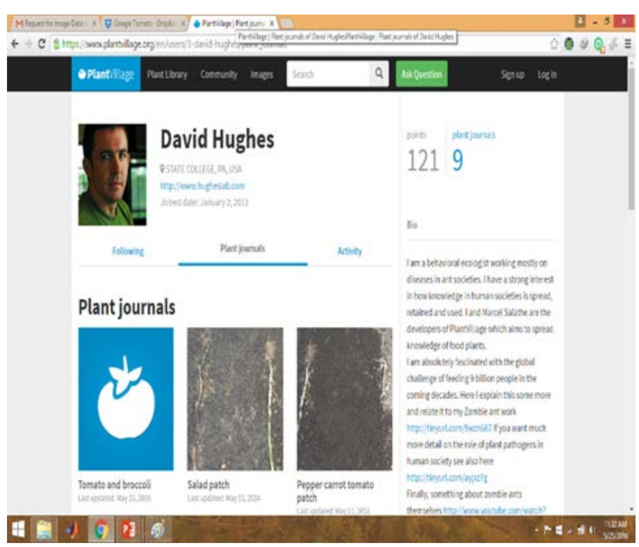

Figure 2: Tomato Leaf Image Diseases Dataset

Tomato Leaf Image Diseases Dataset (TLIDD) consists of nine classes. Each class consist of 100 images.30 images per class are used for Training set, for each of the nine classes. One class consist of Tomato Plant Healthy Leaf Image named as: Tomato Healthy. Eight classes consist of different Tomato Plant Leaf diseases Images named as: Tomato Bacterial Spot, Tomato Early Blight, Tomato Late Blight, Tomato Leaf Mold, Tomato Septoria Leaf Spot, Tomato Spider Mite Damage, Tomato Target Spot, and Tomato Yellow Leaf Curl Virus.

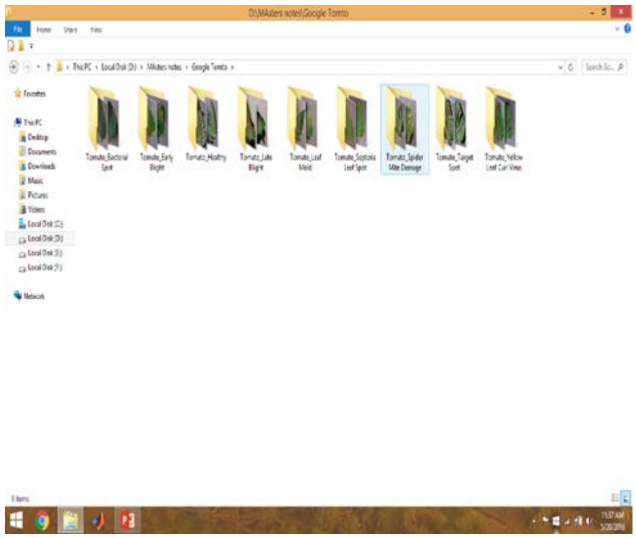

Figure 3: Tomato Leaf Image Diseases Dataset

3.3 Gabor Feature Extraction (GFE)

Gabor filters are band pass filters which are used in image processing for feature extraction, texture analysis and stereo disparity estimation. [12] Gabor filters are efficient in reducing image redundancy and robust to noise. Texture segmentation and texture feature extraction are the major features of Gabor filter. Gabor Filter widely adapted in major Image processing applications. Gabor filter with the specified wavelength (in pixels/cycle) and orientation (in degrees). If you specify wavelength or orientation as vectors, Gabor returns an array of Gabor objects, called a filter bank, that contain all the unique combinations of wavelength and orientation.

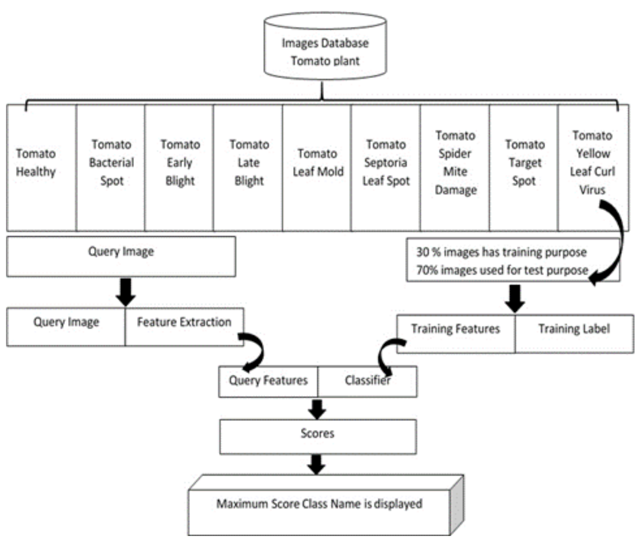

Figure 4: Plant Diseases Detection Using C.B.I.R Model

3.4 PLANT DISEASES DETECTION MODEL

In Plant Diseases Detection using Content Based Image Retrieval Model based on Query Image and TLIDD. Query features extracted from query image and Classifier comprises of trained and labeled features obtained by classifier named as Fitcecoc, Fit multiclass models for support vector machines or other classifiers. Fitcecoc classifier returns a full trained error-correcting output codes (ECOC) multiclass model using the predictors in table and the class labels in table. By default, fitcecoc uses K (K – 1)/2 binary support vector machine (SVM) models using the one-versus-one coding design, where K is the number of unique class labels (levels).

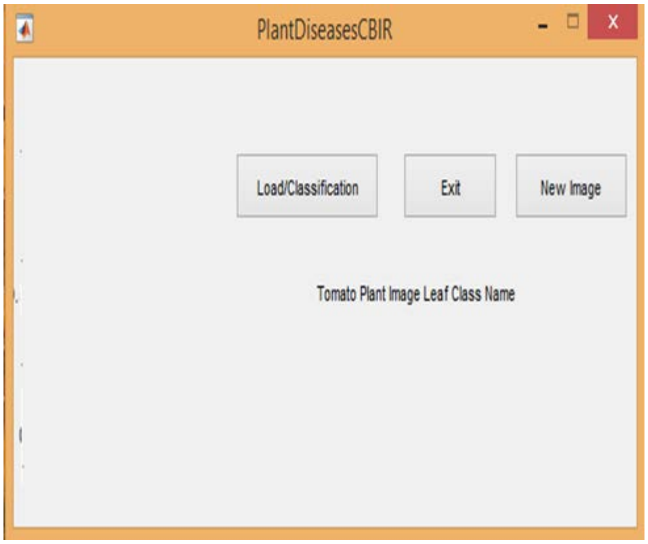

Figure 5: TLIDD Framework Select Query Image

Tomato Leaf Image Disease Detection Framework has three option as show in figure 5(a).Load/Classification is used for Browse and select Query Image. Exit is will close the program. New Image will remove previous Query Image and other image can be select.

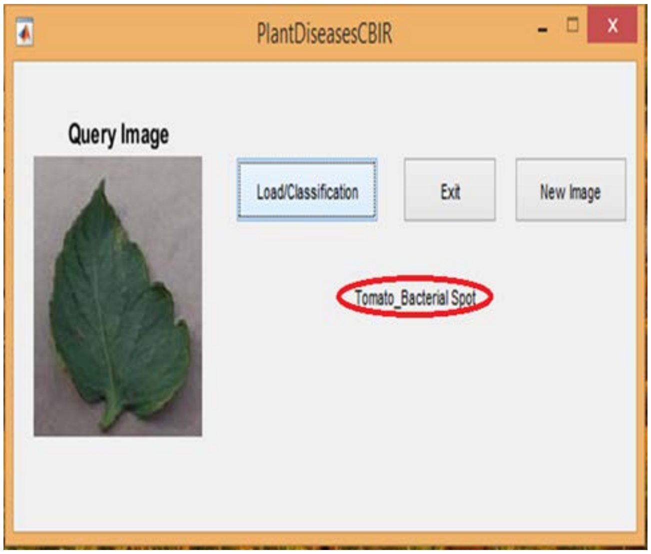

Figure 2: TLIDD Framework diseased detected

After selection of Query Image click on Load \Classification button. The process of Identification is started and at the end disease name is displayed as shown in Figure 5(b). Identification process restart by clicking button New Image.

4. Experimental Results and Discussions

Tomato is one of the major crop of Pakistan, it is cultivated in all parts of country so Tomato leaf is chosen for experiments. Tomato leaf are affected from various diseases. Matlab software is used for experiments simulation. Gabor filter algorithm is used to increase the retrieval accuracy. Calculation of retrieval accuracy (ra) can be obtained by using equation 2 which shows that Retrieved relevant images number (ri) divided by retrieved total number of images (ti).

$$retrieval\ accuracy\,(ra) = retrieved\ relevant\ images\ number\,(ri)/retrieved\ total\ number\ of\ images\,(ti)$$

Gabor Filter algorithm used for texture feature extraction of images. Tomato Leaf Image Diseases Dataset (TLIDD) consist of image having size 128x128.Euclidian distance between query image and TLIDD used for retrieval of images with minimum distances.

There are 9 Class with their respective accuracy as show in table 1. Tomato_Bacterial_Spot has 90% accuracy, Tomato_Early_Blight has 84% accuracy, Tomato Healthy has 96% accuracy, Tomato_Late_Blight has 85% accuracy, Tomato_Leaf_Mold has 80% accuracy, Tomato_Septoria_Leaf_Spot has 83% accuracy, Tomato_Spider_Mite_Damage has 75% accuracy, Tomato_Target_Spot has 88% accuracy and Tomato_Yellow_Leaf_Curl_Virus has 75% accuracy.

The proposed system has overall 84% Retrieval Accuracy. Tomato_Healthy acquiring highest Retrieval Rate is 96% and Tomato_Spider_Mite_Damage and Tomato_Yellow_Leaf_Curl_Virus has lowest Retrieval Rate is 75%.

Class ID	Name	Accuracy
Class 1	Tomato_Bacterial_Spot	90
Class 2	Tomato_Early_Blight	84
Class 3	Tomato_Healthy	96
Class 4	Tomato_Late_Blight	85
Class 5	Tomato_Leaf_Mold	80
Class 6	Tomato_Septoria_Leaf_Spot	83
Class 7	Tomato_Spider_Mite_Damage	75
Class 8	Tomato_Target_Spot	88
Class 9	Tomato_Yellow_Leaf_Curl_Virus	75

Table 1: Accuracy of Classes

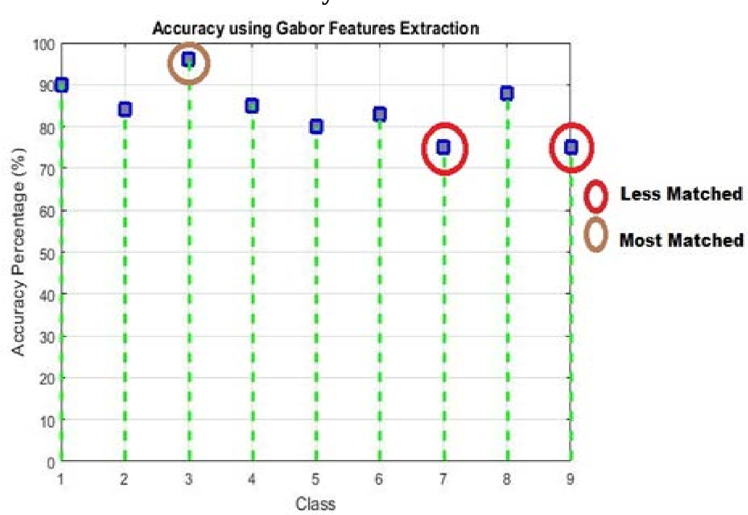

Figure7: Accuracy Image Retrieval using Gabor Feature Extraction

5. CITING REFERENCES

5.1 Related Work

Content Based Image Retrieval has become very informative, efficient and useful in recent past years. CBIR systems developed by researchers in various applications using Texture, Color and Shape or combination of all these together.

Patil and Kumar (2016), used LGGP, HSV, SIFT, Gabor filter and LBP for analysis of plant disease CBIR. [14] Choudhary et al. (2014), LBP and color moment researchers used for CBIR system. [7] Wenfai et al. (2014), Tamura-Hu moments, gray level co-occurrence matrix, color histogram and color correlogram techniques used for development of CBIR system. [26] Ganar et al. (2014), co-occurrence matrix and color histogram used for CBIR system. [10] Belloulata et al. (2014), CBIR system developed by using Shape-Adaptive Discrete Cosine Transform (SA-DCT). [5] Bandaru and Naik (2014), Canny Edge Detection (C.E.D) and Scale Invariant Feature Transform (SIFT) used for CBIR system. [3] Weng et al. (2013), Shukla (2013) and Redi et al. (2011), Color Moments used for CBIR. [27][25][22] Doshi and Schaefer (2013), Local Binary Pattern Varinace used for CBIR System. [9] Kang and Zhang (2012), Zernike moments and gray co-occurance matrix techniques are used for CBIR system. [17] Chakravarti and Meng (2009), RGB color histogram was used for CBIR system. [6] Rasli et al. (2012), color histogram using K-Means and GLCM techinques are used for CBIR system. [21] Chun et al. (2008), BDIP, BVLC and auto-correlogram used for CBIR system. [8] Selvarajah and Kodithuwakku (2011), color histogram moments and wavelets techniques are used in CBIR system development. [23]

Patil and Kumar (2016) worked on analysis of plant disease using texture features, color and shape. Soybean leaves used by researcher for diseases analysis. CBIR system obtained efficiency 72% for ten retrieval images at top and 80% for five retrieval images at top by combination all features. Precision totally dependent on quantity and quality of dataset. [14]

Bankar et al. (2014), research presents identification plant diseases method based on histogram matching, color and edge detection. Biological sciences information and data from image dataset of plant. If plant are affected from various diseases so quality and quantity will be automatically reduced and ultimate loss will affected badly to socio-economic farmers life. Lack of identification plant disease at right time spoil crop, but content based image retrieval help to avoid such consequences. Most important section of research is accurate detection diseased plant. Effective research for identification plant disease by using sample technique and method separated in two major phases. First part of research method associated with training with will distinguish various samples are healthy or diseased. Second part will based upon test sample histogram matching and edge detection training. [24]

Baquero et al. (2014), proposed a system that can provides, a precise identification of tomato crop diseases and identification of pathologies in initial stages is essential for the implementation of control plans. Several diseases and abnormal conditions affect tomato crop so losses of production but that production can be saved by diagnose diseases on right time. Plant diseases can be identified by symptoms with specific knowledge but farmers don't have that knowledge so Computer Vision can proposed tool, which can assist them to identify diseases. Content Based Image Retrieval can be a complementary technique to make some improvement in crop quality by database exploration and other information. Research is useful for Image retrieval of tomato leaves for greenhouse crops. Color Structure Descriptor and Nearest Neighbors based strategy is used and that suitable for diseases diagnosis. Experimental results of proposed approach displayed various diseases, such as sooty moulds, early blight and chlorosis. [4]

Babita Singh and Waseem Ahmad (2014), study proposed a technique Content based image Retrieval and its application. CBIR system had problems while searching images from huge database. Texture, shapes, colors or any other resources information. Image features can be extracted precise and systemic way from database. Most web based image search relies on metadata and due to this wastage of resource and time. Indexing of image content provides improved and accurate results. [2]

Patil and Kumar (2014), study is about Identification of plant disease. It is not possible for ordinary farmer unless he/she is experienced farmer or pathologist. Cultivation expert has ability for recognize plant disease but for other person it is impossible thing to do. Timeliness, availability and consistency is also generate problems experts. [15]

Kamljot Singh Kailey and Gurjinder Singh Sahdra 2012, proposed a system for Plant diseases identification. Lack expertise for identification of plant disease caused a lot of problem for land grower and crop usually damaged. Data and Information gathered from Image dataset will assist in diagnose of plant disease. Quality and Quantity of crops can be increased by plant disease identification at right time with help of content based image retrieval. There are two stages of system, first of all Image Dataset categories into samples. These sample will trained and as resultant sampling will occur two possible conditions, Healthy Plant or diseased Plant. Second stages obtained by training samples with edge detection and histogram matching. [16]

Ahmed J. Afifi and Wesam M.Ashour (2012), research proposed method for avoidance problems occur during retrieval accuracy and computational complexity of CBIR Systems. Color and Texture Feature can assist in improvement of computation complexity and retrieval accuracy. Color Feature extracted from image by calculation of color moment obtain HSV. Texture feature extracted from image by using Ranklet Transform and gray-scale. Ranklet extracted feature by calculating texture moments from original image. Accuracy in image retrieval obtain by using combination of both feature extraction method color and texture. [1]

Kebapci et al. (2011), using CBIR developed plant image retrieval system. Color, Shape and Texture features are used for plant image retrieval. Modified Gabor, Color Histogram and Color Co-occurrence matrix depends on patch based approach. Local characteristics of plant extracted by SIFT algorithm and global characteristics of the plant extracted by global shape descriptor.73% accuracy of identification house plant experiment. [18]

Huang et al. (2010), research proposed content based image retrieval method and address there their issues like low retrieval accuracy as well as high computational complexity, so they can be minimize by using texture and color features. Gabor texture descriptors are used for texture features extraction. Color features extracted by color moments of the Hue, Saturation and Value (HSV) color space. Euclidean distance used for normalization for calculation of similarity combined features texture and color. Feature vector detection has higher retrieval accuracy result as compared to other traditional methods. [28]

Li et al. (2010), proposed method for wheat crop diseases automatic identification. Image Lesion area extract by Otsu algorithm. 85% accuracy rate of disease detection of wheat crop. Principal component analysis of different fourteen morphological characteristics are obtained by filtered segmented region. [19]

Automatic system proposed by Meunkaewjinda et al. (2008), for diagnosis grape plant leaf disease by applying artificial intelligent multiple techniques. Grape Leaf colors recognition by using back propagation and self-organizing feature map. Support vector machine segmentation is used for classification by applying a modified self-organizing feature map. 86.03% average percentage retrieved by diagnosis system. Cotton leaves also diagnosed by self-organizing feature map. [20]

6. Conclusion

The proposed Content based image retrieval system specifically design for Tomato Leaf Image Diseases Dataset (TLIDD) disease detection. There are total nine classes are used. Eight classes consists of diseases tomato leaf images and one is healthy tomato leaf images. Texture features are analyzed hence it shows improvement retrieval accuracy. Maximum average accuracy is retrieved is 84%. There is still gap available to retrieval accuracy depends upon database size.

7. Acknowledgement

This work is support by Mr. David Hughes and Special thanks to him, for his act of kindness. David Hughes shared Dataset of Tomato Leaf with me and without his help my work was not possible. Last but not least, I am grateful to my teachers, family and friends for their co-operation and help in all respects during study period which enabled me to complete this work.

8. References

1. Ahmed J. Afifi and Wesam M.Ashour, “Content-Based Image Retrieval using Invariant Color and Texture Features, ” in Digital Image Computing Techniques and Applications (DICTA), 2012 International Conference on. IEEE, 2012, pp. 1-6.

2. Babita Singh and Waseem Ahmad, “Content Based Image Retrieval: A Review Paper,” in IJCSMC, Vol.3, Issue.5, May 2014, pp. 769-775.

3. Bandaru, R., Naik, D., “Retrieve the similar matching images using reduced SIFT with CED algorithm” in Control, Instrumentation, Communication and Computational Technologies (ICCICCT), International Conference, 2014, pp. 1242-1247.

4. Baquero, Douglas, Juan Molina, Rodrigo Gil, Carlos Bojaca, Hugo Franco and Francisco Gomez, “An image retrieval system for tomato disease assessment,” in 2014 XIX Symposium on Image, Signal Processing and Artificial Vision, 2014, pp. 1-4.

5. Belloulata, K., Belallouche, L., Belalia, A., Kpalma, K., “Region based image retrieval using Shape-Adaptive DCT” in Signal and Information Processing (China SIP), IEEE China Summit & International Conference, 2014, pp. 470-474.

6. Chakravarti, Rishav, Meng, Xiannong, “A study of color histogram based image retrieval” in IEEE Comput. 2009, pp.1323-1328.

7. Choudhary, R., Raina, N., Chaudhary, N., Chauhan, R., “An integrated approach to content based image retrieval” in International Conference on Advances in Computing, Communications and Informatics (ICACCI), 2014, pp. 2404-2410.

8. Chun, Young Deok, Kim, Nam Chul, Jang, Ick Hoon, “Content based image retrieval using multiresolution color and texture features” in IEEE Trans. Multimed.10 (6), 2008, pp. 1073-1084.

9. Doshi, N.P., Schaefer, G., “Compact multi-dimensional LBP features for improved texture retrieval” in Robot, Vision and Signal Processing (RVSP), 2nd International Conference,2013, pp. 51-55.

10. Ganar, A.N., Gode, C.S., Jambhulkar, S.M., “Enhancement of Image Retrieval by using colour, texture and shape features” in International Conference on Electronic Systems, Signal Processing and Computing Technologies (ICESC), 2014, pp. 251-255

11. http://axiv.org/abs/1511.08060 An open access repository of images on plant health to enable the development of mobile disease diagnostics.

12. http://homepages.inf.ed.ac.uk/rbf/CVonline/LOCAL COPIES/TRAPP1/filter.html

13. http://www.finance.gov.pk/survey_1415.html Federal Government of Pakistan Finance Division.

14. Jayamala Kumar Patil, Raj Kumar, “Analysis of content based imaged image retrieval for plant leaf diseases using color, shape and texture features, 2016, pp. 1-10

15. Jayamala Kumar Patil, Raj Kumar, “Comparative study of Content Based Image Retrieval for maize leaf diseases using histogram and scale invariant feature transforms,” in Proceeding of 3rd International Conference on Recent Trends in Engineering & Technology (ICRTET’2014), 2014, pp. 966-974

16. Kamaljot Singh Kailey, Gurjinder Singh Sahdra, “Content-Based Image Retrieval (CBIR) For Identifying Image Based Plant Disease,” in Int.J.Computer Technology & Applications,Vol 3 (3), 2012, pp. 1099-1104.

17. Kang, Jiayin, Zhang, Wenjuan, “A framework for image retrieval with hybrid features” in Control and Decision Conference (CCDC), 2012, pp. 1326-1330.

18. Kebapci, Hanife, Yanikoglu, Berrin, Unal, Gozde, “Plant image retrieval using color, shape and texture features” Comput. J. 54 (9), 2011, pp. 1475-1490.

19. Li, Jinghui, Gao, Lingwang, Shen, Zuorui, “Extraction and analysis of digital images feature of three kinds of wheat diseases” in International Congress on Image and Signal Processing. IEEE, 2010, pp. 2543-2548.

20. Meunkaewjinda, A., Kumsawat, P., Attakitmongcol, K., Srikaew, A, “Grape leaf disease detection from color imagery using hybrid intelligent system” in Proceedings of ECTI-CON. IEEE, 2008, pp. 513-516.

21. Rasli, Ruziana Mohamad, Muda, T.Zalizam T., Yusof, Yuhanis, Bakar, Juhaida Abu,“Comparative analysis of Content Based Image Retrieval techniques using color histogram: a case study of GLCM and K-means clustering” IEEE Comput. 2012, pp. 283-286.

22. Redi, M., Antipolis, Sophia, Merialdo, B., “Saliency-aware color moments feature for image categorization and retrieval” in 9th International Conference on Content-based Multimedia Indexing (CBMI), 2012, pp. 199 - 204.

23. Selvarajah, S., Kodithuwakku, S.R., “Combined feature descriptor for Content Based Image Retrieval” in Industrial and Information Systems (ICIIS), 6th IEEE International Conference, 2011, pp. 164-168.

24. Shital Bankar, Ajita Dube,Pranali Kadam, Prof. Sunil Deokule, “Plant Disease Detection Techniques Using Canny Edge Detection & Color Histogram in Image Processing,” in International Journal of Computer Science and Information Technologies, Vol. 5 (2), 2014, pp. 1165-1168.

25. Shukla, D., “Image retrieval system using block-based statistical features” in Image Information Processing (ICIIP), IEEE 2nd International Conference, 2013, pp. 282-287.

26. Wenfei, Dong, Shuchun, Yu, Songyu, Liu, Zhiqiang, Zhang, “ Image retrieval based on multi-feature fusion” in 4th International Conference on Instrumentation and Measurement, Computer, Communication and Control (IMCCC), 2014, pp. 240-243

27. Weng, Tianfa, Yuan, Yule, Shen, Ling, Zhao, Yong, “Clothing image retrieval using color moment” in Computer Science and Network Technology (ICCSNT) 3rd International Conference, 2013, pp. 1016-1020.

28. Zhi-Chn Huang, Patrick P.K Chan, Wing W.Y.NG, Daniel S.Yeung, “Content_Based Image Retrieval using Color Moment and Gabor Texture Feature,” in Proceedings of the Ninth International Conference on Machine Learning and Cybernetics, Qingdao, 11-14 July 2010, pp. 719-724

EFFECT OF COAL POWER PLANT FLY ASH ON WORKABILITY AND COMPRESSIVE STRENGTH OF CONCRETE.

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Abstract: Industrial waste materials may be of rains risks for environment if it is not properly disposed of or it may be very costly as a landfill disposal, this waste material can be used in construction industry as a substitute of cement and aggregates which results in economical construction as well as ecological beneficial . This experimental study comprises the effect of fly ash on the properties of fresh and hardened concrete. In total 64 standard concrete cylinders were cast by replacing fine aggregates with different proportions of fly ash i.e. 0%, 10%, 20 and 30% to identify the result of fly ash on workability and strength of the concrete which were cured at 3, 7, 14 and 28 days. Concrete cylinders were 6” in diameter and 12” in height and concrete was mixed with water cement ratio of 0.5. The conclusions of this research is indicated that the replacement of fine aggregates with fly ash increases the compressive strength of concrete and workability reduces with increase in proportion of fly ash.

Keywords; Fly Ash; Cement; Aggregates; Cylinders

1. INTRODUCTION

Concrete is a constructional substantial which is used to construct different types of structures it is a complex material which is prepared by adding cement, aggregates, steel and water. The materials required for making of concrete most likely to transport from far distance places. If materials are available in vicinity of construction area construction can be economical for the country [1]. The material like fly ash which has pozzolanic properties can be used as environmental waste from coal power generation plants by replacing with cement as well as with fine aggregates, it is an energy intensive, an expensive material which possess good mechanical properties, acid and fire resistance. In concrete, the use of fly ash will indicate the preservation of natural resources and energy. The residues such as bottom ash, fly ash and slag have also been used as admixtures for different construction material like sub base construction, concrete and road embankment [2]. The concrete in fresh or hardened state can be affected by addition of Cementous and pozzolanic materials. Mineral admixture have influence on the different properties of fresh cement and concrete like water requirement, heat of hydration, workability, consistency, initial and final setting time. Whereas it significantly affects the ultimate strength, durability, workability, pump ability, permeability, resistance to acid and fire attack on hardened cement concrete. Now, In the present study the fly ash is obtained from Lakhra coal power generation plant and partially replaced with fine aggregates to know its effects on workability and on the strength of concrete.

2. MATERIALS

The materials used in concrete which are given below**.**

2.1 Ordinary Portland Cement (OPC)

In this research, we used OPC was obtained from Falcon cement Factory. By using vicat apparatus the following tests like normal consistency and setting time of O.P.C. were determined which are explained in detail by various codes (BS code & ASTM standard) [3].

2.2 Coarse Aggregate

Coarse Aggregate was taken from Nooriabad crush plant. Basic aggregate tests were conducted to find the properties of coarse aggregates i.e Specific gravity and water absorption. Results showed the normal range as per BS-882 in Table 2. Though, the size of CA was not in compliance with BS-882, to have a same nominal maximum size of coarse aggregate an artificial method of compliance was done. In such a way, the artificial procedure was assumed and therefore coarse aggregate approves nominal maximum size of 20 mm of BS-882 [4].

2.3 Fine Aggregate

In this study the fine aggregate was taken from Bholari, satisfied the Zone-II of BS-882 [4]. The following basic test were determined such as Specific gravity and water absorption of fine aggregates which are presented in Table 2.

2.4 Fly Ash

For this study, Fly ash was taken from lakhra power plant located at district Jamshoro and basic tests were conducted to find the properties such as Specific gravity and water absorption. Results showed the normal range as per BS-812 [5]

Table1: Test of OPC

Name of Test	OPC
Normal Consistency	33%
Initial Setting Time	86 minutes
Final setting Time	200 minutes

Table 2: Water Absorption and Specific Gravity

Aggregate	Specific gravity	Water Absorption
Coarse Aggregate	2.6	1.09%
Fine Aggregate	1.66	2.5%
Fly Ash	2.6	15.5%

3. METHODOLOGY

In total 64 concrete cylinders were casted by replacing fine aggregates with different percentage of fly ash. 16 cylinders were cast with plain concrete and remaining 48 cylinders were cast by replacing fine aggregates with different percentages of fly ash i.e. 10% 20% and 30% ratio of cement, fine aggregates and coarse aggregates was kept as 1:2:4 @ 0.5 water-cement ratio for all the cylinders. Concrete cylinders were 6” in diameter and 12” in height. Workability of concrete for each cylinder was measured by slump test. The apparatus of slump test was comprise of a steel mould in the shape of a narrowed frustum known as slump cone having internal diameter 4in at top side and 8in diameter at the bottom side with a total height of 12in. Each test was performed by compacting concrete in 3 similar layers and every layer was tamped with 25 times with a 2ft metal rod having diameter of 5/8in. The steel mould was raised vertically upward direction and fall of any height of the concrete was measured**.**

4. RESULTS AND DISCSSION

4.1 Effect of fly Ash on workability of Concrete

The workability of concrete was decreased with the increase of fly ash percentage; the higher workability was noted at 0% fly ash where the value of workability was minimum at 30% of fly ash. Test results are brief in table 3 and graphical performance is showed in figure 1.

Table 3: Comparative results of workability

S. No	Fly Ash Percentage (%)	Slump in Inches (In)
1	0	1
2	10	0.5
3	20	0
4	30	0

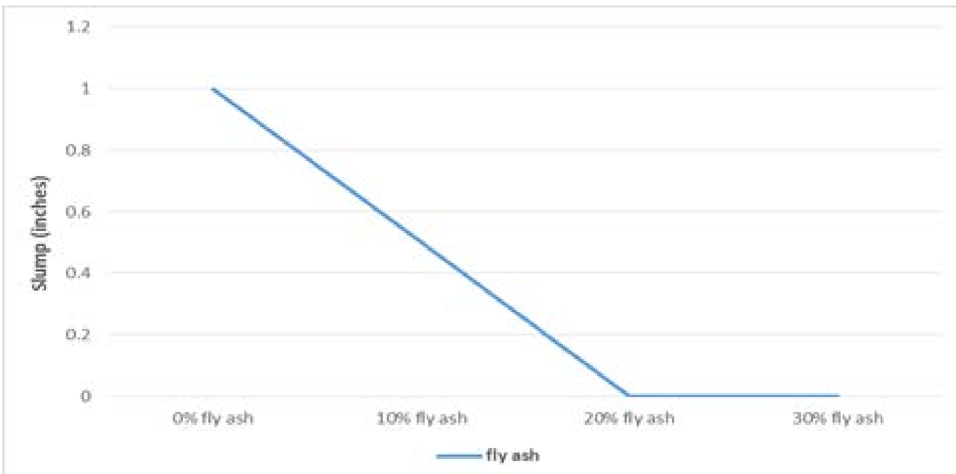

Figure 1: Workability of Concrete

4.2 Effect of fly Ash on Strength of Concrete

Compressive strength of concrete cylinders made by replacing 10% fly ash was higher than all concrete cylinders at 3, 7,14 and 28 days of curing whereas, the compressive strength of concrete cylinders made by OPC only higher than the concrete cylinders made by replacing 20% and 30% fly ash. All test results are shown in Table 4 and their graphical presentation is shown in figure 2

Table4: Comparative Analysis results of Compressive strength at 0%, 10%, 20% and 30% Fly Ash.

No	Descriptions	Average Strength in psi at the Age of:			
		3rd day	**7th day**	**14th day**	**28th day**
1	Concrete Cylinders made with 0% Fly Ash	2686.30	3087.52	3277.79	3527.90
2	Concrete Cylinders made with 10% Fly Ash	2822.64	3370.09	3514.35	4376.78
3	Concrete Cylinders made with 20% Fly Ash	1446.88	1708.80	2172.41	2864.68
4	Concrete Cylinders made with 30% Fly Ash	1406.85	1414.88	1495.11	2477.89

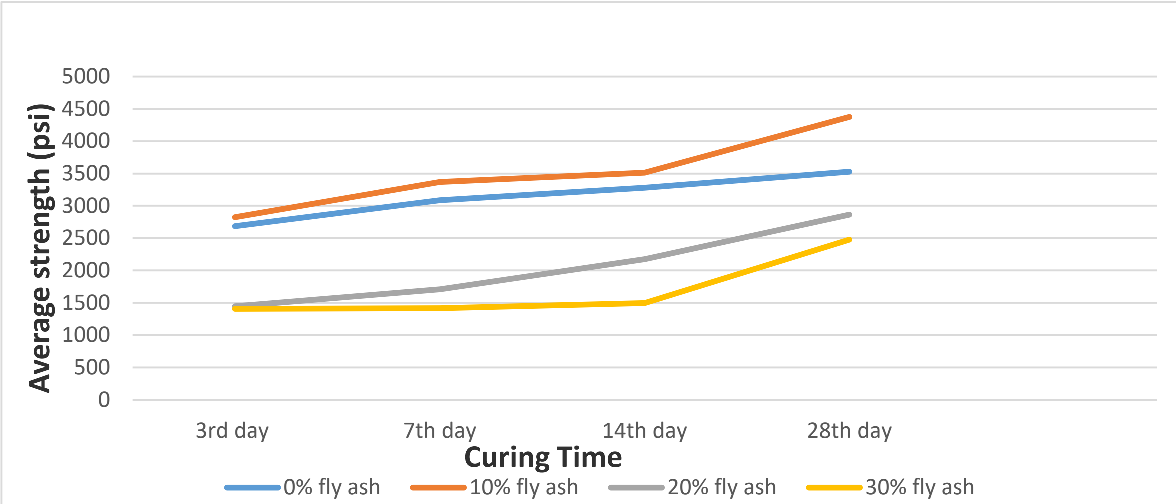

Fig 2: Comparison of Compressive Strength test results

5. CONCLUSIONS

In this research, following conclusion are drawn on the basis of experimental outcomes found by using fly ash as a partial replacement with fine aggregates in concrete.

I. The workability of concrete is decreased with the increase of fly ash percentage.

II. Concrete cylinders made with 10% fly ash showed higher strength than the cylinders made with 0% 20% and 30% fly ash.

III. Use of fly ash as partial substitute material of fine aggregates is suitable, economical for construction industry of Pakistan.

6. ACKNOWLEDGEMENTS

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7. REFERENCES

[1]. Zhang; Yunlan. (2012), “Repair and Strenghing of Reinforced Concrete beams.”

[2]. Nilson, A.H.; Darwin, D.; and Dolan, C.W. (2004), Design of Concrete Structures 13th Edition.

[3]. Shetty, M.S. (2005), Concrete Technology: Theory and Practice.

[4]. Nevill, A.M. (2010), Concrete Technology, 2nd edition, Longman, UK, pp. 77

[5]. Memon, F.A.; Memon, N.A.; and Memon, R.A. (2010), “Study of Compressive strength of concrete with coal Power plant fly ash as partial replacement of cement and fine aggregates.” Mehran University Research Journal of Engineering and Technology, Jamshoro, Vol. 29, No. 4, October, 2010, pp. 647-652.

[6]. Highway Research Board, Bulletin, “Fly Ash in Concrete.” Vol.284, pp.27.

[7]. Ghais, A.; Duaa A.; Siddig, E.; Elsa ding, I.; and Albager, S. (2014), “Performance of concrete with fly ash and kaolin inclusion.” International journal of geoscience, Vol.5, October 2014, pp.1445-1450.

[8]. Hela, R.; Orsakova, D. (2013) “The mechanical activation of fly ash” Procedia engineering, Vol.65, pp. 87-93.

[9]. Duval, R.; Kadri, E, H, K, H. (1988) “Influence of silica fume on the workability and the compressive strength of high-performance concretes.” Cement and concrete, vol. 28, No. 4, pp.533-547

[10]. Haque, M.N: Kayali. O (1998) “Study on properties of high-strength concrete using a fine fly ash”. Cement and Concrete Research, Vol. 28, No. 10, pp. 1445–1452, 1998.

[11]. Chen, B.; Liu, J. (2008), “Experimental application of mineral admixtures in lightweight
Concrete with high strength and workability.” Construction and Building Materials, Vol.22, pp. 1108–1113.

[12]. Berra M, Mangialardi, T; Paolini A (2015) “Study on Reuse of woody biomass fly ash in cement-based materials. “Construction and Building Materials, Vol 76 (2015) 286–296

Comparative study of Quality of China Hui Hong fiber yarn and blended Ring Spun Yarn of Khalis polyester and PSL Polyester fiber

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Abstract: The theme of this research paper was to create a Quality comparison report between yarn made China Hui Hong fiber and yarn made by blended ring spun of Khalis fiber and polyester fiber.
Polyesters yarns of 30Ne were made on ring spinning frame at different recipes (i.e. 100%KFL, 75%KFL +25%PSL, 60%KFL +40%PSL, 50%KFL +50%PSL, 40%KFL +60%PSL, 100% China optical fiber&100% PSL polyester fiber.
Yarn quality characteristics were determined for Yarn Irregularity%, Yan imperfection index, Yarn strength, Yarn CVm and Yarn breakage experiments.
Based on the Results, comparison reports were made using Uster Tester 4.
This research paper will focus on to set such parameters so that yarn spinning industry earns changing market trends, customer requirement, product application and product properties on demand to maintain standard quality of yarn as per customer requirement..
Key Words: KFL Polyester fiber, PSL Polyester fiber, China hui hong Polyester fiber, Ring Spinning.

1. INTRODUCTION

Ring spinning is king and outstanding process for making different types of yarns from textile fibers. No one can deny its importance till the early 1960s. Then it was feel that this process has high capital investment, high raw material cost. Therefore different experiments have been performed to make amazing type of yarn with low raw material cost and gains high profitability range.
Blending of fibers describes made with different fibers which are differ in properties, with a view to achieving or improving certain characteristics of the yarn Baykal, P. et al,2006**)[10]**
Blend is an intimate mixture of staple fibers of different structure, length, diameter or color .Fabric made from blending of yarn have better properties than made from single yarn (Basu,.et al., 2008[9]
Blending of cotton fibre with polyester fibre is done to enhance drape properties, comfort ability, dye ability and many other properties of the fabric products. (Du, M, et al., 2011[16]; Ibrahim, (2014)[12]
In the cotton/polyester blends, polyester fiber plays a outstanding role in all areas from the life saving medical textiles to the geo-textiles. (Parkaash et al (2011)[24]
The plus point of polyester over other fibers are strength, luster, aesthetics properties (Sardag, et al., 2007[4]
The polyester fabric will absorb and wick less water. In order to overcome these limitations, micro-fibers were introduced to improve the polyester wick ability, and thereby dry the material quickly (Singleton, R. ., et al 1980)[5]
When share of polyester fibers decreases in the blend, there occurs decline in yarn strength (Haynie, D et al., 2012)[15]
Fiber properties had unique effect on yarn strength. (Cumming,et al 1963)[2]
Blending of different fibers creates to their non-uniform distribution throughout the yarn cross-section Debnath,.S,et al,2009)[8]
In This Research project, i want to make comparison report of the quality, strength of different fibers such as Pakistan Synthetic limited fiber and Khalis fiber of Sheikhupura, with China Hui hong fiber.

Fabric of hybridized fiber has also same effect, strength, appearance as China fiber fabric
Many researchers have conducted research on Men-made and natural based fibers, which were manufacturing fibers from different materials such as proteins, cellulose, recycling of bottles wastes. Research was conducted on different places and their results were also different due to different properties and Department conditions (hot, cold moisture and other properties). We analyze above all conditions are different so to prepare formula according to the yarn customer requirement which help in different condition to increase productivity as well as to achieve standard quality of yarn. The mechanical properties of yarn are influenced by different processing steps which includes the way of utilizing raw material fibers , fibers dimension , fiber preparation, fibers mixing , strength of fiber, speed of machines , press characters like pressure, temperature etc. Due to mixing of different raw material properties used, changes in mechanical properties of the fibers which finally make new fiber same quality as Chinese fiber to minimize the cost of the raw material. Due to unbalance utilization of raw material causes a large damage because it is the first step and core area which highly influence the productivity and quality. We should focus on that area to utilize in such a way so that no complain or error might emerge in the initial stage of the process.
We can make such a recipe of different two fibers, which fulfill the required quality of Chinese fiber yarn in textile spinning industry.
KFL+PSL (hybridized) Results =New yarn Making
Yarn/ fabric of new fiber has same effects as yarn/fabric of china fiber
During the preparation of recipe we ensure that good quality fiber must be available for whole year and also consume the middle and low quality in such a way that quality, density and mechanical properties of fiber based for yarn customer requirement shall remain constant and our spinning industry run for whole years.

2. MATERIALS AND METHOD

Polyesters yarns of 30Ne and 1.05 HR were produced on ring spinning Machine (Ejm178) by using PSL,KFl and China Hui hong polyesters with following raw material specifications given in Table 1.
Sliver in card department of 65grains was prepared by using Scutcher blow-room line and card machine (Mekin).
These slivers were then fed in two passages through drawing machines i-e breaker drawing machine named Howa Breaker and finisher drawing machine (RSB D 35) to get uniformity of sliver in drawing department
Quality comparison reports of carded, drawn slivers, roving and yarn are given in Table 2&3

3. FIGURES AND TABLES


Figure: 1.1 Khalis fiber[17]


Figure 1.2 Polyester Synthetic Fiber[18]


Figure 1.3 - China Jiangyin HuaHong Polyester Fiber[22]

Figure 1.4 Wrapping wheel[21]

Figure 1.5 UT4[19]

Figure 1.6 HVI 900[20]

Table:1 HVI Fiber Testing of PSL polyester, KFL polyester and China Polyester

Parameters	KFL polyester	PSL polyester	China polyester
Denier	1.2	1.2	1.2
Length(mm)	51	51	51
Type	Dull	Semi Dull	Semi Dull
Color R	55	92	80
Color b	45	8	20
No of Crimps	4	13	8
Moisture%	0.41	0.39	0.4
Elongation%	15	24	19
Tenacity	5	7	6
Shrinkage%	3	3.5	3.3
Grade	C	A	B

Table:2 Quality summary Report of All slivers

Fiber Used	100% china optical	100% KFL	100%PSL	75%KFL+25 %PSL	60%KFL+40 %PSL	50%KFL+50 %PSL	40%KFL+60 %PSL
Specific ations	1.2Denx51 mm	1.2Denx51 mm	1.2Denx51 mm	1.2Denx51m m	1.2Denx51m m	1.2Denx51m m	1.2Denx51m m
Simplex Departement							
Roving U%	3.80%	5%	3.50%	4.20%	4%	3.80%	3.70%
Roving Cv%	0.80%	1.10%	0.70%	0.95%	0.85%	0.81	0.75%
Cvm	3.80%	4.20%	3.40%	4.20%	3.90%	3.6	3.55%

Finisher Departement							
Drawn sliver U%	2.40%	3%	1.80%	2.50%	2.45%	2.41%	2%

Breaker Departement							
Breaker Sliver U%	3.50%	4.00%	3%	3.80%	3.70%	3.52%	3.30%
Sliver Cv%	0.75%	1%	0.65%	0.78%	0.76%	0.75%	0.70%
CVm	3.70%	5%	2.80%	3.70%	3.50%	3.40%	3.20%
Card Departement							
Card sliver U%	4.30%	5.00%	4%	4.50%	4.40%	4.28%	4.20%
Sliver Cv%	0.75%	1%	0.65%	0.78%	0.76%	0.75%	0.70%
Sliver Cv%	0.75%	1%	0.65%	0.78%	0.76%	0.75%	0.70%

Table;3 Quality Analysis of Yarn

Summary of Uster-4Reports of yarn(30Hoisery Carded Non compact)							
Fiber Used	100% china optical	100% KFL	100%PSL	75%KFL+25 %PSL	60%KFL+40 %PSL	50%KFL+50 %PSL	40%KFL+6 0%PSL
Specifications	1.2Denx51 mm	1.2Denx51 mm	1.2Denx51 mm	1.2Denx51m m	1.2Denx51m m	1.2Denx51m m	1.2Denx51m m
Fiber Type	Polyester	Polyester	Polyester	Polyester	Polyester	Polyester	Polyester
Count	29.43	29.53	29.55	29.6	29.45	29.53	29.59
Count cv%	1.35	1.25	1.2	1.38	1.35	1.37	1.35
Strength(lbs)	161	130	171	145	155	160	165
CLSP	4738.23	3838.9	5053.05	4292	4564.75	4724.8	4882.35
Imperfection Index	73	150	38	128	69	55	50
Detail of IPI							
Thin-50%	1	5	1	2	0	0	0
Thick+50%	32	45	12	46	31	25	20
Neps+200%	40	100	25	80	38	30	30
Uniformity% of yarn	9.80%	11%	9.60%	10%	9.90%	9.80%	9.70%
CVm	12.9	15	11.1	13	12.9	12	11.7
Yarn breakage%	2.80%	4%	1.80%	3.6%	3.30%	2.60%	2.50%

4. RESULTS & DISCUSSION

4.1 ANALYSIS OF IRREGULARITY% OF YARN OF KHALIS FIBER, PAKISTAN SYNTHETIC FIBER AND CHINA HUI HONG FIBER

Graph 4.1 shows the analysis on Irregularity %of yarn of of China hui hong fiber, PSL fiber and Khalis fibers. As the ratio of PSL fiber increases, Irregularities values are also decreases gradually. The minimum irregularities values are obtained at 100%PSL.

Irregularities of 50%KFL+50%PSL is better than 100% Chinese hui hong fiber.

Due to which department runs smoothly and getting high smoothness in yarn

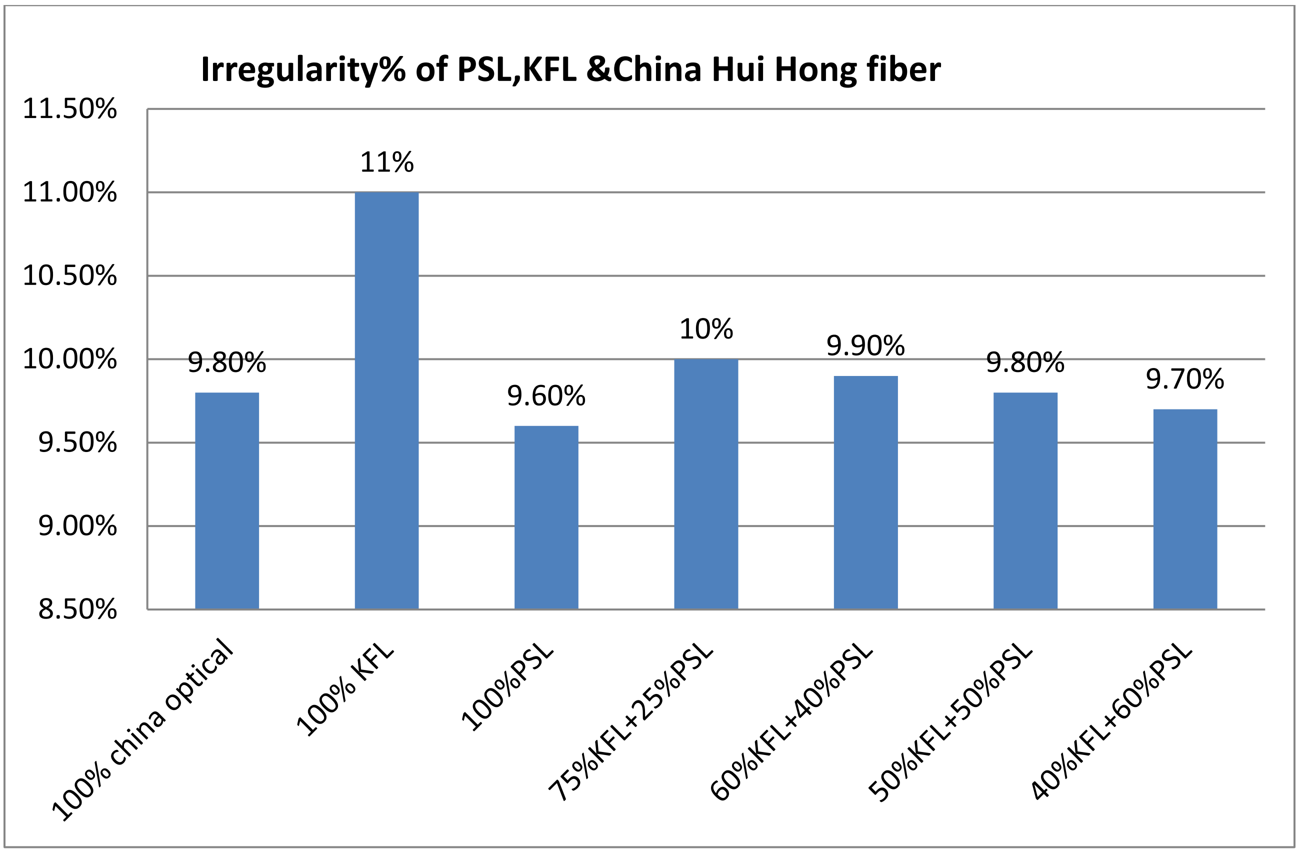


Figure 4.1 ANALYSIS OF IRREGULARITY% OF YARN OF KHALIS FIBER, PAKISTAN SYNTHETIC FIBER AND CHINA HUI HONG FIBER

4.2 ANALYSIS OF CLSP OF KHALIS FIBER, PAKISTAN SYNTHETIC FIBER AND CHINA HUI HONG FIBER

Graph 4.2 shows the analysis of CLSP of China hui hong fiber, PSL fiber and Khalis fibers. As the ratio of PSL fiber increases, CLSP values are also increase gradually. The maximum CLSP values are obtained at 100%PSL. Higher CLSP means higher strength in yarn.

CLSP of 50%KFL+50%PSL is almost equal to 100% Chinese hui hong fiber

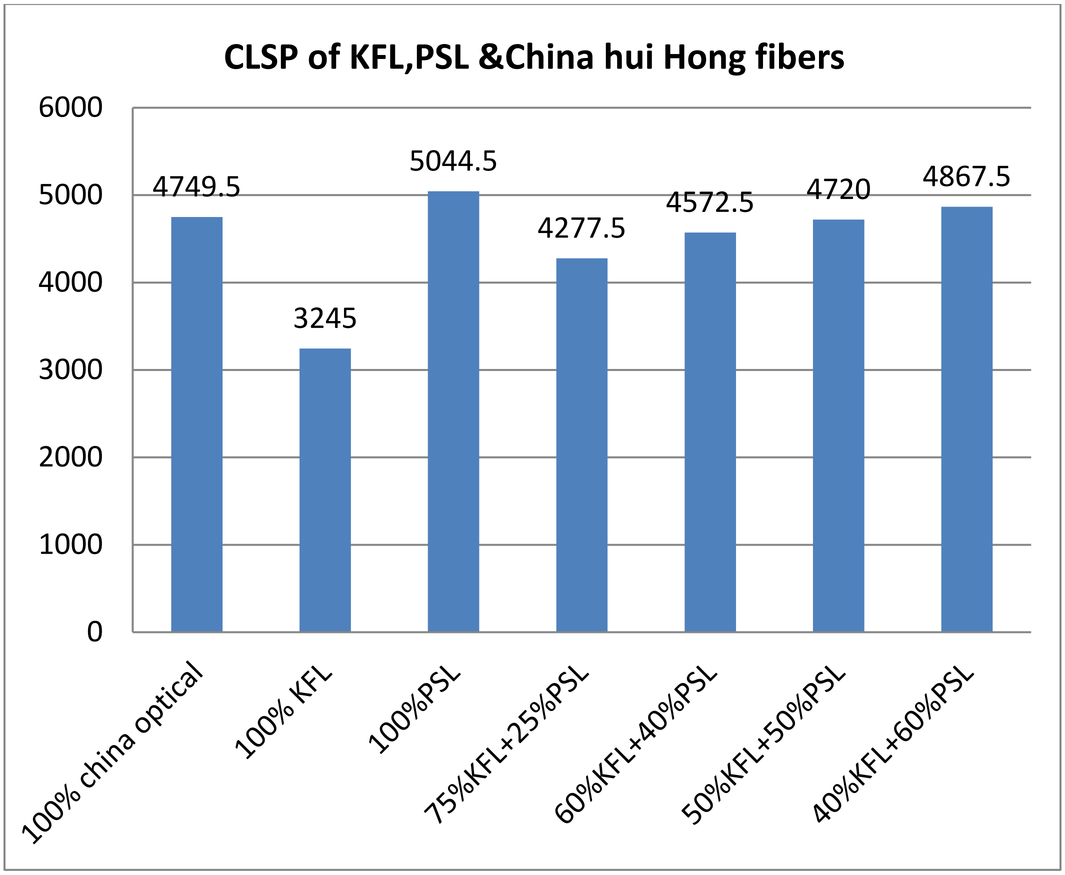
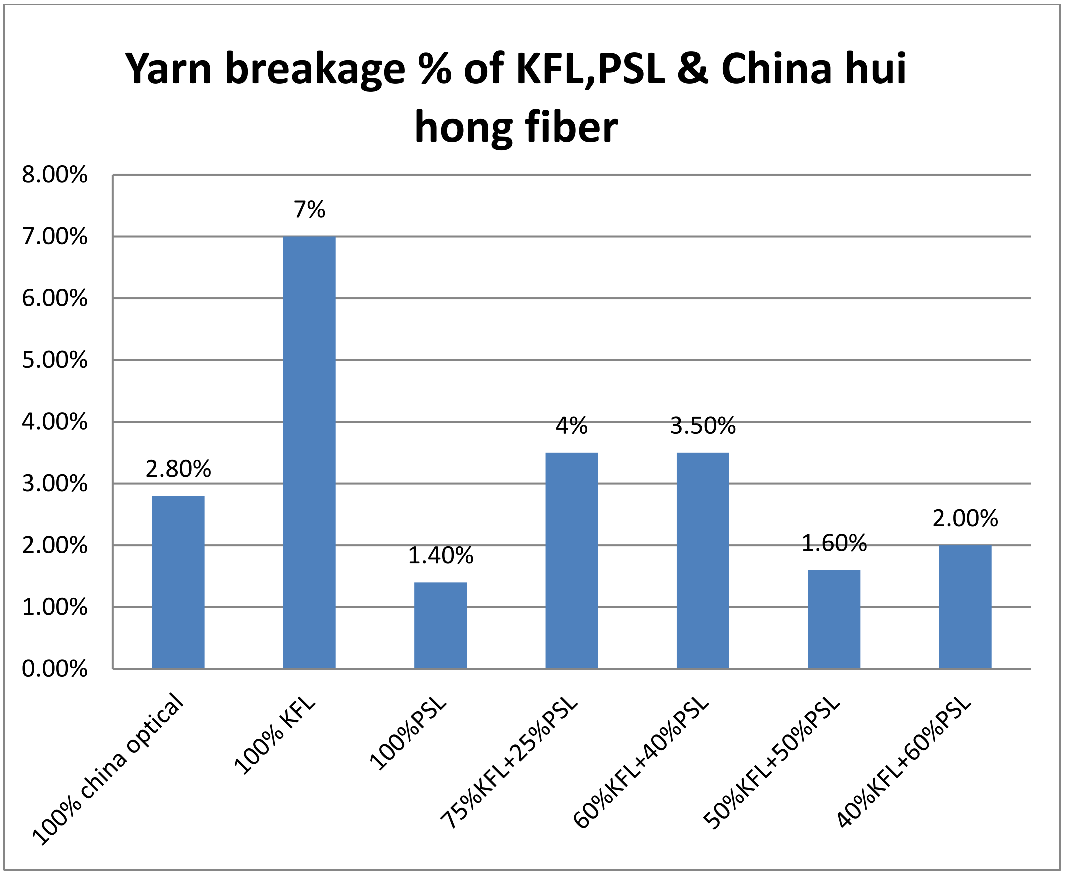


Figure 4.2 ANALYSIS OF ON CLSP OF KHALIS FIBER, PAKISTAN SYNTHETIC FIBER AND CHINA HUI HONG FIBER

4.3 ANALYSIS OF YARN BREAKAGE%OF KHALIS FIBER, PAKISTAN SYNTHETIC FIBER AND CHINA HUI HONG FIBER

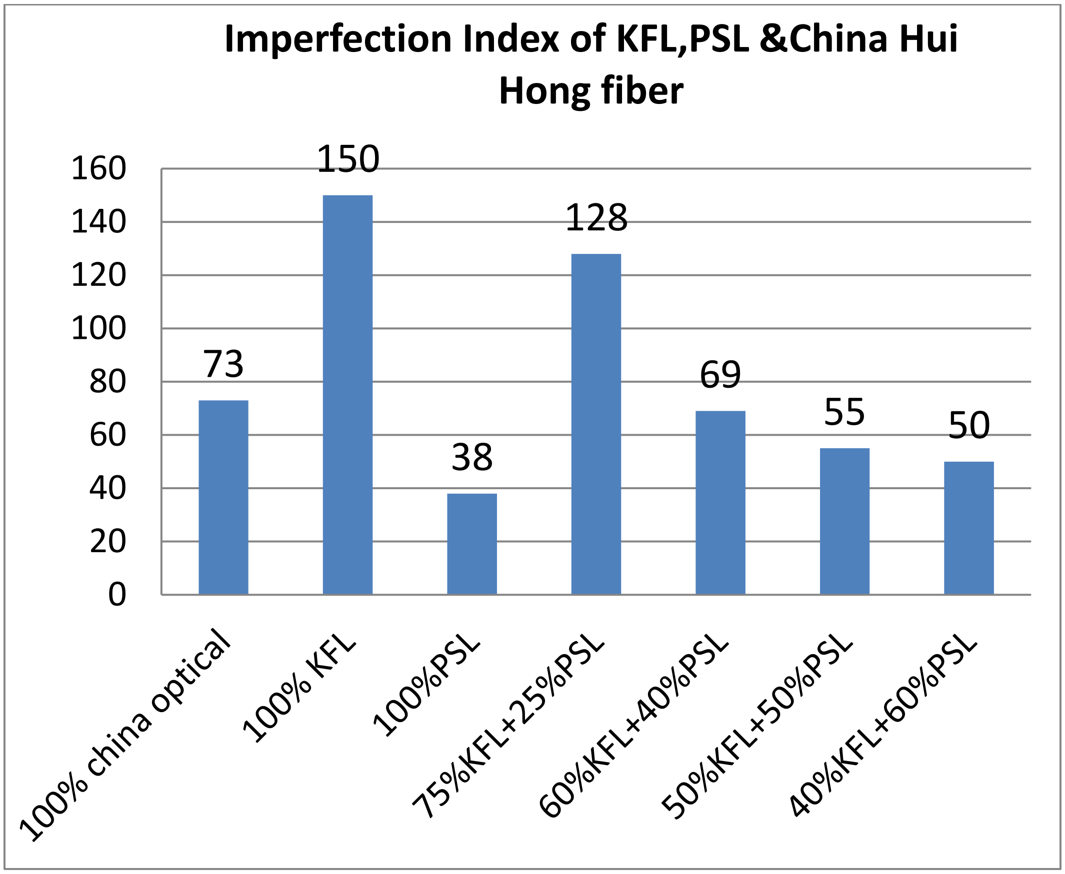
Graph 4.3 shows the analysis of Yarn breakage% of of China hui hong fiber, PSL fiber and Khalis fibers . As the ratio of PSL fiber increases, Yarn breakage% values are also decreases gradually. The minimum breakage values are obtained at 100%PSL.
Yarn breakage% of 50%KFL+50%PSL is much less than 100% Chinese hui hong fiber.
Due to which department runs smoothly and getting high recovery of fibers.



Graph 4.3ANALYSIS OF YARN BREAKAGE%OF KHALIS FIBER, PAKISTAN SYNTHETIC FIBER AND CHINA HUI HONG FIBER

4.4 ANALYSIS OF IPI OF YARN OF KHALIS FIBER, PAKISTAN SYNTHETIC FIBER AND CHINA HUI HONG FIBER

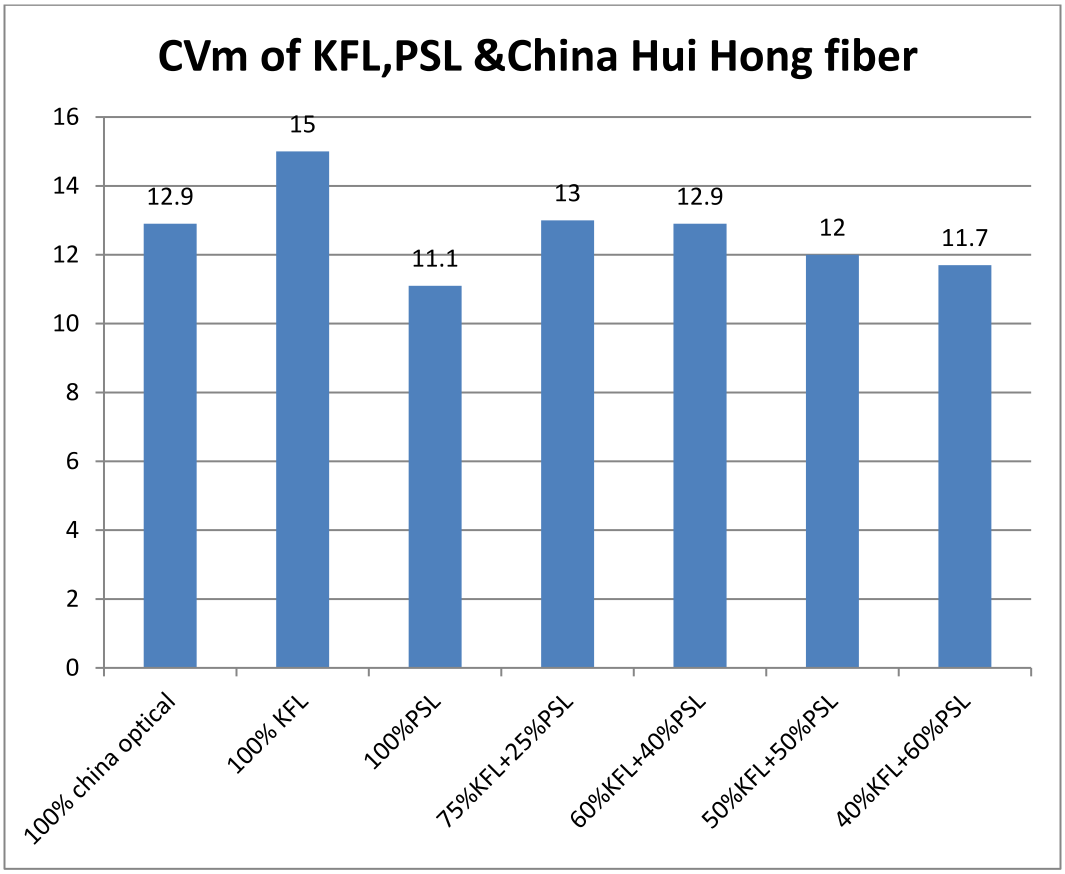
IPI is called quality of yarn. Higher IPI values means Yarn quality is not good
Graph 4.4 shows the analysis of IPI of of China hui hong fiber, PSL fiber and Khalis fibers. As the ratio of PSL fiber increases, IPI values are also decreases gradually. The minimum IPI values are obtained at 100%PSL.
IPI shows quality of 50%PSL +50%KFL is also better



Graph 4.4 ANALYSIS OF IPI OF YARN OF KHALIS FIBER, PAKISTAN SYNTHETIC FIBER AND CHINA HUI HONG FIBER

4.5 ANALYSIS OF CVM OF KHALIS FIBER, PAKISTAN SYNTHETIC FIBER AND CHINA HUI HONG FIBER

Graph 4.5 Shows the analysis of PSL fiber on CVm of of China hui hong fiber, PSL fiber and Khalis fibers . As the ratio of PSL fiber increases, CVm values are also decreases gradually. The maximum CVm values are obtained at 100%PSL.
Higher CVm means higher Variation in mass in yarn.
CVm of 50%KFL+50%PSL is much less than 100% Chinese hui hong fiber means quality wise 50KFL+50PSL is much better than 100% china optical.



Graph 4.5 ANALYSIS OF CVM OF KHALIS FIBER, PAKISTAN SYNTHETIC FIBER AND CHINA HUI HONG FIBER

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5. CONCLUSION

In this research project, there was focus on quality of product. It was totally focused on to set such parameters so that yarn spinning industry earns, changing market trends, customer requirement, product application and product properties on demand to maintain standard quality and productivity of yarn as per customer requirement..

There were industry requirements to form recipes of different types of fibers in such ratios as final quality & profitable product can be made. This research was conducted to investigate the final qualitative & profitable product of the yarn via blending of PSL & Khalis polyesters, achieving the quality parameters and maximizing profitable range. Recipe of the KFL & PSL polyesters fibers in different ratios were made to achieve the required strength and quality characteristics of China optical Qualitative yarn.

From the Preformed Experiments in different ratios of PSL& KFL fibers, it is concluded that whenever you are increasing ratio amount of of PSL Polyester in KFL polyester fiber, it gets strength and more productive and qualitative.

When you were performed Experiments in 75%KFL +25%PSL, 60%KFL +40%PSL, 50%KFL +50%PSL, 40%KFL +60%PSL,

Strength and quality were going better when we were increasing ratio % of PSL.

At 50%PSL+50%KFL,raw material cost was equal to 100% china optical and quality was good as compared to 100%china optical.

For China optical fiber user industries 50%PSL+50%KFL is best in place of 100% china optical polyester fiber,

So Present research suggests new methods for development of quality products from different cheaper recopies . This will be beneficial for industries to save cost of purchasing high quality of yarn at high market rates.

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6. References

1. Behery, H. M., Vaughn, E. A., & Lee, M. (1980). Fiber migration and characteristics in open-end spun cotton-rich blended yarn". Journal of Engineering for Industry, V.102,No.1,pp 67-72.
2. Borisova, A., & Reihmane, S. (2013, August). A study of absorption properties improvement of cotton blended fabric. In Key Engineering Materials (Vol. 559, pp. 13-18).
3. Chen, L., Yi, D. F., Zhai, Y. L., & Gu, Y. L. (2012, January). Spinning Technics Research of St. Ma/Polyester Blended Hard Twist Slub Yarn. InAdvanced Materials Research (Vol. 430, pp. 913-916).
4. Choi, Y. J., & Kim, S. H. (2015). Characterization of recycled polyethylene terephthalates and polyethylene terephthalate–nylon6 blend knitted fabrics.Textile Research Journal, V.85,No.4, pp 337-345.
5. Haynie, D. T., Khadka, D. B., & Cross, M. C. (2012). Physical Properties of Polypeptide Electrospun Nanofiber Cell Culture Scaffolds on a Wettable Substrate. Polymers" (20734360),V.4,No.3.
6. Ibrahim, D. F. (2014). Comparative study for Improving Printing of Cotton/Polyester Blended Fabrics. Journal of Textile Science & Engineering..
7. Kemp, A., & Owen, J. D. (1955).—The Strength and Behaviour of Nylon/Cotton Blended Yarns Undergoing Strain". Journal of the Textile Institute Transactions,V.46,No.11, p684-698.
8. Kim, H. J., Pant, H. R., Park, C. H., Tijing, L. D., Hwang, B. S., Choi, N. J., & Kim, C. S. (2013). Electrical properties of ZnO/nylon-6 spider-wave-like nanonets prepared via electrospinning".
9. Lee, J. H., Lim, K. S., Hahm, W. G., & Kim, S. H. (2013). Properties of recycled and virgin poly (ethylene terephthalate) blend fibers. Journal of Applied Polymer Science, V.128,No.2, pp1250-1256.
10. Ouchi, A., Toida, T., Kumaresan, S., Ando, W., & Kato, J. (2010). A new methodology to recycle polyester from fabric blends with cellulose. V.17,No.1, pp215-222.
11. Owen, J. D. (1962). 10—The strength of stress-strain behavior of blended yarns. Journal of the Textile Institute Transactions, V.53,No.3, pp144-167.
12. Pan, N., & Postle, R. (1995). Strengths of twisted blend fibrous structures: Theoretical prediction of the hybrid effects. Journal of the Textile Institute, V.86, No.4, pp559-580.
13. Prakash, C., & Ramakrishnan, G. (2013). Effect of blend proportion on thermal behaviour of bamboo knitted fabrics. Journal of the Textile Institute", V.104, No.9, pp907-913.
14. Prakash, C., Ramakrishnan, G., & Koushik, C. V. (2011). Effect of blend ratio on quality characteristics of bamboo/cotton of ring spun yarn".
15. Rajalakshmi, M., Koushik, C. V., & Prakash, C. (2012). Effect of Cotton/Micropolyester Blends on Physical Properties of Ring Spun Yarn".Journal of Textile Science & Engineering.
16. Ratnam, T. V;Shankaranarayana, K. S; Underwood, C& Govindarajulu, K; (1968). Prediction of the Quality of Blended Yarns from that of the Individual Components". Textile Research Journal, V.38,No.4, pp 360-365.
17. http://web.utk.edu/~mse/Textiles/Polyester%20fiber.html
18. http://www.khalisgroup.com/khalis-fibre.html
19. http://www.wotol.com/1-uster-tester-4-yarn-testing/second-hand-machinery/prod_id/232082
20. http://textilelearner.blogspot.com/2012/10/concept-of-high-volume-instrument-hvi_14.html
21. http://dir.indiamart.com/impcat/wrap-reel.html
22. http://huahonghx.en.ec21.com

Effect of Pakistan synthetic limited fiber on Quality Characteristics of Khalis Limited fiber like as Yarn Imperfection index, Strength, CVm and breakage.

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Abstract: This research paper illustrates the effect of PSL (Pakistan synthetic polyester) on yarn made by blending of Khalis fiber &PSL polyester fiber via quality characteristics.
Polyesters yarns of 30Ne was made on ring spinning frame at different recipes (i.e. 100%KFL, 75%KFL +25%PSL, 60%KFL +40%PSL, 50%KFL +50%PSL, 40%KFL +60%PSL,100%PSL
Yarn quality characteristics were determined for Yan imperfection index, strength, CVm and breakage experiments.
Based on the Results, comparison reports were made using Uster Tester 4.
This research paper will focus on quality of product. It will focus on to set parameters like as yarn imperfection index, strength, CVm and breakage of yarn.
Key Words: KFL Polyester fiber, PSL Polyester fiber, China hui hong Polyester fiber, Ring Spinning.

1. INTRODUCTION

Ring spinning is king and outstanding process for making different types of yarns from textile fibers. No one can deny its importance till the early 1960s. Then it was feel that this process has high capital investment, high raw material cost. Therefore different experiments have been performed to make amazing type of yarn with low raw material cost and gains high profitability range.
Blending of fibers describes made with different fibers which are differ in properties, with a view to achieving or improving certain characteristics of the yarn Baykal, P. et al,2006**)[10]**
Blend is an intimate mixture of staple fibers of different structure, length, diameter or color .Fabric made from blending of yarn have better properties than made from single yarn (Basu,.et al., 2008[9]
Blending of cotton fibre with polyester fibre is done to enhance drape properties, comfort ability, dye ability and many other properties of the fabric products. (Du, M, et al., 2011[16]; Ibrahim, (2014)[12]
In the cotton/polyester blends, polyester fiber plays a outstanding role in all areas from the life saving medical textiles to the geo-textiles. (Parkaash et al (2011)[24]
The plus point of polyester over other fibers are strength, luster, aesthetics properties (Sardag, et al., 2007[4]
The polyester fabric will absorb and wick less water. In order to overcome these limitations, micro-fibers were introduced to improve the polyester wick ability, and thereby dry the material quickly (Singleton, R. ., et al 1980)[5]
When share of polyester fibers decreases in the blend, there occurs decline in yarn strength (Haynie, D et al., 2012)[15]
Fiber properties had unique effect on yarn strength. (Cumming,et al 1963)[2]
Blending of different fibers creates to their non-uniform distribution throughout the yarn cross-section Debnath,.S,et al,2009)[8]
Many researchers have conducted research on Men-made and natural based fibers, which were manufacturing fibers from different materials such as proteins, cellulose, recycling of bottles wastes. Research was conducted on different places and their results were also different due to different properties

and Department conditions (hot, cold moisture and other properties). We analyze above all conditions are different so to prepare formula according to the yarn customer requirement which help in different condition to increase productivity as well as to achieve standard quality of yarn. The mechanical properties of yarn are influenced by different processing steps which includes the way of utilizing raw material fibers , fibers dimension , fiber preparation, fibers mixing , strength of fiber, speed of machines , press characters like pressure, temperature etc. Due to mixing of different raw material properties used, changes in mechanical properties of the fibers which finally make new fiber same quality. Due to unbalance utilization of raw material causes a large damage because it is the first step and core area which highly influence the productivity and quality. We should focus on that area to utilize in such a way so that no complain or error might emerge in the initial stage of the process.

2. MATERIALS AND METHOD

Polyesters yarns of 30Ne and 1.05 HR were produced on ring spinning Machine (Ejm178) by using PSL,KFL polyesters with following raw material specifications given in Table 1.
Sliver in card department of 65grains was prepared by using Scutcher blow-room line and card machine (Mekin). These slivers were then fed in two passages through drawing machines i-e breaker drawing machine named Howa Breaker and finisher drawing machine (RSB D 35) to get uniformity of sliver in drawing department

3. FIGURES AND TABLES

Figure: 1.1 Khalis fiber[18]

Figure 1.2 Polyester Synthetic Fiber[17]

Figure 1.3 Wrapping wheel [21]

Figure 1.4 UT4 [19]

Figure 1.5 HVI 900[20]

Table:1 HVI Fiber Testing of PSL polyester, KFL polyester and China Polyester

Parameters	KFL polyester	PSL polyester
Denier	1.2	1.2
Length(mm)	51	51
Type	Dull	Semi Dull
Color R	55	92
Color b	45	8
No of Crimps	4	13
Moisture%	0.41	0.39
Elongation%	15	24
Tenacity	5	7
Shrinkage%	3	3.5
Grade	C	A

Table:2 Quality summary Report of All slivers

Fiber Used	100% KFL	100%PSL	75%KFL+25%PSL	60%KFL+40%PSL	50%KFL+50%PSL	40%KFL+60%PSL
Specifications	1.2Denx51mm	1.2Denx51mm	1.2Denx51mm	1.2Denx51mm	1.2Denx51mm	1.2Denx51mm
Roving U%	5%	3.50%	4.20%	4%	3.80%	3.70%
Roving Cv%	1.10%	0.70%	0.95%	0.85%	0.81	0.75%
Drawn sliver U%	3%	1.80%	2.50%	2.45%	2.41%	2%
Sliver Cv%	1%	0.65%	0.78%	0.76%	0.75%	0.70%
Breaker Sliver U%	4.00%	3%	3.80%	3.70%	3.52%	3.30%
Sliver Cv%	1%	0.65%	0.78%	0.76%	0.75%	0.70%
Card sliver U%	5.00%	4%	4.50%	4.40%	4.28%	4.20%
Sliver Cv%	1%	0.65%	0.78%	0.76%	0.75%	0.70%

Table;3 Quality Analysis of Yarn

Fiber Used	**100% KFL**	**100%PSL**	**75%KFL+25 %PSL**	**60%KFL+40 %PSL**	**50%KFL+50 %PSL**	**40%KFL+60 %PSL**
Specifications	1.2Denx51 mm	1.2Denx51 mm	1.2Denx51mm	1.2Denx51mm	1.2Denx51mm	1.2Denx51mm
Fiber Type	Polyester	Polyester	Polyester	Polyester	Polyester	Polyester
CLSP	3838.9	5053.05	4292	4564.75	4724.8	4882.35
Imperfection Index	150	38	128	69	55	50
CVm	15	11.1	13	12.9	12	11.7
Yarn breakage%	4%	1.80%	3.6%	3.30%	2.60%	2.50%

4. RESULTS & DISCUSSION

4.1 EFFECT OF PSL FIBER ON CLSP OF KHALIS FIBER

Graph 4.1 shows the effect of PSL fiber on CLSP of Khalis fiber. As the ratio of PSL fiber increases, CLSP values are also increase gradually. The minimum CLSP values are obtained at 100%KFL .
Lower CLSP means less strength in yarn.
As the ratio of PSL fiber increased, CLSP increased from 3300 lbs to 5044..5 lbs.

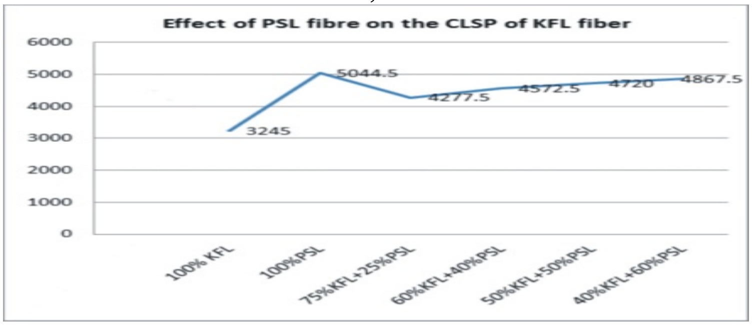

Figure 4.1 Effect of PSL fibers on CLSP of Khalis fiber

4.2 EFFECT OF PSL FIBER ON YARN BREAKAGE%OF KHALIS FIBER

Graph 4.2 shows the effect of PSL fiber on Yarn breakage% of Khalis fiber. As the ratio of PSL fiber increases, Yarn breakage% values are decreases gradually. The minimum breakage values are obtained at 100%PSL.

As the ratio of PSL fiber increased, yarn breakage% decreased 7% to 1.4%

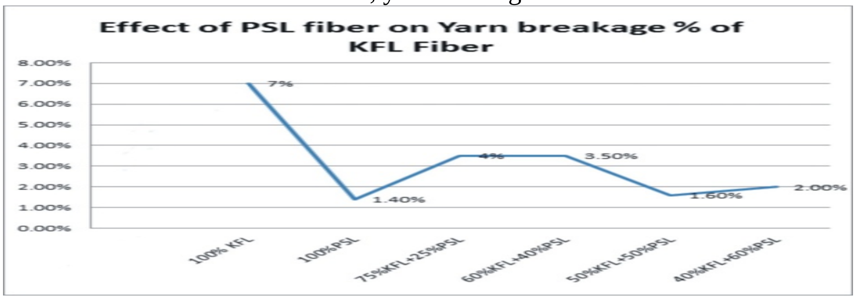

Figure 4.2 Effect of PSL fiber on Yarn breakage%of Khalis fiber

4.3 EFFECT OF PSL FIBER ON IPI OF YARN OF KHALIS FIBER

IPI is called quality of yarn. Higher IPI values means Yarn quality is not good

Graph 3.3 shows the effect of PSL fiber on IPI of Khalis fiber. As the ratio of PSL fiber increases, IPI values are also decreases gradually. The minimum IPI values are obtained at 100%PSL.

As the ratio of PSL fiber increased imperfection index values are decreased 150 to 38

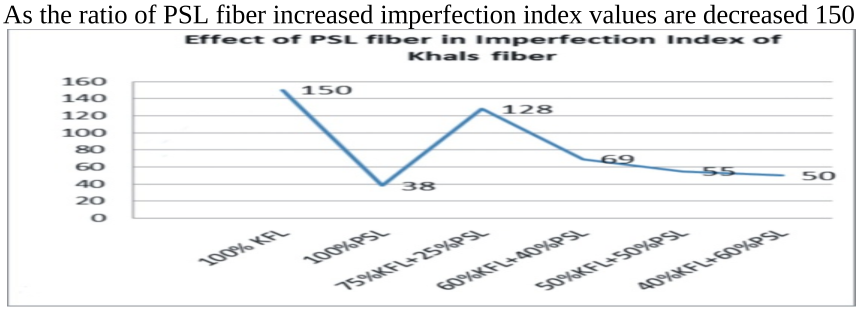

Figure 4.3 Effect of PSL fiber on IPI of Yarn of Khalis fiber

4.4 EFFECT OF PSL FIBER ON CVM OF KHALIS FIBER

Figure 4.4 Shows the effect of PSL fiber on CVm of Khalis fiber. As the ratio of PSL fiber increases, CVm values are also decreases gradually. The minimum CVm values are obtained at 100%PSL.
Higher CVm means higher Variation in mass in yarn.
As the ratio of PSL fiber increased, Coefficient of variation in mass values are decreased 15 to 11.1

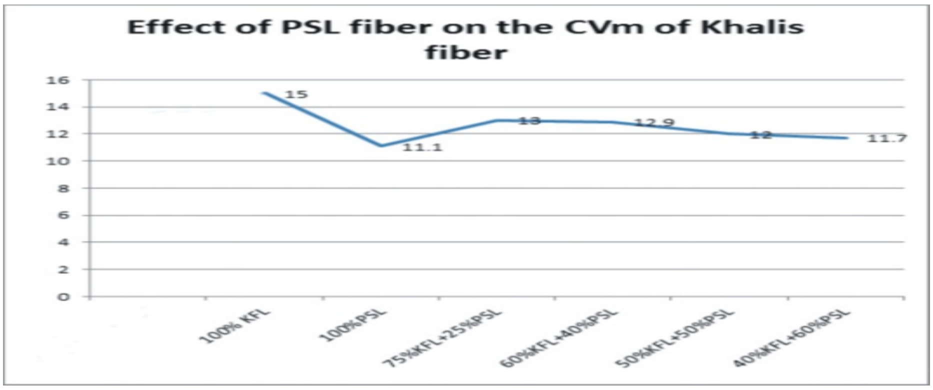

Figure 4.4 Effect of PSL fiber on CVm of Khalis fiber

5. CONCLUSION

In this research paper, there was focus on quality of product .It was totally focused on to set such parameters so that yarn spinning industry product properties on demand to maintain standard quality and productivity of yarn as per customer requirement..
This research was conducted to investigate the final qualitative yarn via blending of PSL & Khalis polyesters, achieving the quality parameters .Recipe of the KFL & PSL polyesters fibers in different ratios were made to achieve the required strength and quality characteristics of China optical Qualitative yarn.
From the Preformed Experiments in different ratios of PSL& KFL fibers, it is concluded that whenever you are increasing ratio amount of of PSL Polyester in KFL polyester fiber, it gets strength and more productive and qualitative.
When you were performed Experiments in 75%KFL +25%PSL, 60%KFL +40%PSL, 50%KFL +50%PSL, 40%KFL +60%PSL,
Strength and quality were going better when we were increasing ratio % of PSL.

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6. REFERENCES

1. Basu G, & Roy, A. N. (2008),Blending of jute with different natural fibres.Journal of Natural Fibers",V.4,No.4, pp13-29.
2. Baykal, P. D., Babaarslan, O., & Erol, R. (2006). Prediction of strength and elongation properties of cotton polyester-blended OE rotor yarns, Fibres and Textiles in Eastern Europe", V.14,No.1, pp 18.
3. COPLAN, M. J. (1961). Some Effects of Blend on Structure"..
4. Debnath, C. R. (1974). Some Optimum Conditions for the Blending of Jute and Viscose Rayon".
5. Du, M., & Lv, L. B. (2011, January). Study on Structure and Property of Polyester/Cotton/Silk Three-Component Sirofil Spun Composite Yarn". In Advanced Materials Research (Vol. 175, pp. 524-528).
6. Fan, L. S., Lai, K., Sun, R. J., & YAO, M. (2006). Production principle of the tri-component filament and staple fiber composite yarn". Journal of Textile Research, V.27,No.11,pp 40.
7. Foulk, J. A., Dodd, R. B., McAlister, D., Chun, D., Akin, D. E., & Morrison, H. (2007). Flax-cotton fiber blends: Miniature spinning, gin processing, and dust potential. Industrial Crops and Products", V.25,No.1, pp8-16.
8. Haynie, D. T., Khadka, D. B., & Cross, M. C. (2012). Physical Properties of Polypeptide Electrospun Nanofiber Cell Culture Scaffolds on a Wettable Substrate. Polymers" (20734360),V.4,No.3.
9. Ibrahim, D. F. (2014). Comparative study for Improving Printing of Cotton/Polyester Blended Fabrics. Journal of Textile Science & Engineering..
10. Kim, H. J., Pant, H. R., Park, C. H., Tijing, L. D., Hwang, B. S., Choi, N. J., & Kim, C. S. (2013). Electrical properties of ZnO/nylon-6 spider-wave-like nanonets prepared via electrospinning".
11. Lee, J. H., Lim, K. S., Hahm, W. G., & Kim, S. H. (2013). Properties of recycled and virgin poly (ethylene terephthalate) blend fibers. Journal of Applied Polymer Science, V.128,No.2, pp1250-1256.
12. Ouchi, A., Toida, T., Kumaresan, S., Ando, W., & Kato, J. (2010). A new methodology to recycle polyester from fabric blends with cellulose. V.17,No.1, pp215-222.
13. Salim, H. A. (2015). Performance of Dyeing and Printing of Polyester/Viscose Yarns Blends for Clothing Use. Journal of Engineering and Computer Science, V.16,No.1.
14. Sardag, S; Ozdemir, O & Kara, I. (2007). The effects of heat-setting on the properties of polyester/viscose blended yarns. Fibres and Textiles in Eastern Europe, V.15,No.4, p50.
15. Skomra, E. (2006). A Comparative Study of Athletic Apparel Made from Cotton/Flax, Cotton/Pes, Pes/Flax Blends" (Doctoral dissertation, Thesis in Apparel, Textiles and Merchandising, Eastern Michigan University).
16. Zhang, J. Y. (2012, February). Design and Development of Non-Ironing Fabric of Cotton/Fractal Polyester Twisted Yarn". In Advanced Materials Research (Vol. 418, pp. 2235-2238).
17. http://web.utk.edu/~mse/Textiles/Polyester%20fiber.html
18. http://www.khalisgroup.com/khalis-fibre.html
19. http://www.wotol.com/1-uster-tester-4-yarn-testing/second-hand-machinery/prod_id/232082
20. http://textilelearner.blogspot.com/2012/10/concept-of-high-volume-instrument-hvi_14.html
21. http://dir.indiamart.com/impcat/wrap-reel.html

STUDY OF OCCUPATIONAL HEALTH PROBLEMS FACED BY IT PROFESSIONALS

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Abstract: This study is designed to explore and document the occupational health problems among those individuals that regularly work on computers. Data was collected from 115 IT professionals that regularly used computers for their occupational needs; data was collected using survey questionnaire. Analysis was performed on the data collected using SPSS software. Descriptive statistics techniques were used to analyze the data. The Results revealed that most of the users face health problems: eye strain, back and neck pain followed by headache arm/wrist pain. It was also identified that majority of the respondents were unaware of the preventive measures available in the market place.

Key Words: Occupational health, Musculoskeletal Disorders, IT Professionals, Computer

1. INTRODUCTION

In these modern times, computers have become a core in almost every individual's life. The use of computers leads towards many occupational health problems. In 21st century the use of computers has drastically increased and has been continuously increasing day by day, because they are being used in every field of knowledge as well as life with the advent of various social media platforms and communication apps. Moreover, Use of computers has changed the work environment significantly (Moom et al., 2015). However, working for long time on computers and sitting in incorrect postures leads to many occupational health problems (SKA et al., 2016). These problems can be musculoskeletal disorders, eyestrain, and pain in wrist or hand (Prasad et al., 2014). These type pains have major concern among the computer users which impose socioeconomic burden on both employee and society (Singh and Singh, 2016). Socioeconomic burden include loss of wages, medical treatments, pain and reduction in quality of life (Gopang et al., 2017).

In his research paper (Jensen, 2003) have stated that neck pain problems are very common among both office workers particularly who are using computers intensively. Improper sitting in front of computer for long time can lead to prolonged disabilities: back ache, head ache and stiffness. Carpal tunnel syndrome is also one of the types of musculoskeletal disorders caused due to pressure on main nerve for long period that passes through wrist (Shrivastava S., 2012). Similarly, visual problems are also very common among computer users, about 70% of computer workers suffer from such occupational health problem (Shrivastava S., 2012).

Various studies have been carried out by researchers in developed as well as in developing countries, to explore the health problems related to use of computers. Like, (Suparna et al., 2005) have carried out a cross sectional survey to identify the health problems among persons of information technology industry. It was found that professionals were facing many health problems i.e. visual, musculoskeletal and computer related morbidity. Inadequate illumination level and no use of antiglare was causing visual discomfort among them and were at higher risk towards musculoskeletal problems due to inappropriate ergonomic design of workstations. Another cross-sectional study was carried out by (Kumari et al., 2010) to study the health problems among the employees of two educational institutes who were using computers regularly for administration, teaching and research duties. It was found that employees were facing problems related to eye, back pain, pain in wrists, elbows, forearms followed by neck.

Furthermore, (Montreuil and Lippel, 2003) have carried out study on home telework workers to know the health problems among them. It was found that due to static posture, long periods of continuous work and repetitive movements resulted in musculoskeletal problems in lumber, hand, shoulders and neck. Similarly, (Vijay Subbarayalu, 2013) has carried out a study to explore the occupational health problems: mental, physical and psychosocial, among call center workers. Results revealed that more than half of the of respondents reported musculoskeletal health problems in the shape of low back pain, neck pain, eye, ear and throat pain along with they also reported mental and psychosocial health related problems. Likewise, (Moom et al., 2015) carried out study to investigate the prevalence of Musculoskeletal disorders (MSD) among the bank employees who were regularly using computers. The questionnaire used for collecting that data was Nordic Musculoskeletal Disorders questionnaire. Results reveled that employees were suffering from lower back and upper back pain followed by neck, wrist and shoulder pain.

Hence, literature tells that there are various studies that have been carried out in different parts of the world but there is scarcity of studies like this in the perspective of Pakistan. Therefore, an effort has been made to explore and document the health problems of computer related people of this region. In a way this research paper explores a new avenue within the context of Pakistan.

2. METHODOLOGY

A cross-sectional descriptive study was carried out with an aim to explore the occupational health problems among the IT professionals due to use of computers. Data was collected with the help of a pre tested semi-structured questionnaire adopted from the study of (Kumari et al., 2010). Questionnaire contained close ended questions that covered age, working hours, health problems while working on computers. Furthermore, with the help of SPSS software, descriptive statistics techniques (frequency, percentage and mean) were used for the analysis of data.

3. DATA ANALYSIS AND DISCUSSION

Totally 200 questionnaires were sent out to the participants. Out of which 115 fully filled questionnaires were selected for analysis purpose, the final response rate was 57.5%.

1.1 Demographics of the Respondents

This portion of questionnaire contained age, experience and education of the respondents. They were asked to answer closed ended questions in this portion in order to assess that which group they belonged too.

1.1.1 Age of the respondents

According to collected data, 76.5% of them belonged to age group of 20-29 years, 12.2% belonged to the age group of below 20 years, 7% to the age group of 30-39 years and 4.3% of the respondents belonged to the age group of >40 years as shown in Figure 1. Two broad age-groups of individuals responded to the study questionnaire. Majority of the respondents were in the age group 20-29 years in total 76.5%.

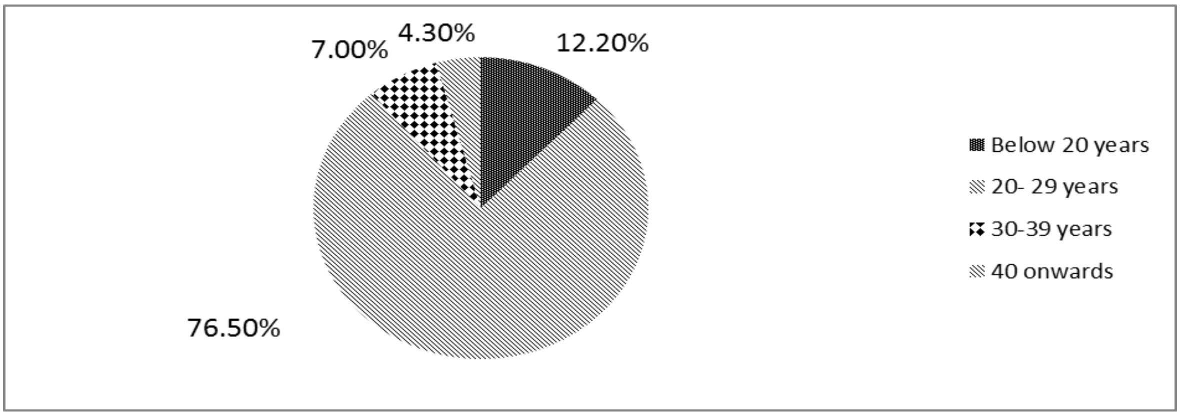

Figure 1: Age of the respondents

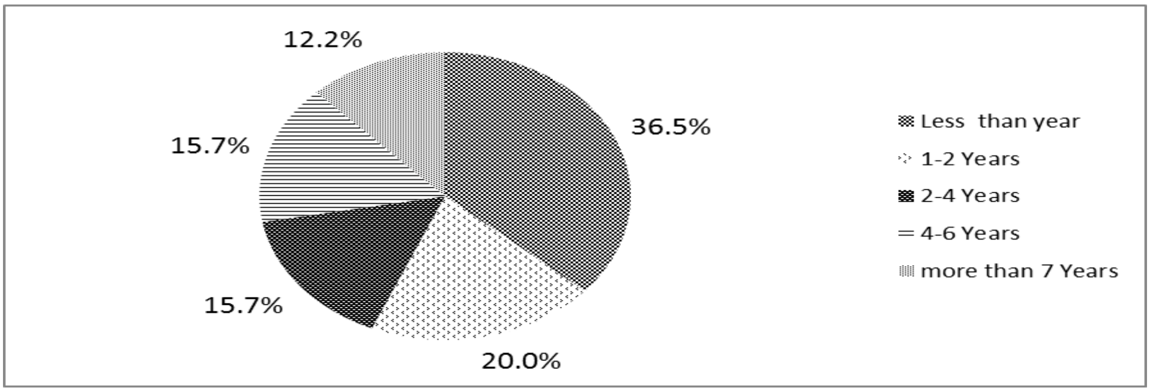

Figure 2: Work Experience

1.1.2 Work Experience of the respondents

According to data, 12.2% of the respondents were having more than 7 years of work experience, 15.5% of the respondents were having the experience ranging from 4-6 years, 15.7% of respondents having 2-4 years of experience where 36.5% were having the experience of less than 1 year as shown in Figure 2. Different work experiences were reported during the survey. All this signifies that the majority of the respondents were those IT professionals that had prolonged exposure to computer usage and could adequately respond to the questions asked.

1.1.3 Working Shift of survey participants

The time of working, has a significant impact on performance as well as on the occupational health of individuals. According to collected data, 89.6% were working in morning shift, 9% of respondents reported that they were working in evening shift and rest 1.4% reported that they were working in night shift as shown in Figure 4. It is clear from the above statistics that most of the respondents used to work in general shift (morning shift), as the morning shift or in some cases referred to as the general shift, this study could not however answer shift variations in occupational health and safety as there was insufficient data for the remainder evening and night shift.

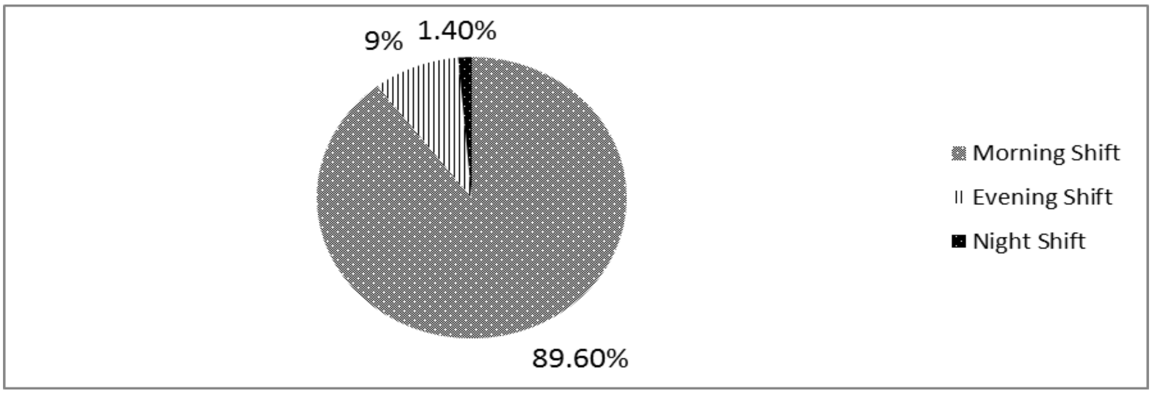

Figure 3: Working Shift

1.1.4 Qualification of the survey respondents

One major factor within any occupation is that the skill level is determined by the educational qualification an individual possess. However, in the IT sector as with many professions nowadays the industry is more skill oriented as compared to credential oriented. The data shows, 65.2% were having Bachelor's/undergraduate degree, 24.3% were having master's/graduate degree, 7% having F.Sc/College., 2.6% having PhD and rest of them having diploma or certificate course in a certain IT skill as shown in Figure 5. It is clear from the statistics that most of the respondents have higher qualification, qualification therefore this correlates the earlier working shift data as majority of higher qualified individuals mostly work the morning shift.

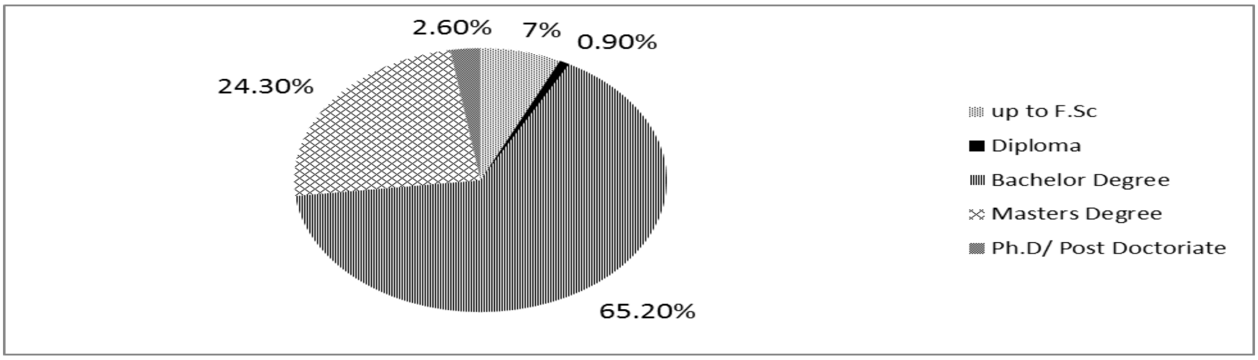

Figure 4: Qualification of the respondents

1.1.5Respondents working hours on computer

Respondents were asked to report the time in hours they spent on the computer on an average day. In total, 33% of the respondents reported that they were using computer 2-5 hours per day, 31% of the respondents reported that they used computer more than 7 hours, whereas; 18% of the respondents reported that they used to work on computers for 5-7 hours and similarly 18% reported that they used to work on computer for less than 2 hours as shown in Figure 5. It is clear from the statistics that majority of the respondents used to work on computers for more than 2 hours per day, and this accounts for occupational usage requiring focus and attention.

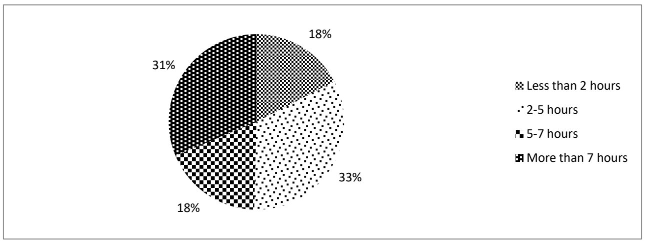

Figure 5: Computer Usage

1.2 Occupational Health Status of the Respondents

In order to know the health status of the respondents they were asked to respond to questions like "whether they face health problems while using computer or not? The survey questionnaires were received from 115 and the results below give a divided picture regarding health problems in IT professionals. Among them 53% of participants responded “yes” and 47% answered “No” as shown in Figure 6. The statistics shows us that more than half of the percentage of participants faces occupational health problems due to the usage of computers. However, the remainder 47% could be attributed that they were taking proper precautions or maybe followed the necessary health protocols for prolonged usage of computer. In any case the 53% is an alarmingly high percentage as its slightly more than of the entire respondent sample.

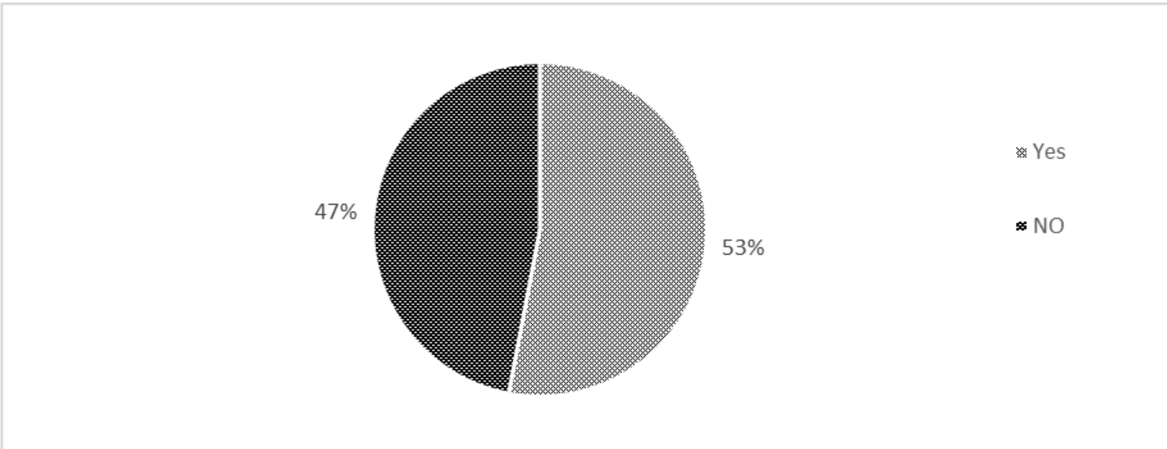

Figure 6: Occupational Health Problems

1.2.1 Early warning Signs: Symptoms

In order to understand the warning signs that almost always lead towards health problems while using computers regularly for prolonged periods of time. The respondents were asked to "tick those symptoms they felt". Majority of the respondents said the main problem they are faced with is “pain or aching in wrist, forearms, elbows, neck or back” with 43.5% followed by “general fatigue or tiredness” with 40.9%, weakness felt by 36.5% of respondents the least felt symptom was “swelling or stiffness”, numbness, tingling or bowing sensation in hand or fingers” with 5.2% and 4.3% respectively as shown in Figure 7.

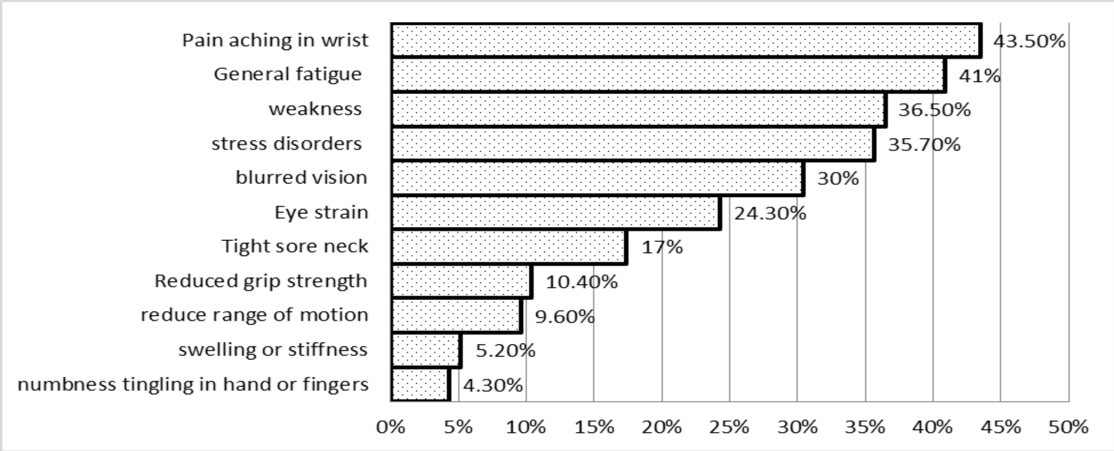

Figure 7: Symptoms towards Health Problems

1.2.1 Musculoskeletal Problems faced by Respondents

This question pertained to specific parts of the body that they felt had suffered during the prolonged usage of computers. Prolonged usage is a precursor to health problems arising in the form of musculoskeletal problems. In response, 28 participants that is 24.3% answered arms, 46 respondent responded as neck 60% of total responses maintaining back as most affected body part, and 62.6% of them stated that eyes were the most affected body part as shown in Figure 8.

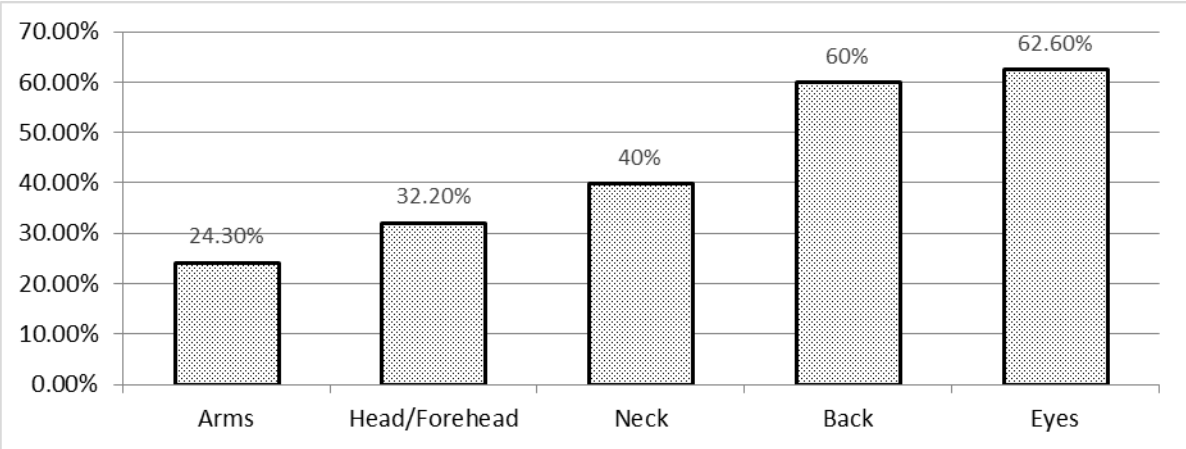

Figure 8: Musculoskeletal Problems

1.3 Knowledge of Preventive Measures among Respondents

The questionnaire concluded by asking the respondents, regarding knowledge about the preventive measures available in the market to overcome these problems? Again the results indicated a divided response with 40% saying "Yes" they know about the preventive measures and 60% saying "No", they did not know about the preventive measures available in the market as shown in Figure 9.

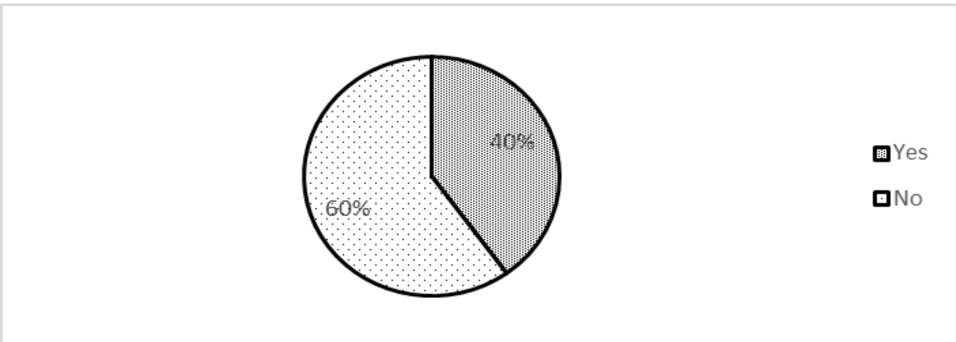

Figure 9: Knowledge of preventive measures

4. CONCLUSION

This article was an attempt at understanding the occupational health problems faced by IT professionals due to prolonged usage of computers. As we know that every occupation has necessary precautions towards its working and routine, so does the usage of computer. But we have become so accustomed to not taking the time to understand these necessary precautions and adequately apply them in our daily lives that many of us face the problems as discussed in this article. The results are alarming as many respondents were not even aware of the necessary precautions available in the market place. These problems are easily avoidable with minor adjustments and a little investment in personal health. Major problems like hemorrhoids is preventable by simply refreshing yourself every 1 hour to 2 hours with a simple get up and take a few steps to help in blood flow.

5. REFERENCES

1. Gopang, M.A., Nebhwani, M., Khatri, A., Marri, H.B., 2017. An assessment of occupational health and safety measures and performance of SMEs: An empirical investigation. Saf. Sci. 93, 127–133. doi:10.1016/j.ssci.2016.11.024.
2. Jensen, C., 2003. Development of neck and hand-wrist symptoms in relation to duration of computer use at work. Scand. J. Work. Environ. Health 29, 197–205.
3. Kumari, G., Pandey, K.M., Khanaka, S.S., 2010. Studies on Health Problems of Software People : A Case Study of Faculty of GCE and GIMT Gurgaon , India. Int. J. Innov. Manag. Technol. 1, 388–397. doi:10.7763/IJIMT.2010.V1.70.
4. Montreuil, S., Lippel, K., 2003. Telework and occupational health: a Quebec empirical study and regulatory implications. Saf. Sci. 41, 339–358. doi:10.1016/S0925-7535(02)00042-5.
5. Moom, R.K., Sing, L.P., Moom, N., 2015. Prevalence of Musculoskeletal Disorder among Computer Bank Office Employees in Punjab (India): A Case Study. Procedia Manuf. 3, 6624–6631. doi:10.1016/j.promfg.2015.11.002.
6. Prasad, M.A., Wagh, V., Mudey, A., 2014. Study of Prevalence of Health Problems Among Computer Professionals in Selected Information Technology (It) Company in Nagpur District of Central India. Innov. J. Med. Heal. Sci. 4, 96–98.
7. Shrivastava S., B.P., 2012. Computer Related Health Problems Among Software Professionals in Mumbai - a Cross- Sectional Study 1–6.
8. Singh, B., Singh, S., 2016. Intervention Approaches in Management of Neck Pain Among Computer Users. Int. J. Ther. Rehabil. Res. 5, 19–24. doi:10.5455/ijtrr.000000121.
9. SKA, S., I, S., P, A., Zulkifley NH, A.S., S, S., 2016. EVALUATION OF AN INTERVENTION PROGRAM TO PROMOTE NECK CARE FOR COMPUTER USERS AMONG STAFF AND STUDENTS OF A MALAYSIAN PUBLIC UNIVERSITY. Int. J. Public Heal. Clin. Sci. 3, 59–68.
10. Suparna, Sharma, A., Khandekar, J., 2005. Occupational health problems and role of ergonomics in information technology professionals in national capital region. Indian J. Occup. Environ. Med. 9, 111.
11. Vijay Subbarayalu, A., 2013. Occupational Health Problems of Call Center Workers in India : A Cross Sectional Study Focusing on Gender Differences. J. Manag. Sci. Pract. 1, 63–70.

PRACTICES OF GREEN SUPPLY CHAIN MANAGEMENT (GSCM) AND PERFORMANCE OF AUTOMOTIVE INDUSTRIES IN SINDH PAKISTAN

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ABSTRACT. Green supply chain management is one of growing concept in Sindh Pakistan, it is related with environmental friendly and reducing environmental impact. This paper aims to measure the degree to which green supply chain management practices adopted by automotive industries at Sindh Pakistan and also measure the performance while adopting green supply chain management practices.

In order to research automotive industries at Sindh Pakistan and its green activities, seven industries have been selected which are Pak Suzuki , Indus motors ltd , Nissan Ghandhara ltd , Masters motors ltd, Karakoram motors ltd, Hino pak ltd, and Dewan farooque motors.
Keywords : Green supply chain management , Green practices , and automotive performances.

1. INTRODUCTION

1.1 Green Supply Chain Management

The concept of Green supply chain management was first suggested by ‘Michigan State University in 1996’ during an “Environmental responsible manufacturing” research. It resulted as effective way of management by scholars in Michigan university. later it seems that green supply chain management was implemented number of the organizations such as IBM which was used green supply chain management to solved economic interests of environmental protection, so many people appreciated it.

According to “Srivastava in 2007” defines green supply chain management as an interlinked environmental thinking into supply chain management including product design, material sourcing and selection, manufacturing, product delivery, and end of life after its useful life.the purpose of green supply chain management is to reduce environmental effect and to eliminate or minimize waste that include solid, chemical, hazardous as well as energy and emissions (Ninlawan et al, 2010).

1.2 Background Of Companies

There are many automotive industries at Sindh Pakistan, but we selected seven automotive industries from Sindh Pakistan for this research paper. These are given here under;

Table 1. introduction of companies

Name	Products
Toyota Indus Motor ltd (1989)	Passenger cars, commercial vehicles and 4WD.
Hino Pak ltd (1986)	Assembles, manufactures, heavy trucks and buses.
Pak Suzuki ltd (1983)	Cars, small vans, cargo vans and motorcycles.
Nissan Ghandhara (1981)	Passenger cars,, light and heavy commercial vehicles.
Karakoram motors ltd (2003)	Cars, vans, single and double pickups.
Master motors corporation ltd(2002)	Commercial vehicles, light duty and heavy duty trucks.
Dewan farooque motors ltd(1998)	Light commercial vehicles and cars.

1.3 Problem Statement

During some years the natural environment has become one of challenging factor for the automotive companies that is taking into consideration due to economic and ecological impacts and increase awareness of environment protection among society (Dixit garg et al 2014).

In developing countries like Pakistan automotive sectors play very important role on economy and employment factor, that's why this sector must be environmental friendly, and this is achieved by implementing green supply chain management activities in organizations. According to "Pakistan journal of scientific and industrial research the major source of pollution are industries and vehicles, the manufacture and use of automobiles emits 20% to 25% of carbon dioxide that is major cause of global climate change (Naeem et al).

1.4 Purpose

The purpose of this research paper is to analyze the present state of Green supply chain management in automobile industries of Sindh Pakistan. We also intended to analyze the impact of GSCM practices on the performance of automotive industries at Sindh Pakistan. In this research paper we tried to find the major challenges faced with the adaption of GSCM.

1.5 Objectives Of Study

There are two objectives of this research paper, these are

- To measure the degree of GSCM practices implemented in automobile industries of Sindh Pakistan and challenged faced with adaption of GSCM.
- To analyze the impact of GSCM practices on the performance of automotive industries at Sindh Pakistan.

1.6 Conceptual Framework

Conceptual framework to link GSCM practices and firm performance in the study, the dependent variables are the firm performance while GSCM practices are the independent variables. GSCM practices are expected to have impact on performance of the firms in the automotive industries in Karachi Pakistan, the impact of GSCM practices on the performance of the firms is shown in table 1.2

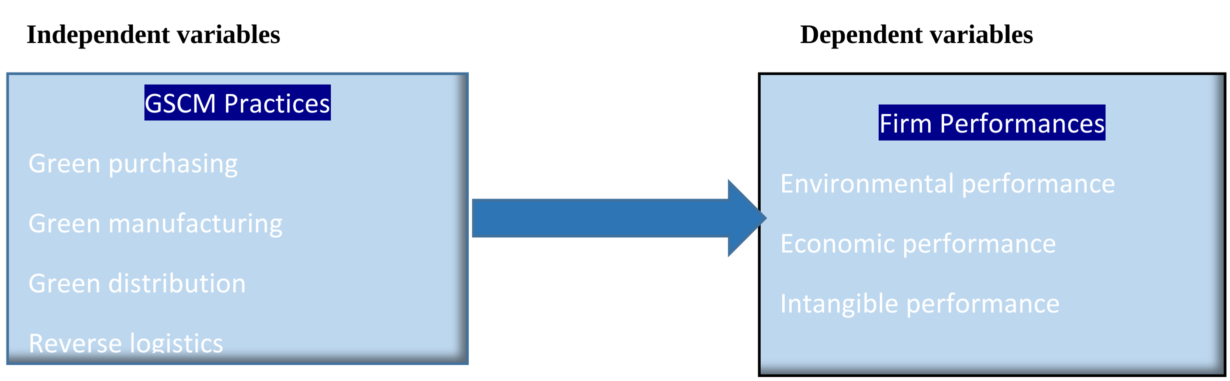

Figure 1. Conceptual Framework

2. RESEARCH METHODOLOGY

2.1 Research Approach

It is Qualitative data it helps to find out explanation of problems, in this research comments and observations from the questionnaires are used as q qualitative data. We focus to find out the level of GSCM implemented in automotive industries at Sindh, and made the relationship between the performance of the firm and the GSCM.

2.2 Questionnaire Development

Questionnaire was consider from the research article named as “Korir Gladys Jemutai 2014”.
Questionnaire are replied using a five point likert type dimensions, in which 1= Very large extent ,
2= large extent , 3= Moderate , 4= small extent , 5= not at all.
Questionnaire contains four sections, first is about ‘General information’, second is ‘GSCM practices’, third is about ‘performance of firm after implemented GSCM practices’ and fourth is about ‘challenges faced by companies’. Further the GSCM practices section involved more sections which are named as ‘Green purchasing, Green manufacturing , Green distribution and reverse logistics’, then the performance section is divided in to ‘Economic, Environmental and intangible performances’.

2.3 Data Collection

2.3.1 Primary Data

The data was collected with the help of questionnaire, questionnaire was sent to seven companies which are Indus motor ltd, Master motors ltd, Hino pak ltd, Nissan ghaandhara ltd, Pak Suzuki ltd, Karakoram motors ltd, and dewan faroque motors ltd. In three companies the questionnaire was filled by visiting them and in others the questionnaire was filled by sending them through email.

2.3.2 Secondary Data

secondary data is the collected data from the net and the literature of the different research papers, the reference of these papers were given at last. The analysis is of secondary data is an important part for the definition of problem.

2.4 Data Analysis

Data is analyzed by using statistical package for social sciences (SPSS), It is one of the most popular statistical packages which can perform highly complex data manipulating and analysis with simple instructions, it is frequently used in the social science. Data was analysed according to the objective of this thesis. The first objective is to measure the level of GSCM practices implemented in Sindh Pakistan and challenges faces while adopting the GSCM. The gathered data about these were analysed by using description statistics such as mean and standard deviations.

2.5 Validity

the primary data was collected by the experienced employee of the department of the firm whose experience more than two years and above. The secondary data get from the authentic and official websites of the companies, further the data is gathered from the published articles and research journals. Validity in research represents acceptable research from the research community (Korir Gladyss Jamutai 2014).

2.6 Limitations

In this research paper we considered seven automobile industries of province Sindh Pakistan but this is very limited because in Sindh there are many industries. Hence how research findings could vary if similar research is undertaken in other province of Pakistan.

3. DATA ANALYSIS, RESULTS AND DISCUSSIONS

3.1 Introduction

this research was conducted to measure the extent to which green activities adopted and performance of automobile industries of Sindh Pakistan. Data was gathered by fulfilling the questionnaire from seven industries, one questionnaire from each industry.

3.2 General Information

this section of questionnaire contains questions which are designation in the company, experience and views about GSCM implementation.

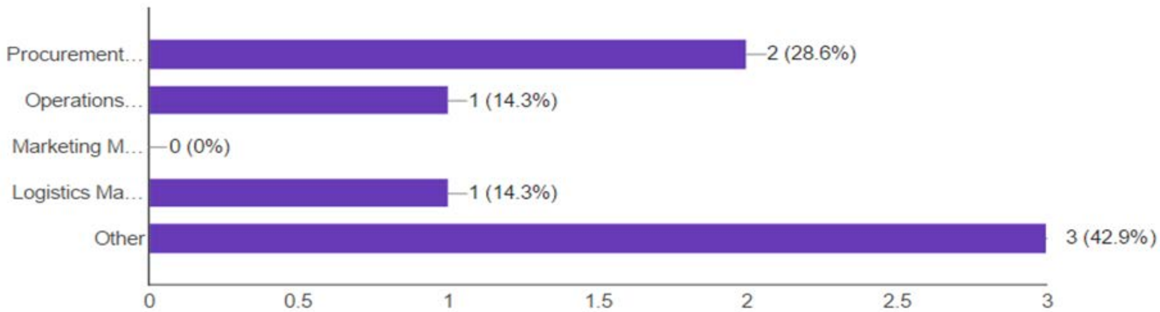

Figure 2. source, data from 7 automotive industries at Sindh Pakistan (2016)

3.3 Results Of Green Supply Chain Management Practices

Table 2. about results of GSCM practices

Green Practices	Total Mean	Total Std deviation	Average Mean	Average Std deviation
Green Purchasing	15.8571	2.85357	2.2714	0.3903
Green Manufacturing	16.2857	1.79947	2.3143	0.26726
Green distribution or transportation	9.572	4.08248	2.393	0.99702
Reverse logistics	18.33	7.0333	3.122	1.1099

According to the above results it is clear that the average mean score was 2.2714 which indicated that firms in the automotive industries of Sindh have implemented green purchasing practices to large extent. According to Korirr Gladys (2014), the commonly accepted dimension in GSCM. For Green Manufacturing activities the average score is 2.3143 which is near to 2 however green manufacturing activities implemented in automobiles industries Sindh Pakistan at large extent. The average of green transportation activities is 2.393 the results shows that the above activities of green transportation in selected companies adopted to large extent. And the result shows that the above activities of reverse logistics in the selected companies adopted moderately because the average is 3.122.

3.4 Impact Of GSCM Practices Over The Performance Of The Firm

Table 3. firm performance after implementing GSCM practices.

Firm Performance	Total Mean	Total Std deviation	Average Mean	Average Std deviation
Economic performance	**13.00**	**3.000**	**2.243**	**0.61606**
Environmental performance	**11.4286**	**2.69921**	**2.286**	**0.53984**
Intangible performance	**3.572**	**1.98806**	**1.929**	**0.93223**

The above result indicates that the component of the economic performance of the automotive industries of Sindh Pakistan may increase to large extent because the average mean value is 2.243, therefore the green supply chain management had a positive impact on the economic performance of the automotive industries of Sindh Pakistan. The environmental performance of automotive industries of Sindh Pakistan may increase to large extent because the average mean value is 2.286, however there may very large decrease in consumption for hazardous and toxic materials, therefore the green supply chain management had a positive impact on the environmental performance of the automotive industries of Sindh Pakistan. According to the result if the companies which are selected for the study uses GSCM practices may lead to improve public image of company, the GSCM practices result in improving the customer loyalty the average of total mean value is 1.929.

3.5 Challenges In Adopting GSCM Practices

This portion of the study consist of the analysis of the pressure while adopting green supply chain management practices.

Table 4. Challenges faced by firms while adopting GSCM activities

Challenges	Mean	Std deviation
Lack of appropriate technology needed to implement GSCM.	2.143	0.69007
Lack of awareness among the employees, retailers etc	2.714	0.95119
Lack of tools and techniques for measuring GSCM performance.	2.2857	1.25357
Suppliers or vendors are reluctant to adopt GSCM practices.	2.500	0.54772
Difficulties in complying with the organization standards.	3.000	0.57735
Lack of commitment from the top management.	3.429	1.27242
Poor planning of implementation of the sustainability program.	2.714	1.38013
Lack of effective communication among the supply chain team	3.1429	1.46385
Failure to integrate supply chain optimization efforts with GSC efforts	2.4286	1.27242
Strict government rules and regulations.	2.500	0.83666
Trade off between green requirement and lean practices.	3.1429	0.69007
Total	29.2857	6.84871
Average	2.7376	0.68639

The average value indicates that the automotive industries of Sindh Pakistan were facing challenges to a large extent while adopting green supply chain management.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

The conclusion of this paper is that the companies which are selected for the study uses green supply chain management practices to a large extent included green purchasing, green manufacturing and green transportation, whereas the reverse logistics practices considered moderately. And also the automotive industries of Sindh Pakistan were facing lot of challenges while adopting green supply chain management practices. So the first objective to measure the degree to which GSCM practices implemented in automobile industries of Sindh Pakistan and also challenges faced while adopting GSCM activities. It is observed that the GSCM practices may lead to improve the economic, environmental and intangible performances. Hence the second objective to analyze the impact of GSCM practices on the performance of the automotive industries at Sindh Pakistan has been achieved.

4.2 Recommendations

The study results indicate the some components of GSCM have not been utilized well enough e.g reverse logistics, from the results it is observed that GSCM had a positive impact on the performance of the firms so the automotive companies should adopt the GSCM practices. Therefore the government agencies regarding environment improvement should enforce the companies to adopt the green supply chain practices completely in order to reduce environment burden.

4.3 Suggestions for future research

GSCM practices play an important role in improving the performance of the firms. Therefore there is need to conduct research other than automotive sector e.g. service, textile sector etc. and there is need to find out critical success factor for implementing GSCM in order to completely implement the GSCM practices.

5. REFERENCES

1. Carter, craig r and p liane Easton (2011). “ sustainable supply chain management, evolution and future directions.” International journal of physical distribution and logistics management 41.1.2011: 46-62
2. Demirci u (2014). “ green supply chain management case: Turkish automotive industry by practices, pressures and performances. “ student paper. Hogskolani gavle,
3. Emmett, stuart and vivek sood (2010). Green supply chain an action manifesto john wiley and sons.
4. Korir Gladys j (2014). green supply chain management practices and performances of firms in automotive industry in Nairobi, kenya. Disss University of Nairobi.
5. Seman, noor aslinda abu et al (3.1.2011)Green supply chain management a review and research direction international journal of managing value and supply chain 1-18.
6. Wisner , koel D(2014). keah choon tan and G.koeng keong. Pra=inciples of supply chain management a balanced approach cengage learning.
7. www.toyota-induss.com
8. http://ghandharanissan.com.pk
9. www.pak Suzuki.com.pk
10. www.yousufdewan.com
11. www.hinopak.com
12. www.karakorammotors.com
13. www.mmcl.com.pk
14. Xu, lie eet al (2013).“ multiple comparative studies of green supply chain management pressures analysis.” “ ressources, conservation and recycling “ 78. 2013 26-35

Development of Service Quality Scale in Telecom

Research on Customer Satisfaction in Telecom industry

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Abstract

The structure of this research paper classifies the basic and support activities of a telecom company. The correlation analysis between the quality of the service, technical improvement, customer satisfaction and post purchase behavior in the Pakistani Telecom Sector is the objective of this research.

CFA (confirmatory factor analysis) is used to analyze the technical improvement needs, service quality features and indicators for the measurement of such technical improvement and service quality have been developed after privatization to enhance the customer satisfaction. Service quality features and indicators were proposed from a deep study of all operational departments of PTCL (Pakistan Telecommunication Company Limited).

Information about the PTCL's technical improvement and Service Quality is collected through detailed interviews of top management of PTCL. While main dependency during this study remains on primary data. This information is used to analyze the enhancement of service quality & customer satisfaction in PTCL.

At the end, the outcome of this research is a service quality scale will help the top management of PTCL to delight its customers with the help of development of service quality in PTCL. The main conclusion of this study is to enhance the poor quality service, adopt the latest technology,

and focus on publicity and media campaign in order to cope up with the diverse environment of PTCL.

Introduction

According to Gamini & Thapisa (1999), quality is a continuous improvement process. Service quality's theoretical and practical link to customer satisfaction has turned it into a core marketing instrument (Venetis & Ghauri, 2004). This research is an effort to convince telecom sector that, how to achieve excellence in the quality services they provide to enhance customer satisfaction.

With reference to customer satisfaction and service quality assessment in the telecom sector of Pakistan, no significant input has been done. So for development and selection of a credible and decisive service quality scale for telecom sector of Pakistan is the goal of this research. The correlation analysis between the quality of the service, technical improvement, customer satisfaction and post purchase behavior in the Pakistani telecom sector and in PTCL is the objective of this research.

The research intentions are to design a scale of SQ (Service Quality) which will be helpful for PTCL top management to delight its customers with the help of technical improvement and development of service quality in PTCL. Information about the PTCL's technical improvement and Service Quality is collected through interviews of top management of different departments. In this study main emphasis remains on basic data. This information will be used to analyze the enhancement of service quality & customer satisfaction before and after privatization of PTCL.

Gronroos (1984) concluded that both functional and technical qualities are the components of service quality. The output of a service relates to technical quality and functional quality relates to the delivery process of a service. Orr (1973) stated that quality is actually a good service or a good product and it does not depend on, whether the service is large or not. Quality actually relate to their liability of a product/ service for the user's intentions. This means that service quality is actually the perceptions of a customer like reliable, unreliable, bad or a good service, reliable or not.

In Pakistani culture, if we look around for measuring customer satisfaction related to telecom companies, we'll find that managers often use the wrong way to serve the customers and losing them. SERVQUAL model has been playing a basic function for assessment of SQ in marketing research and customer satisfaction practices over the last two decades. Particularly this research will help those managers, who want to enhance the company's SQ& CS (Customer Satisfaction). Consequences of our research will help the top management of any telecom service provider company in Pakistan to set up priorities for the quality enhancement efforts in the telecom sector. In Pakistan, most of the organizations in Telecom sector have not adopted the new and successful techniques of TQM (Total Quality Management). Some organizations are trying to implement these TQM techniques, but they are still at a basic level.

We provide a review relevant literature in fourth coming section. This is followed by the methodology and results of an empirical research. The paper is concluded with the implications of the results and suggests for the future prospects of research.

Literature Review

Quality is stepping stone for survival and to implement TQM, top management commitment is the prerequisite. Initial work on TQM as done by D. Juran and Erward Daming in 1950. TQC (Total Quality Control) approach was then introduced by Armend Feiganbuan (1970). TQM started implementing practically in 1980 when American Companies faced major market share loss. After that lots of efforts are being made to popularize TQM (Kaynak, 2003).

Researchers proposed 25 success factors for TQM and Sila and Ebrahimpour (2002) used factorial analysis to classify them. According to Khan (2003), who proposed TQM philosophy, customer focus is its main component. They also found elite management commitment to be the most crucial success factor in TQM implementation. Gandhinathana and Karuppusami (2006) classified 56 critical success factors into two major classes like "vital few" and "trivial many". 14 success factors were of "vital few" class and their ratio was 80 %. The remaining 42 critical success factors are useful also but their ratio was only 20%. The main target of TQM is increased profit which is directly achieved through continuous improvement and indirectly by satisfying customer needs and reducing waste and errors (IMECS, 2009). TQM benefit all the three parties involved in any particular transaction. Customers will be provided better customer service that will increase their level of satisfaction. Staff will acquire more skills and hence more recognition and company`s productivity will increase and cost will be reduced (IMECS, 2009).

According to Boulding et al. (1993), customer satisfaction is the assessment of buying experience of customers, as transaction specific perspective stated. Whereas, Johnson & Fonell

(1991) stated that in cumulative perspective, customer satisfaction assessment should be according to the overall buying experience of customers, instead of a specific skill of buying. Parasuraman et al. (1988) described that forecasting of post purchase intentions of customers and for assessment of service performance of a company cumulative perspective is more reliable. Customer with negative image about the company informs 7 to 20 people, whereas with a positive image, a customer will informs only to 3-5 people about his good experience Kan (1995).

Customer satisfaction can also be affected due to the contribution of the customers themselves during delivery of service or product (Kelly, Skinner et al. 1982). Customers also assess the quality of a product or of a service and their features in many ways, according to the delivery, production and conditions (Mathe and Shapiro, 1993). Kristensen et al. (1999) highlighted customer satisfaction as a main factor for improved performance.

When organizations want to develop the scope of a product or service, and improve continuously, then quality becomes an issue. Orr (1973) stated that quality is actually a good service or a good product and it does not depend on whether a service is large or not. Quality actually relates to the reliable service for intentions of users. Quality had been most important consumer's trend of the 1980's (Rabin, 1983) but is even higher in demand now. Quality is the service and product's status for the intentions of customers, according to the demands of customers, users and public. Hence, quality is a continuous improvement process as Gemini and Quality is defined as: "Achieving the excellence" (Thapesa, 1999).

Service Quality is the differentiation of perceptions and expectations of customers, as Berry, Parasuraman and Ziethamal proposed during their research in 1985 to 1988. So, according to this proposed statement, Parasuraman used a model for the measurement of SQ which included 5 dimensions as, RES, TAN, REL, ASS, EMP. This model was SERVQUL.

Two scholars Taylor and Cronin argued that SERVPERF model is better than SERVQUAL model for the measurement of validity, predictive power and for reliability. Also, it was proved through research work that for measurement of SQ, SERVPERF is a better model. SQ is most important research topic of marketing service quality in today's work, as Fisk et al stated in 1993. Pararsurama et al. (1985) established gap model for the measurement of indicators of SQ. The base of gap model is the comparison between perception and expectations of users

(SERVQUAL model) and states that service quality according to user's perceptions is the role of direction and magnitude of the gap in service perceptions and expectations. Parasuraman et al. (1985) evolved service quality scale comprising of 10 and composed of 34-item and later on using the service quality scale of 5 dimensions comprising 22 items in 1988. In 1985 a scale comprising of little dimensions was retained while a new dimension "assurance" was coined by merging security, courtesy, credibility, competence and communication. Competence, credibility, courtesy and security merged as a new dimension "assurance". But there is no standard dimension of service quality as different researchers have worked on it in their own way.

This research is the first effort to implement the TQM practices in the Pakistan Telecom Sector. The method to establish service quality for telecommunications was determined by Noam, Dvorak and Richters in October 1988. Different authors have proposed different service quality criteria, including Garvin, Zeithaml, Parasuraman, and Berry, Eli M. Noam. (Boston: Kluwer Academic Publishers, 1991).

In Pakistan teledensity progressed to 13.67% breaking a record of growth percentage of 105% within one year. Telecom sector was awarded "industry" status in 2005 owing to the fact that it is expanding exponentially from the last few years. Telecom industry made revenues of Rs. 161.4 billion in 2005 which was just Rs. 129.4 billion last year. In overall GDP (Gross Domestic Product) of the country, Gross Value Addition made by the telecom sector has reached 115 billion or close to 2% of GDP while the telecom`s share of GDP reached 1.9%. In the history of Pakistan's mobile sector, the mobile sector, thus grew by 181.6% in one year (in 2005) which is the highest ever annual growth. Average Revenue Per User (ARPU) of the Mobile Sector stands at US$ 6 per month with the reduction of 30% (June 2005). Currently, Mobilink has the maximum market share of 56.5%. Initially Telenor services are restricted to metropolitan areas only. With the commercial launch of Warid, it has offered services in 28 cities simultaneously. Ten companies have started a new segment LDI (Long Distance & International) operations by the end of June 2005. In 2005, Broadband gained much popularity in Pakistan. Total broadband subscribers (DSL, wireless, cable and satellite) crossed 30,000 whereas total DSL subscribers in Pakistan have reached 14,600.

PTCL believes in the concept of servicing with a smile. The company is determined to provide high quality to the users. Various payment modes are devised by working closely with various banks. PTCL has a total of 116 OSS (one stop shops) at various locations in Pakistan. OSS provides services like EVO wireless broadband, sale of equipment's, service related bills, audio conference, video conference.

From the previous chapter of literature review, it is concluded that in any culture without internal service quality it is impossible for any service organization to deliver high level of customer satisfaction. There is no universal set of dimensions and items that determine the service quality across a section of service industries in different cultures.

Methodology

This chapter explains the method and track of development of service quality scale in the telecom sector, and explain how the goal of customer satisfaction can be achieved. A questionnaire is designed on the basis of items and dimensions and a model regarding service quality is developed by using AMOS 18 (SEM).

From the previous chapter, it was identified that CS is the most important component of TQM Philosophy and top management commitment is an important indicator to implement TQM Philosophy successfully. From the previous chapter, we also identified that in any culture without internal service quality it is impossible for any service organization to deliver high level of customer satisfaction, whereas there is no universal set of dimensions and items that determine the service quality across service industries in different cultures. So, this research is based on TQM practice's impact on customer satisfaction, and then, identifies the important indicators in TQM implementation in PTCL organization. This research also identifies the important items and dimensions of service quality provided by PTCL users. So, the research question for this study is:

Q: What are the important items and service quality dimensions in the telecom sector of Pakistan?

In general, there are two approaches for research,

1- Quantitative
2- Qualitative

According to Saunders et al. (2000), qualitative approach can be much more prolonged whereas quantitative research can be quickly complete and it is normally possible to predict accurately the time schedules. Because academic research is time limited, so this research is also following quantitative approach. The current study is the first research about TQM Philosophy and about development of service quality scale in the telecom sector of Pakistan, and for PTCL, so I'll prefer quantitative for this research. Due to budget constraints, quantitative approach is preferred as qualitative approach is much expensive.

Morgan (1993) suggested that focus group's strategy should be used to adopt a research instrument to new populations. As per Robson (1993) the service strategy is often employed for cross-sectional studies. Because of a large number of clients of PTCL, the survey is a better approach for data collection. This research is a cross-sectional study. As this analysis is the first research about TQM Philosophy and about development of service quality scale in the telecom sector of Pakistan, and for PTCL, so primary data have to collect. Kumar (1999) concluded that the use of the questionnaire may be the only choice of collecting data. If potential respondents are scattered over a wide geographical area. Sauders et al. (2000) classified questionnaire as a self-administrated or interviewer administrated. Use of telephone or structured interview is helpful in developing Interviewer administrated questionnaire. Questionnaire consists of closed ended questions. The questions used were comprehensive and brief. In order to enhance understanding and interest of the respondents the use of technical language was avoided, Parasuraman et al. (1988) have suggested service quality dimensions to measure and discuss SQ in different service areas. These dimensions and items are shown in the following table.

Table 1: SQ dimensions and Items

Service Quality Dimensions		Item
Reliability	REL-1	• Customer service centers provide all facilities. (Q.10)
	REL-2	• Products & Services of PTCL are of a good quality.(Q.23)
	REL-3	• Technology using by PTCL is advance and updated.(Q.24)
	REL-4	• Employees are knowledgeable.(Q.3)
	REL-5	• Calls seldom drops during busy hours due to network congestion or line failure.(Q.14)
Responsiveness	RES-1	• While any problem occurs, PTCL can instantly overcome it.(Q.15)
	RES-2	• Employees quickly apologize for mistakes.(Q.5)
	RES-3	• Call center operators response quickly for complaints.(Q.16)
	RES-4	• Telephone service faults are cleared in 1week.(Q.17)
	RES-5	• PTCL widely circulates information about corporate progress and plans.(Q.28)
Assurance	ASS-1	• Employees have skills and abilities to deal with complaints.(Q.8)
	ASS-2	• PTCL provides diversified value-added services, e.g. DSL, Smart TV, call back service, Conference Calls, Prepaid, Post Paid etc. (Q.18)
	ASS-3	• Value-added services provide regularly updated content.(Q.19)
	ASS-4	• PTCL provides multiple tariff options.(Q.21)
	ASS-5	• PTCL successfully provided the services as I requested.(Q.27)
Access	ACC-1	• Employees are always available to receive requests for a new connection.(Q.1)
	ACC-2	• Employees are always available for complaint requests.(Q.4)
	ACC-3	• Customer service centers are at convenient locations.(Q.9)
	ACC-4	• Customer service centers operating hours are convenient.(Q.11)
	ACC-5	• Bills can be deposited easily at convenient locations.(Q.12)
	ACC-6	• Bills can be deposited on-line.(Q.13)
Image	IM-1	• I am satisfied with PTCL for services provided by it.(Q.29)
	IM-2	• I'll recommend the services provided by PTCL to my relatives and friends.(Q.30)
	IM-3	• Services of PTCL are better than expected.(Q.26)
	IM-4	• PTCL provides good after sales-services.(Q.25)
	IM-5	• I can easily access the value-added services.(Q.20)
	IM-6	• I can easily vary the contract of value added services.(Q.22)
Empathy	EMP-1	• Employees care about customer's complaints. (Q.6)
	EMP-2	• Employees care about customer's time & expectations. (Q.7)
	EMP-3	• Employee's behavior is friendly & polite.(Q.2)

This questionnaire was distributed among customers of PTCL. The numbers of dimensions in service quality measurement scale were comprised of a similar number of dimensions as that of Seay et al. (1996). This service quality measurement scale comprised of 30 items among those 5 dealt with reliability, 6 with access, 5 with responsiveness, 6 with Image, 5 with assurance and 3 with empathy. For data analysis, the Structural Equation Modeling (SEM) program AMOS 18 was used. The model was designed on the basis of items and dimensions of service quality of PTCL by using SEM is following,

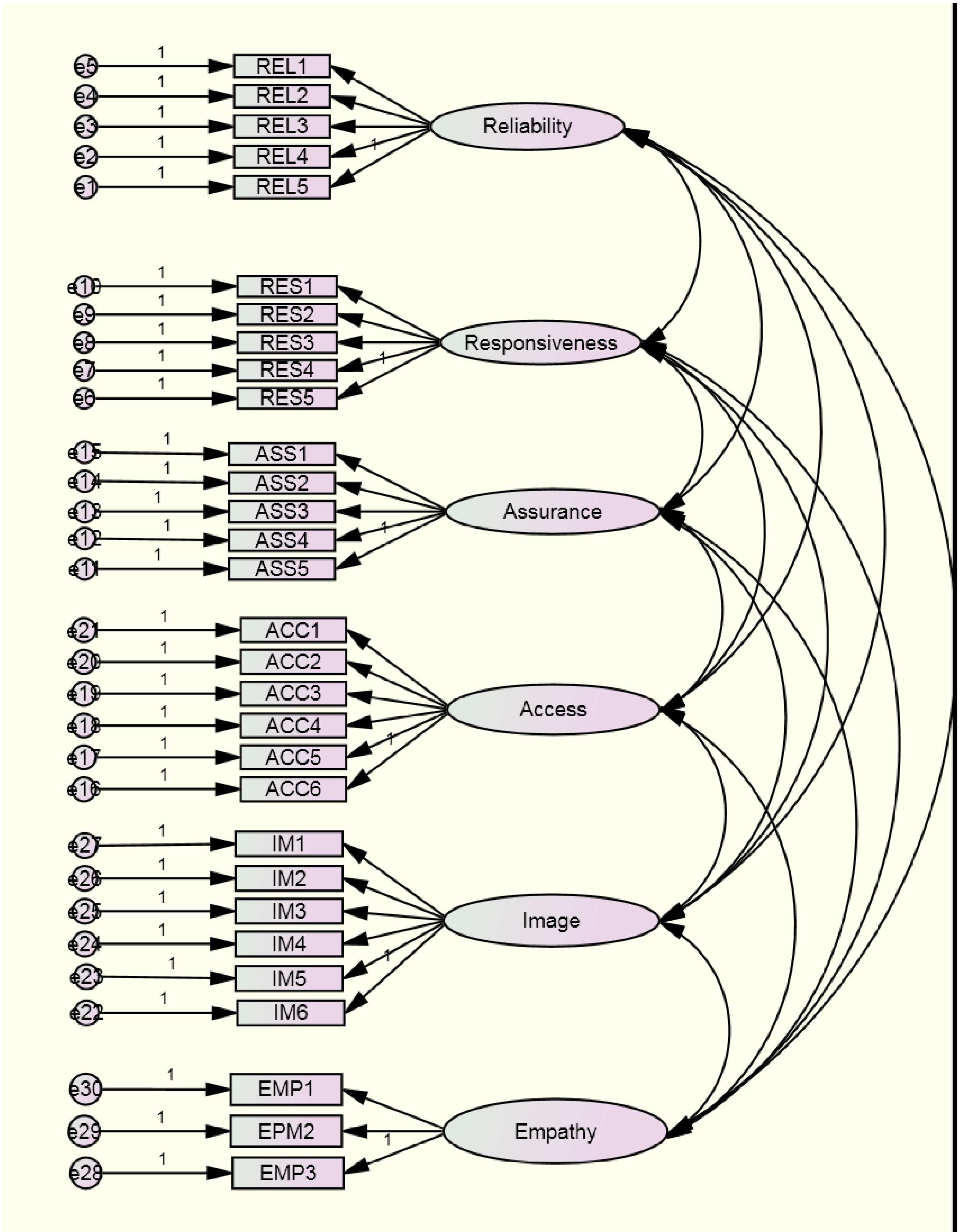

DIAGRAM 1: Designed Model of SQ before CFA.

The survey questionnaire was distributed among 600 customers of PTCL from different professionals. 500 useable questionnaires were considered for data analysis. Scale purification is developed in this process and this scale is for customer satisfaction in Pakistan Telecommunication Company Limited.

The survey was conducted for data collection. Samples were randomly selected from the university students, faculty members, domestic users as well as commercial users and DAI's (degree awarding institutions). Everyone in the population has equal chances of inclusion in the sample because of random sampling. For data transformation and for data analysis, we used SPSS software and confirmatory factor analysis (CFA) respectively. CFA is used with the help of Structural Equation Modeling (AMOS 18). (**The questionnaire is attached in Appendix I)**

Data Analysis Of Survey Questionnaire

On the basis of survey of service quality of PTCL, among PTCL users, a pure form of the model is developed by using the designed questionnaire. At the start of the data analysis, 6 SQ dimensions agreed in the focus group discussion was the parameters for the group of questionnaire items. SQ measurement scale in PTCL was developed first and next step was to do CFA. Anderson and Gerbing, (1982) used CFA before the construct validation and reliability of the scale are assessed when the scale unidimensionality is ensured. For data analysis, the Structural Equation Modeling (SEM) program AMOS 18 was used.

In SEM, six runs were conducted. The achievement of satisfactory goodness of fit statistics was based on the process continuation. While processing, RESPONSIVENESS, ACCESS and ASSURANCE three dimensions were completely disappeared. Out of 30 items, 21 were deleted. As the final scale may contain even one fifth of the original items, such intensity of item deletion is not remarkable in scale development research (Beinstock et al, 1997). The lesser the amount of elucidated variance for any item, the extra poorly it is weighted in the model, thus making it a a prefrence for deletion from the model. After CFA the scale emerged was assessed for goodness.

Table 2

Service Quality Dimensions		Item
Reliability	REL-3 REL-5	• Technology using by PTCL is advance and updated.(Q.24) • Calls seldom drops during busy hours due to network congestion or line failure.(Q.14)
Responsiveness	RES-1 RES-2 RES-3 RES-4 RES-5	• PTCL can instantly cope with it.when any problem occurs. (Q.15) • Employees quickly apologize for mistakes.(Q.5) • Call center operators response quickly for complaints.(Q.16) • Telephone service faults are cleared in 1week.(Q.17) • PTCL widely circulates information about corporate progress and plans.(Q.28)
Assurance	ASS-1 ASS-2 ASS-3 ASS-4 ASS-5	• Employees have skills and abilities to deal with complaints.(Q.8) • PTCL provides diversified value-added services, e.g. DSL, Smart TV, callback service, Conference Calls, Prepaid, Post Paid etc. (Q.18) • Value-added services provide regularly updated content.(Q.19) • PTCL provides multiple tariff options.(Q.21) • PTCL successfully provided the services as I requested.(Q.27)
Access	ACC-1 ACC-2 ACC-3 ACC-4 ACC-5 ACC-6	• Employees are always available to receive requests for a new connection.(Q.1) • Employees are always available for complaint requests. (Q.4) • Customer service centers are at convenient locations. (Q.9) • Customer service centers operating hours are convenient. (Q.11) • Bills can be deposited easily at convenient locations. (Q.12) • Bills can be deposited on-line. (Q.13)
Image	IM-4 IM-5 IM-6	• PTCL provides good after sales-services. (Q.25) • I can easily use the value-added services. (Q.20) • I can easily vary the contract the services of value addition. (Q.22)

To provide consistent results is the reliability of an instrument. For this reason internal consistency of a questionnaire is checked (Kline, 1993). In this research the reliability of the data is checked by comparative fit index (CFI) and PMSEA value and Cronbach's coefficient Alpha. For data analysis the structural equation modeling program AMOS 18 was used.

CFI: In the comparative fit index, differentiation between a null model and a suggested model is assumed, which stated that among the measures, there is no interaction or association. According to Bantler (1992), the value of the comparative fit index is adequate for data if it is more than 0.90. CFI value 0.928 indications during analyzing CFA model, shows a distinguished model fit.

RMSEA: In suggested model, for the adjustment of the economy and for the assessment of residuals, RMSEA is used. According to Bantler and Hu (1991), the value of RMSEA should be equal or less than 0.08 for a suitable model. In this CFA model indication of RMSEA value 0.059 approved as an adequate model fit. Browne and Cudack (1993) stated that RMSEA value equal to or less than 0.05 (practically) shows a suitable model in the relationship to degree of freedom. 0.05 values of RMSEA are a biased conclusion. Being more reasonable than the requirement more reasonable than the requirement of exact fit with the RMSEA = 0.0, We cannot treat it as correct value, The value of RMSEA 0.08 or less would mention a feasible error of a likeness and would be unable to employ a model with a RMSEA greater than 0.1."

After the uni-dimensionality of the developer construct by using CFA, Crobanch’s Alpha was used for validity and reliability of the questionnaire as well as of every dimension. According to Cronbach, Hair, Anderson, Tattham, & Black (1999); and Nunnally (1978), the coefficients of reliability equal to or more than 0.70 are assumed suitable. The values of Reliability, Image and Empathy are less than 0.7 respectively. According to Ven, Ferry & Van (1980), 0.35 values of Cronbach’s Alpha coefficient are the limit of suitable value. Hence, these values are also acceptable. The reliability evaluation of overall questionnaire was determined through C.A analysis. In the questionnaire comprising of 30 items maintains excellent C.A value i.e. 7.39. C.A value for reliability is 0.544 (good) for Image is 0.540 (good) and for Empathy is 0.571 which is acceptable.

In order to attain satisfactory goodness of fit statistics, six runs of CFA were conducted in AMOS 18. Meanwhile processing three dimensions ASSURANCE, ACCESS, RESPONSIVNESS were completely cut out and 21 items out of 30 also deleted. As the final scale may contain even one fifth of the original items, such intensity of item deletion is not exceptional in scale development studies (Beinstock et al., 1997). The lower the amount of explaining variance for any item, the poorer it is loaded in the model, thus making it a choice for deletion from the model. The scale emerged after the CFA was assessed for goodness of fit statistics. According to Sila and Ebrahimpour (2005), practically, CFA is evaluated by the root mean square error of approximation (RMSEA) as stated above, importance of approximation of indicators, CFI and extent of squared multiple correlations. The coefficients of correlation are depicted among a single and every other variable during analysis, creating a matrix of correlation containing rectangular arrangements of digits. Having similar values principal diagonal in a matrix of correlation resembles with the coefficient of correlation among a digit and is always one. Above and below of the diagonal, coefficients of correlations have a similar range in above and below of the diagonal. The table displaying the correlation between the six dimensions is mentioned below. The correlations between the six factors were significant (P<0.001) i.e., correlation between ASS & REL was 0.595 (P < 0.001); ASS & EMP had also positive relativity (r = 0.461, P < 0.001); ASS & RES correlation was 0.398 (P<0.001); and is significant (P<0.001); and ASS & ACC correlation is between 0.546 (P<0.001).; correlation between ASS & IMAGE is 0.641 (P<0.001).; similarly we can see the correlation between other Dimensions as above.

After using AMOS 18, three dimensions were extracted and the coefficients of correlation above and below the principal diagonal are similar. All the correlations between the three extracted factors have highly significant correlations (P<0.001) i.e., REL & Image correlation value was 0.388 (P < 0.001); REL & EMP had also positively related (r = 0.463, P < 0.001); The correlation between Image & EMP was 0.411 and is a significance (P<0.001).

This correlation is significant at the level 0.01 (2-tailed). Assessment of unidimensionality is assessed by use of goodness of fit statistics (SEM) reliability of the scale and correlation analysis, a good model emerged during CFA. The model is comprised of three dimensions (Reliability, Image, and Empathy) and 9 items. Service quality in PTCL is measured through a service quality scale which is represented in the model. The CFA model is comprised of the list of 9 items which is mentioned as fallow, Table 12.

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Table 3

Service Quality Dimensions		Item
Reliability	REL-1 REL-2 REL-4	• Customer service centers provide all facilities. (Q.10) • Products & Services of PTCL are of a good quality.(Q.23) • Employees are knowledgeable.(Q.3)
Image	IM-1 IM-2 IM-3	• The services provided by PTCL are satisfactory.(Q.29) • I'll recommend the services provided by PTCL to my relatives and friends.(Q.30) • Services of PTCL are better than expected.(Q.26)
Empathy	EMP-1 EMP-2 EMP-3	• Employees care about customer's complaints. (Q.6) • Employees care about customer's time & expectations. (Q.7) • Employee's behavior is friendly & polite.(Q.2)

The dimensions and items are representing the developed SQ Scale. The developed model is as under,

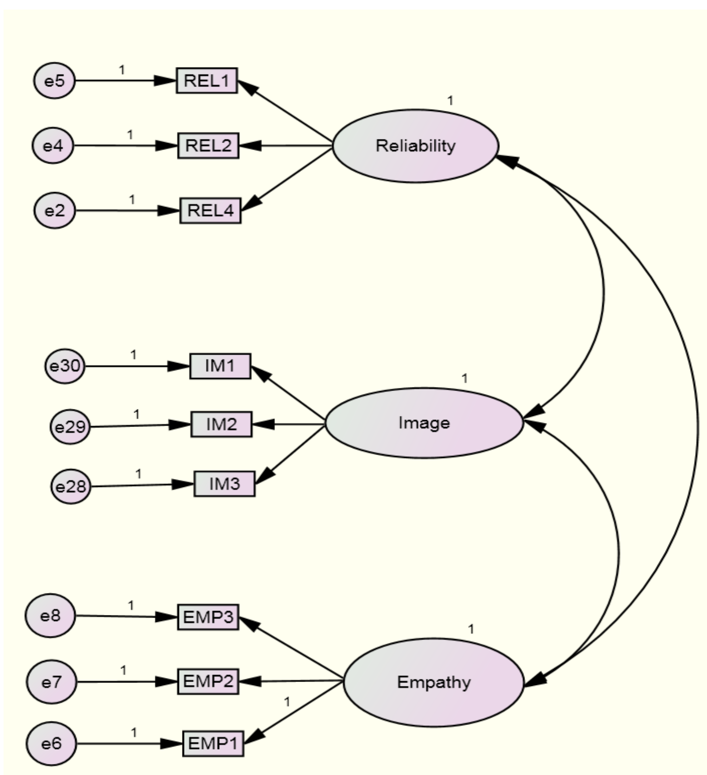

DIAGRAM 2: Developed SQ Model for Pakistani Telecom Sector.

Discussion, Conclusion And Recommendations

To remain successful in the present day's market, achieving excellence is essential for telecom industries. The old approach of controlling the service of telecom industry should be shifted to the new approach of TQM. TQM philosophy is based on customer satisfaction and for successful TQM practices, top management support is necessary. In order to achieve customer satisfaction both internal and external customers must be satisfied, in this regard role of service quality toward customer satisfaction is vital. The conclusion of this study as validity and reliability of the service quality scale, which help the managers of PTCL to measure the service quality to enhance the customer satisfaction. The 9 items out of 30 items and 3 dimensions out of 6 were used to design a valid and reliable service quality model which is a fit model for PTCL. Empathy alone has no fruitful meaning without "IMAGE" and "RELIABILITY". By knowing the demands of the customers through a planned questionnaire, providing facilities, clarity of directions at the point of use, presenting skills to staff and customers by assuring the customers that their problems will be handled in an effective way is the basic need for implementing TQM. The correlations between the six factors were significant. There is a strong relationship of all six dimensions with user satisfaction, and major emphasis on the soft aspects of telecom companies, and also are extremely important to enhance the users overall satisfaction. A useful relationship will result if staff and customers are interacting each other in a good environment. Valuable service will result from these relationships.

Conclusion

The results of this research have indicated that developed service quality dimensions are critical in the PTCL. A telecom company should know that a service of a good quality is about providing the required service to customers on time which should satisfy their needs. A customer may change his demand, need, features or form of the service according to his use. This is the responsibility of the service provider to adapt such needs. By changing behavior towards effectiveness, efficiency and customer satisfaction, most of the technical improvements were achieved in PTCL. But these technical improvements are also due to the amendments in conditions of National Regulatory Authority in Pakistan and worldwide. Every research has some limitations to some areas. This research has also limited to developing countries and for telecom companies. The most important limitation is that such research was restricted to the Telecom Sector of Pakistan and especially focused in PTCL, Pakistan. The findings of this research are very useful for researchers and for the managers of telecom sector of Pakistan as well as for developing countries. The management of PTCL should keep determined to make this company customer friendly and competitive in today's market. For achieving this excellence, management should have to improve the quality of service, customer satisfaction and the technical capabilities

REFRENCES

Akerloff, George A. "The Market for 'Lemons': Quality Uncertainty and the MarketMechanism." *Quarterly Journal of Economics* 84 (1970): 488-500

Alliance for Telecommunications Industry Solutions. *Network Reliability Steering Council Annual Report*. Washington, D.C.: ATIS, 1995.

"Ameritech-Ohio Settles Service Complaint Probe." *State Telephone Regulation Report* 13, no. 20 (Oct. 5, 1995): 13-14.

Awan, M.U. (2008), "Development of Pharmaceutical Distribution Model for Customer Satisfaction."

Baker, J., Parasuraman, A., Grewal, D. and Voss, G.B. (2002), "The influence of multiple store environment cues on perceived merchandise value and patronage intentions", *Journal of Marketing,* Vol. 66 No.2, pp.120-41.

Baldrige Criteria for Performance Excellence. (2007). Retrieved January 17, 2007, from Baldrige National Quality Program, National Institute of Standards & Technology: http://baldrige.nist.gov/Business_Criteria.htm

Bateson, J.E.G and K.D. Hoffman (1999). Managing Services Marketing: Text and Reading Fort Worth, TX, Dryden Press.

Berry (Chicago: American Marketing Association, 1983), 99-104; V. A. Zeithaml, A.

Barnard, A.M. (2002). Feedback seeking in customer Service Relationships. The Department of Psychology, Loulslana State University.

Bayraktaroglu, G., & Ozgen, O. (2008). Integrating the Kano model, AHP and planning matrix. *Library Management, 29*(4/5), 327–351.

Berry, L. L. and A. Parasuraman. *Marketing Services.* New York: The Free Press,1991

Bitner, M.J. and Hubbert, A.R. (1994), "Encounter satisfaction versus overall satisfaction versus quality: the customer's voice", in Rust, R.T. and Oliver, R.L. (Eds), Service Quality: New Directions in Theory and Practice, Sage Publicatios, Thousand Oaks, CA,pp. 72-94.

Bolton, R.N. and Drew, J.H. (1991), "A multistage model of customers' assessment of service quality and value", Journal of Consumer Research, Vol. 17, pp. 375-84.

Bolton, R.N. and Drew, J.H. (1991), "A longitudinal analysis of the impact of service changes on customer attitudes", Journal of Marketing, Vol.55, pp. 1-9.

Bauer, Falk, Hammerschmidt (2006) proposed eTransQual (including five quality aspects, namely functionality/ design, enjoyment, process, reliability, and responsiveness) to measure the quality of online shopping service

Boulding, W., Kalra, A., Staelin, R. and Zeithaml, V.A. (1993), "A dynamic process model of service quality: from expectations to behavioral intentions", Journal of Marketing research. Vol. 30, pp.7-27.

Buttle, F. (1996), "SERVQUAL: review, critique, research agenda", *European Journal of Marketing*, Vol. 30 No. 1, pp. 8-32.

Cresswell, J. (1994), *Research Design*: *Quantitative and Qualitative Approaches,* Sage, London.

Crawford, D. "CEOs Unite to Influence U.S. Technology Policy." *Communications of the ACM* 34, no. 6 (1991): 15-18. "Customer Care Special," supplements to *Telephony* (Nov. 6, 1995).

Cronbach, L.J. (1951). Coefficient Alpha and the Internal Structure of Test. Psychometrica, 16,297-300.

Cronion, J.J. and Taylor, S.A. (1992), "Measuring service quality: reexamination and extension", The TQM Magazine, Vol. 14 No.4, pp.207-16.

Cronin, J.J., Brady, M.K., Brand, R.R., Hightower, R. and Shemwell, D.J. (1997), "A cross-sectional test of the effect and conceptualization of service value", *The Journal of Services Marketing*, Vol.11 No. 6, pp.375-91.

Collier, *The Service/Quality Solution*, 170, citing R. C. Lewis and B. H. Booms, "The Marketing Aspects of Service Quality," in *Energy Perspectives on Service Marketing*, ed. L. L.

Cronion, J.J., Brady, M.K. and Hult, T.M. (2000), "Assessing the effects of quality, value, and customer satisfaction on customer behavioral intentions in service environments", *Journal of Retailing*, Vol, 76 No. 2, pp.193-218.

De Brentani, U, (1989). “Success and failure in new industrial services.”

Delightful customer service, Richard J. Georage, John L. Stanton.

David A. Garvin, “Competing on the Eight Dimensions of Quality,” *Harvard Business Review* 87, no. 6 (1987): 101-109.

Economic Survey of Pakistan, 2005-2006, retrieved January, 10, 2006 from http://www.finance.gov.pk/survey/home.htm

Edvardsson, B. (1997). “Quality in new service development. Key concepts and frame of reference.” International Journal of Production Economics 52 (1-2):31-46.

Edvardsson, B., A. Gustafsson, *et. al.* (2000). New service development and innovation in the new economy. Lund, Studentitteratur.

Edvardsson, B., Johnson, Michael D., Gustafsson, Anders (2000). “The effects of satisfaction and loyalty on profits and growth. Products versus services.” Total Quality Management 11(7): S 918-11.

Gabbot Mark, H.G. (2000), “An empirical investigation European Journal of Marketing 34(3): 384-398.

Gronroos, C. (1984), “A service quality model and its marketing implication”, *European Journal of Marketing,* Vol. 18 No. 4, pp.36-45.

Gronroos, C. (1990), Service Management and Marketing. Lexington, MA, Lexington Books.

Gronroos, C. (1998). “Marketing services the case of a missing product.”

Gupta, G. and Jain, K.S. (2004). Measuring Service Quality: SERVQUAL vs. Servperf Scales. The Journal for decision makers, 29 (2): 25-37.

Hair, J.F., Jr.l Anderson, R.E.; Tatham, R.L.; & Black, W.C. (1998). *Multivariate data analysis with readings, 5th ed.* Englewood Cliffs, NJ: Prentice-Hall.

Heskett, J.L., Jones, T.O., Loveman, G.W., Sasser, W.E. and Schlesinger, L.A. (1994), “Putting the service-profit chain to work”, *Harvard Business Review*, Vol. 72 No.2, pp.164-74.

IMECS 2009, March 18-20, 2009, Hong Kong.

www.ptcl.com.pk

John S. Richters and Charles A. Dvorak, “A Framework for Defining the Quality of Communications Services,” *IEEE Communications Magazine* (October 1988): 19-23; Eli Noam, testimony to the New York Public Service Commission, Case 28961, Fifth Stage. Undated Xerox.

Jain, S.K. and Gupta, G. (2004), "Measuring service quality: SERVQUAL vs SERVPERF scales", *Vikalpa: The Journal for Decision Makers*, Vol. 29 No.2, pp. 25-37.

Jen. W. and Hu, K-C. (2003), "Application of perceived value model to identify factors affecting passengers' repurchase intentions on city bus: a case of the Taipei metropolitan area", *Transportation,* Vol. 30 No. 3, pp. 307-27.

Kan, S. (1995). Metrics and Modeis in software Quality Engineering. Boston, MA, Addison-Wesley.

Kano, N., N. Seraku, *et. al.* (1996). "Must-be quality and attractive quality." The Best on Quality 7:165.

Karuppusami, G. and Gandhinathan, R. (2006) Pareto analysis of critical success factors of total quality management- A literature review and analysis, *The TQM Magazine,* Vol. 18 No. 4, pp. 372-85.

Kaynak, H. (2003), "The relationship between total quality management practices and their effects on firm performance", *Journal of Operations Management,* Vol. 21, pp.405-35. (This Journal does not have numbers).

Kelly, S.W., S.J. Skinner, *et. al.* (1982). "Organizational socialization of service customers." Journal of Business Research 25: 197-214.

Khan, J.H. (2003), "TQM implementation in Pakistan: revolutionary vs. evolutionary approach", *Proceedings Pakistan's Sixth International Convention on Quality Improvement, Lahore.*

Khurshid, A. (1969). Standards for Library Education in Burma, Ceylon, India and Pakistan, PhD dissertation, University of Pittsburgh, Pittsburgh.

Kline, Rex B. (1998). *Principles and practice of structural equation modeling*. NY: Guilford Press. Covers confirmatory factor analysis using SEM techniques. See esp. Ch. 7.

Kristensen, K., Martensen, A. and Gronholdt, L., (1999). Measuring the Impact of Buying Behaviour on Customer Satisfaction. Total Quality Management, 10. 602-614.

Kumar, R. (1996), *Research Methodology*- A Step by Step Guide for Beginners, Sage, London.

Kvist, A. K. J., & Klefsjo, B. (2006). Which service quality dimensions are important in inbound tourism? Managing Service Quality, 16(5), 520-537.

Landrum & Prybutok , 2004; pitt. Watson, & kavan, 1997; Van dyke, Kappelman, & Prybutok, 1997), and ziethaml , Parasuraman, and malhotra (2002)

Lepik, A., & Liivamagi, T. (2003). Past decade-transforming measures and values in Estonian library practice.

Madu, CN. (1998). An empirical assessment of quality: research consideration. International Journal of Quality Science, 3(4), 384-55.

Mahmood, K. 2005. “Multipurpose Community Telecenters for Rural Development in Pakistan.” *The Electronic Library* 33 (2005):204–220.

Mathe, H. and R.D. Shapiro (1993). Integrating Service Strategy in the Manufacturing Company. London, Champan & Hall.

Murphy, K., & Balzer, W. (1989). Rate Error and Rating Accuracy. Journal of Applied Psychology, 71(4), 619-24.

Nunnally,J.C. (1978). Psychometric theory. New York: Mc Graw Hill Book Company.

Orr, R.H. (1973), “Measuring the goodness of library services: a general framework for considering quantitative measures”, Journal of Documentation, Vol. 29 No. 3, pp. 315-32.

Parasuraman, A., Zeithaml, V.A. and Berry, L. L. (1985). A conceptual Model of Service Quality and Its Implications for Future Research, Journal of Marketing, 49, 41-50.

Parasuraman, A., Zeithaml, V.A. AND Berry, L. L. (1988). SERVQUAL: A Multiple Item Scale for Measuring Consumer Perceptions of Service Quality. Journal of Retailing, 64, 12-40.

Parasuraman, and L. L. Berry, *Delivering Quality Service* (New York: The Free Press, 1990), 24-26; and L. L. Berry and A. Parasuraman, *Marketing Services* (New York: The Free Press, 1991).

Parasuraman, A. and Grewal, D. (2000), “The impact of technology on the quality-value-loyalty chain: a research agenda,” *Journal of the Academy of Marketing Science*, Vol. 28 No.1, pp.168-74.

Petrick, J.F. (2002), “Development of a multi-dimensional scale for measuring the perceived value of a service”, Journal of Leisure Research, Vol. 34 No. 2, PP. 199-34.

Rabin, Jonatthan (1983), “Battleground of the eye,” The Article Monthly, Seattle Center, Seattle, Contemporary seattle art of the 1980’s.

Rajan, N.V. and Ravi, B. (2001), “Total quality in libraries: the reality”, in Dhawan, S.M. (Ed.), *Quest for Quality*, Indian Library Association, New Delhi, pp. 49-154.

Raubenheimer, J. E. (2004). An item selection procedure to maximize scale reliability and validity. *South African Journal of Industrial Psychology*, 30 (4), 59-64.

Robson, W. (1994), Strategic Management and Information Systems, Pitman publishing, London.

Richters, John S. and Charles A. Dvorak. "A Framework for Defining the Quality ofCommunications Services. *IEEE Communications Magazine* (October 1988): 19-23

Saunders, M.N.K., Lewis, P. and Thornhil, A. (2000), *Research Methods for Business Students*, Prentice Hall, London.

Schneider, B., & White, S. S. (2004). Service quality – Research perspectives. London: Sage.

Seay, Thomas, Seaman and Cohen (1996), ``Measuring and improving the quality of public services: a hybrid approach", Library Trends, Vol. 44 No. 3, Winter, pp. 464-90.

Sharma, J.C. (2001), "Total quality management in library and information services", in Dhawan, S.M. (Ed.), *Quest for Quality*, Indian Library Association, New Delhi, pp.166-71.

Sila, I. and Ebrahimpour, M. (2002), "An investigation of the total quality management based research published between 1989 and 2000- A literature review", International Journal of Quality & Reliability Management, Vol. 19 No.7, pp. 902-70.

Sila, I. and Embrahimpour, M. (2003) Examination and comparison of the critical factors of total quality management (TQM) across countries, *International Journal of Production Research*, Vol. 41 No. 2, pp. 235-68.

Sirohi, N., McLaughlin, E.W. and Wittink, D.R. (1998), "A model of consumer perceptions and store loyalty intentions for a supermarket retailer", *Journal of Retailing*, Vol. 74 No. 2, pp.223-45.

Su, C.T., Lin, C.T., Lin, C.S. and Chiang, T.L. (2008), "Systematic improvement in service quality through TRIZ methodology: an exploratory study", *Total Quality Management & Business Excellence*, Vol. 19 No. 3, pp. 223-43.

Sweeney, J.C., Soutar, G.N. and Johnson, L.W. (1999), "The role of perceived risk in the quality-value relationship: a study in a retail environment", *Journal of Retailing*, Vol.75 No, 1, pp. 77-105.

Thapisa, A.P.N. and Gamini, V. (1999), "Perceptions of quality service at the university of Botswana library: what nova says", *Library Management*, Vol.20 No. 7, pp.373-383.

Malcolm Baldrige Quality criteria for performance Excellence (MBNQA, 2007),

Thompson, B., Cook, C. and Heath, F.M. (2003), "Two short forms of the LibQUAL+ survey: assessing users' perceptions of library service quality", *Library Quarterly*, Vol. 73 No. 4. pp.453-65.

Venetis, K. A., & Ghauri, P. N. (2004). Service quality and customer retention: Building longterm relationships. European Journal of Marketing, 38(11/12), 1577-1598.

Woodruff, R.B. (1997), "Customer value: the next source for competitive advantage", *Journal of the Academy of Marketing Science*, Vol. 25 No. 2, pp. 139-53.

Zeithaml, V.A. (1988), "Consumer perceptions of price, quality and value: a means-end model and synthesis of evidence", Journal of Marketing, Vol. 52 No. 3 pp.2-22.

Zeithaml, V.A., Parasuraman, A., & Malhotra, A. (2002). Service quality delivery through Web sites: A critical review of extant knowledge. *Journal of the Academy of Marketing Science*, 30,362-375.

Zeithaml, V.A., & Parasuraman, A. (2004), Service quality. Cambridge, A: Marketing Science Institute.

Zeithaml, V. A., A. Parasuraman and L. L. Berry. *Delivering Quality Service.* New York: The Free Press, 1990.

ANALYZING THE IMPACT OF IMPLEMENTING VALUE STREAM MAPPING (VSM) IN MANUFACTURING PROCESSES

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Abstract: The term value stream mapping, a lean manufacturing technique, involves flowcharting the various steps, process, activities, materials flow, communications that are involved to convert the product from raw material to the arm of the customer. Value stream mapping help to identify waste, value added and non-value added activities produce in manufacturing process and also categories these waste. A case study was carried out to identify value added and non-value added activities in manufacturing processes, and shows the importance of VSM in Auto Industry; Current State of the rubber mixing material has been developed by using VSM symbols. The time study was conduct for the analysis of various types of wastes and identification of bottleneck during manufacturing process. The wastes identified during the current state VSM were transportation, defect and inventory. Value stream mapping has shown to be a useful technique to reduce delivery time, improved production rate and reduce production cost. A future state value stream map was finally developed without waste (non-value added) activities showed improved productions rate and quality. Further research may also be carried out to construct the Ideal State Value Stream Map for the further improvement in manufacturing process.
Keywords: value stream mapping, waste reduction, Transportation, Inventory

1. INTRODUCTION

Identifying non-value added activities (wastes) for smooth flow of production has been one the basic and most important issue in both production and service sectors/ industries. For decades, enhancing productivity and improving quality have been considered as the important and challenging aspects in the organizational efficiency and effectiveness. Both developed and developing countries are facing such problems, especially developed countries are more prone to these challenges due to expensive labor cost, pay for absenteeism which creates burden on their economies. This is the reason; developed countries are shifting their companies to developing countries commonly termed as outsourcing. On the contrary, developing countries are facing more problems pertinent to lack of resources, skilled labor, environmental issues and wastes, which negatively affect the productivity and quality. Nevertheless, different manufacturing philosophies and technologies (for example, lean manufacturing, Flexible manufacturing, etc.) have been introduced to enhance the productivity and quality eventually affects in improving organizational efficiency and effectiveness.

This research therefore, focuses on one of the tool of lean manufacturing, Value stream mapping that aims to identify the wastes in terms of value added and non-value added activities using a map that involves different processes. Following section therefore, discusses in detail about the concept of value stream mapping, its application and problems in order to develop the research question.

2. VALUE STREAM MAP AND ITS IMPACTS ON PRODUCTIVITY IMPROVEMENT

The value stream is visual lean principle for modelling and improving manufacturing processes. Value Stream Mapping has played a key role in success of Toyota, Japan 1980’s. More specifically, VSM has been considered as the systematic and functional tool that highlights the non-value added actions that hurdle the manufacturing processes.

Rother and Shook (2003) describes VSM as a continuous method for mapping and evaluating activities that do not add value. Lasa et al., (2008), further clarifies the aims of VSM by mentioning that the purpose of VSM is quantifying and communicating production process elements involving material and information flows along with non-value adding activities. VSM helps to analyze and evaluate work processes in a manufacturing operation. VSM is primarily used to identify, reveal and reduce waste, as well as creates flow and improve the manufacturing processes (Wilson, 2010).

Value stream mapping is also considered as the typical type of lean manufacturing that consists of symbols called “language of lean”, which are used to manage the flow of inventory, information and analysis how that flow can be improved by using lean principles. Value Stream Mapping (VSM) is a method to visually display the flow of materials and information that is required to complete the final product through different production processes. The objective of VSM is to identify and improve value-addition through eliminating non-value adding activities. VSM serves as first step towards execution of Lean programs ensuing success.

The Analysis and visual representation of a value stream from receiving raw material to the final packaging of goods to the customer according to their requirements. Value stream maps use symbols, charts and describing the flow of materials and information within a facility (Womack, 2006).

3. DESIGN OF RESEARCH WORK

Value stream mapping consist of symbols (as shown in figure 1) that are used to develop the map in order to depict the flow of inventory and information aiming to identify and reduce the waste and optimize the processing flow.

Customer / supplier icon	It shows the customer supplier icon	**Electronic info icon**	This symbol shows the electronics flow
Shipment icon	it represents transportation of raw material	**Manual information icon**	This symbol shows the general flow of information
process **Process flow icon**	It represents a process, operation of machine or department through	**Arrow icon**	It shows the of material from one process to another process
N/W:0 N/W:0 **Data box icon**	It Shows the significant information/data.	**Push arrow icon**	It represents the pushing of material from one destination to another
Time line icon	Shows the value added and non-value added time.	**Inventory icon**	Show the inventory during the process.
Go see icon	To collect the information through visual means.	**Safety stock icon**	Represents the safety stock.
Operator icon	shows the number of operators required to perform the process.	0 X 0 X **Load leveling**	It represents the load levelling during the process.

Figure 1. shows the typical symbols used in value stream mapping

The design and development of VSM require three types of VSMs, which include present state value stream mapping (PSVSM), Future state value stream mapping (FSVSM) and Ideal state value stream mapping (ISVSM). Each successive value stream mapping requires different processes of evaluation and analysis therefore, consists of following five steps.

- Identify the product in manufacturing process
- Create a current VSM
- Evaluate the current map and identify problem areas
- Draw a future state VSM

To identifying the products is the first step to make the value stream map, consists of selecting the product on which VSM will focus. After that, a current process state is drawn. The team collects data of the processes and steps involved. For each step, considerations could involve cycle time, TAKT time, work in progress (WIP), set up time, down time, unnecessary motion, number of defects, number of workers, and scrap rate. All the collected information is gathered and presented on a map and analysis is performed. VSM shows the value addition in the processes and recognize non value added activities. After analysis and evaluation of the current state of producing the product, the problem areas can be identified and the current process can be altered to minimize problematic areas completely, thus a final state VSM can be created.

The implementation of value stream mapping process is the last step. Figure 2 shows the structure of Value stream mapping that is created after detailed evaluation and analysis involved in a particular production system.

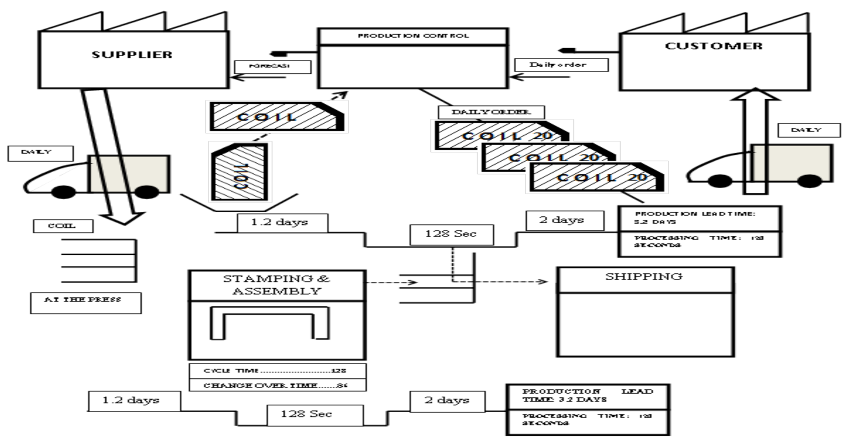

Figure 2. shows structure of value stream mapping

4. RESEARCH OBJECTIVES

Following are the objective of this research

1) To identify and highlight the value added and non-value added activities in a particular manufacturing process.
2) To develop the Current State Map
3) Evaluate the current state map for the development of Future State Map
   Analyze the effectiveness on Future state map and comparison between current state and future state map.

5. METHODOLOGY

Selection of Critical Shop floor

↓

Preparation of current state map
- Observing the main processes (Gamba walk)
- Obtain data of various production process activities
- Conduct Time studies & Map the data

↓

Analysis of current state Map

↓

Identify non-value added activities

↓

Development of Future state map
- Analysis of TAKT time of activities
- Identification and Calculation of wastages.
- Apply value stream strategy to develop future state map.

6. DATA COLLECTION AND ANALYSIS

6.1 Value Added Activity

Those activities that transform the raw material into finish or exact product according to the requirement of the customer, for which the customer would be happy to pay for and that full fill the demands of end user.

6.2 Non-Value Added Activity

Activities that do not involves directly to satisfying the requirement of the customers, that consumes resources but do not add value to the end product.

6.3 Non-Value Added but necessary

Necessary under present operating system and that will take time to eliminate, that don’t add value to the customer point of view.

Table 1. list of wastes

Waste	Anything that do not add value to the product but add cost is called waste.
Over production	Unnecessary, producing too much without requirement pushing rather than pulling, over dissemination producing more than required quantity.

Transportation	Unnecessary movement of material between workstations picking up and setting down items.
Waiting	Waiting for material or operator, spent idle time for next activity/process
Processing	Doing more processing work than required, unintentionally serial effort, unnecessary data conversions, excessive processing steps on same work piece.
Inventory	Unnecessarily high level of Work in process (WIP) materials, too much raw materials, store more than customer requirement that leads higher storage cost.
Unnecessary Movement	Physical movement Frome one place to another place, difficult physical movements due to poorly designed ergonomics that effect the performance of work.
Defect	Physical defects, Scrap/rework which directly add to the costs of goods sold.

6.4 Current state value stream map

The current value stream map shows the data about what is currently going on and how much time consuming in current production process, identifies the types of waste and non-value-added activities are performed during current process, current value stream map is flowcharting and pictorial representation of current data that presents with value stream map specific symbols. Current state map draws the entire process for identifying the non-value added activates, calculates the non-value added time, categories the various types of waste. It also identifies those areas which can be improved. In current state map the supplier(s) are placed in the left side and the customers to the right side, cycle time of each activities and number of workers are shows by data box after construct the current state map and data collection the next step is to generation of future state map.

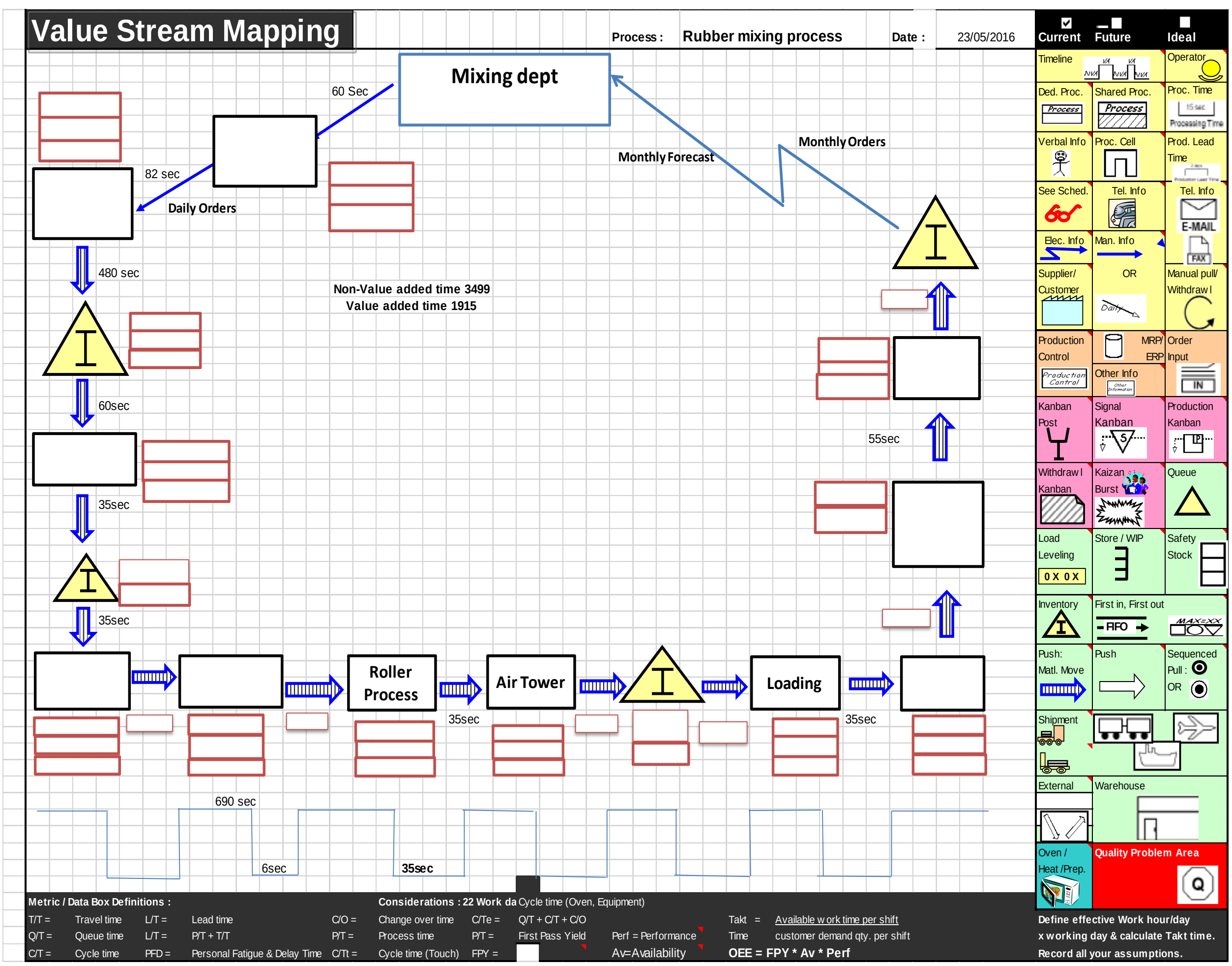

Figure 3. Current Value Stream of Rubber Mixing Process.

6.5 future state value stream map

The future state map is visionary map constructed for proposed recommendations and suggestions for Ideal value steam map the aim of future state map is to continuo improvement we reduce non value added time, work in process inventory and cut down the number of worker and reduce the transportation cost during the process in future state map we suggest to create the supermarket concept to provide required product on time and to use work cell, FIFO etc. In future value stream map some other activities should be eliminated that which are not adding value to the product.

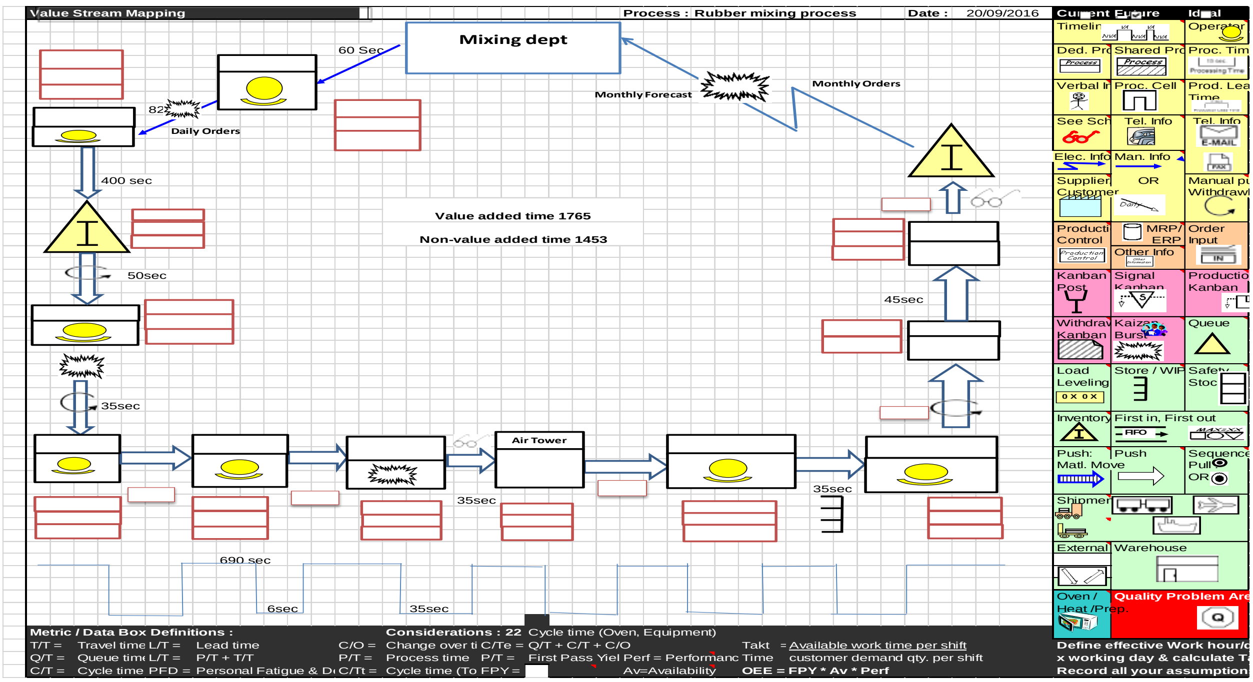

Figure 4. Future State of Value Stream Map

7. Result and Discussion

Now a day every manufacturing industry's aims to eliminate waste in their production process, maximize its productivity profit, reduce labor, minimize non-value added time and rework etc. The requirement of all these aims/goals are to investment huge amount of resources/capital and use the proper tool, to get these done by useful tool of lean manufacturing, value stream mapping in actual production scenario.

The result is presented in form of comparison between various process parameters for current value state map (CVSM) future value state map (FVSM).

Table 2. list of results

Parameters	In Current State Value Stream map per day		In Future State Value Stream map per day		Improvement	
	Sec	Min	Sec	min	Sec	Min
Value-Added Time	1915	32	1765	29	150	25

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Non value-added Time	3499	58.5	1453	24	2046	34
Workers	16		13		03	
Transportation Time	979	16.5	813	13.5	166	03
Work In Process inventory Time.	2520	42	540	9	1980	33

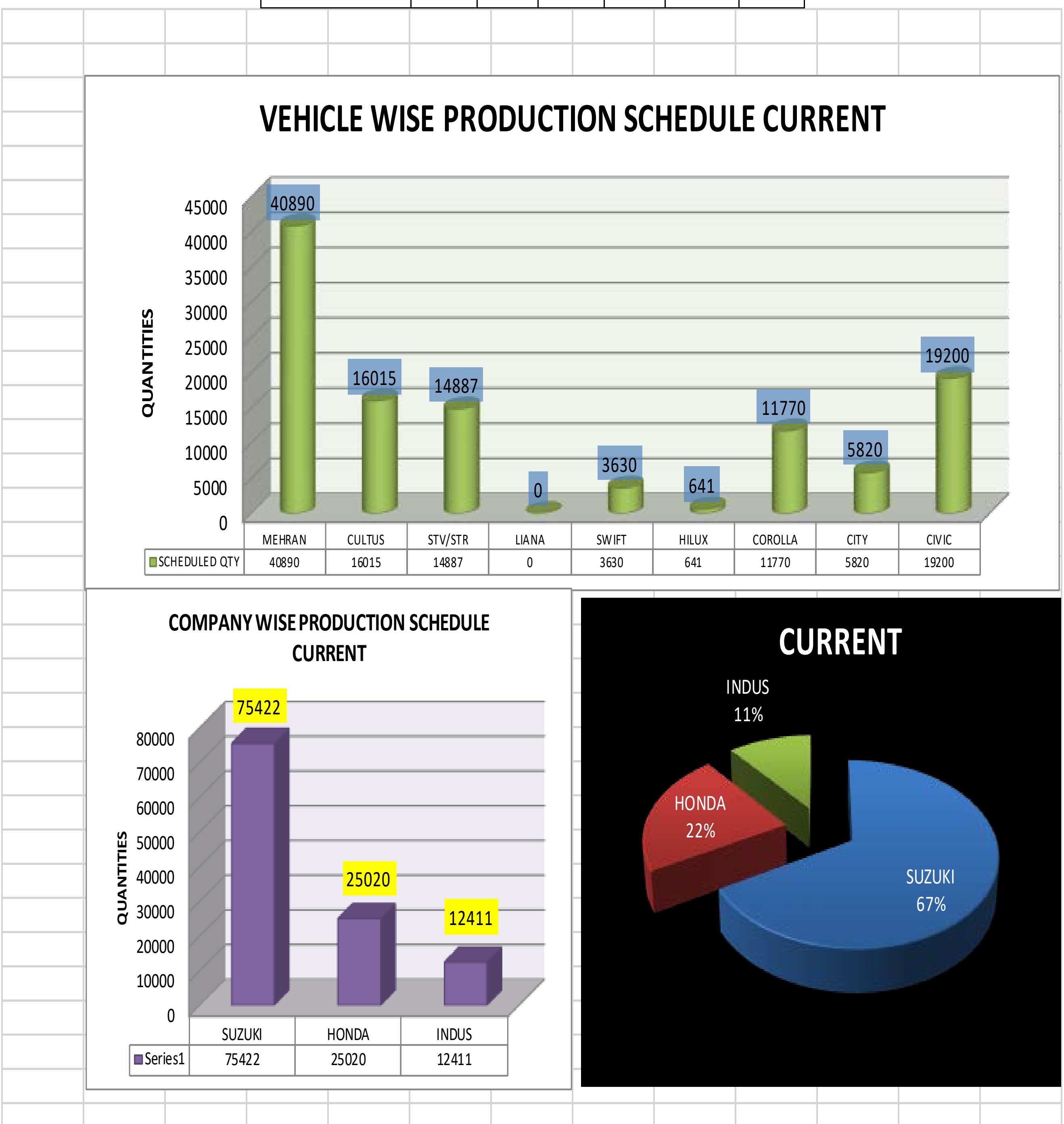
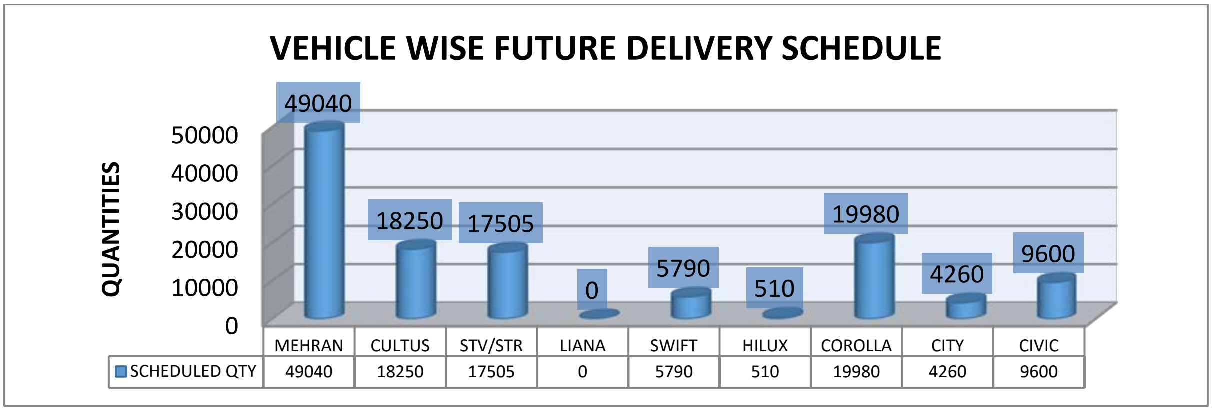
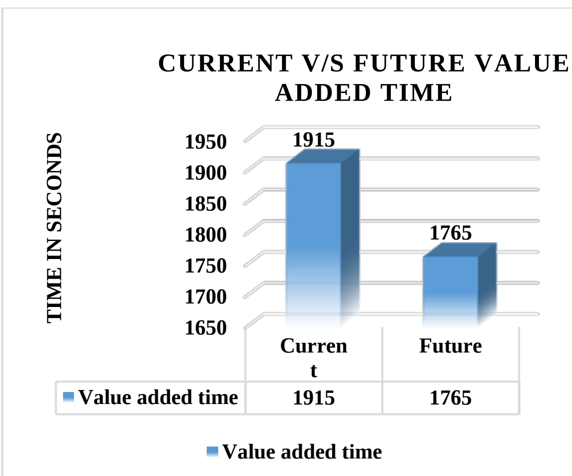


Figure 5. Current state production Schedule.



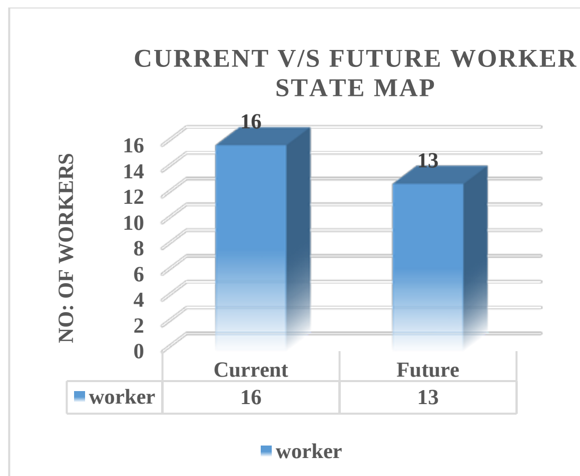
	MEHRAN	CULTUS	STV/STR	LIANA	SWIFT	HILUX	COROLLA	CITY	CIVIC
SCHEDULED QTY	49040	18250	17505	0	5790	510	19980	4260	9600

Figure 6. Future state production Schedule.



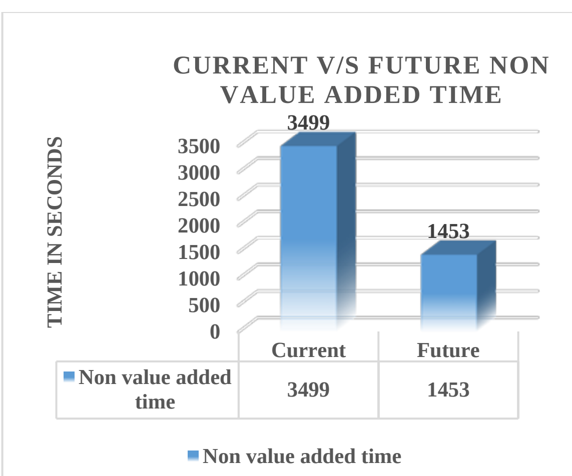
	Curren t	Future
Value added time	1915	1765

Figure 7. Value added time



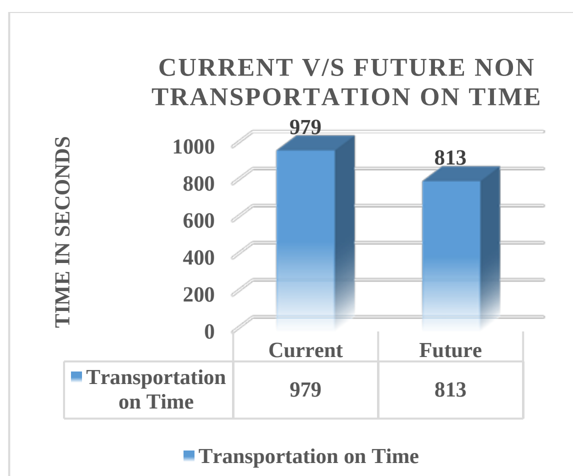
	Current	Future
worker	16	13

Figure 9. No. of workers



	Current	Future
Non value added time	3499	1453

Figure 8. Non-value added time



	Current	Future
Transportation on Time	979	813

Figure 10. Transportation time

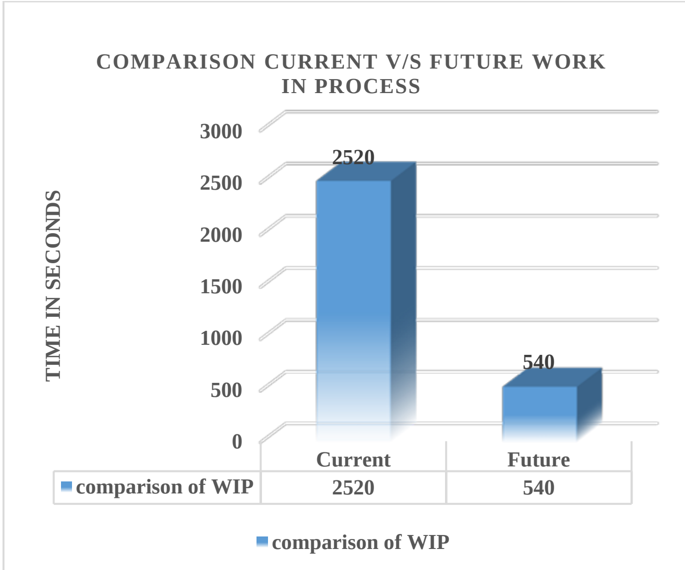


Figure 11. Work in process inventory time

8. Conclusion and Recommendation

The case study has been used to show the importance of VSM in Auto Industry, Current State of the rubber mixing material has been developed by using VSM symbols, the time study was conduct for the analysis of various types of waste and identification of bottleneck during manufacturing process the major waste is transportation, defect and inventory. Value stream mapping is proved as a useful technique to reduce delivery time, improved production rate and reduce production cost future state value stream map is created without waste activities with improved productions rate and quality.

Further Research can be carried out to construct the Ideal State Value Stream Map for the Further improvement in manufacturing process.

9. References

1. Abuthakeer, P.V. Mohanram, G. Mohan Kumar (2010) "*Activity Based Costing Value Stream Mapping*" International Journal of LeanThinking Volume 1, Issue 2, pp 52-64

2. Dimple Khatri, Pardeep Dhull, Rajender Kumar, Vinod Dhull (2011), "*Reduce the Work In Progress by using Value Stream Mapping*

3. D. Rajenthira Kumar, P.V. Mohanram, S.G. Harikarthik (2011) "*Process Cycle Efficiency Improvement Through Lean: A Case*

4. Gapp, R., Fisher, R., & Kobayashi, K. (2008). Implementing 5S within a Japanese context: an integrated management system. Management Decision, 46(4), pp. 565-579.

5. Jones, D. T., & Womack, J. P. (2002). Seeing the whole. Brookline, MA: Lean Enterprise Institute. Lean Enterprise Institute. (2008). Principles a/lean. Retrieved from

6. Lixia Chen, Bo Meng [2010] "*The Application of Value Stream Mapping Based Lean Production System*" International Journal of Business and Management Vol. 5, No. 6, pp 203-209

7. Marr, K. (2009). Toyota passes general motors' as ·world's largest carmaker. Retrieved from http://www.washingtonpost.com/wp

8. Nash, M. A. , & Poling, S. R. (2008). Mapping the total value stream: The complete guide to production and transactional mapping. New York, N.Y.: Productivity Press.

9. Nicholas, J., & A vi, S. (2006). The portal to lean producNon: principles and practices for doing more with less. Boca Raton, FL: Taylor & Francis.

10. Ramesh, K.V. Sreenivasa Prasad, T.R. Srinivas (2008) "Implementation *of a Lean Model for Carrying out Value Stream*

11. *Mapping in a Manufacturing Industry*" Journal of Industrial and Systems Engineering Vol. 2, No. 3, pp 180-196

12. V. Ramesh1, K.V. Sreenivasa Prasad, T.R. Srinivas (2010) "*Implementation of a Lean Model for Carrying out Value Stream*

13. Stephen L. Woehrle, Louay Abou-Shady ([2010) "*Using Dynamic Value Stream Mapping and Lean Accounting Box Scores to Support Lean Implementation*". pp 834-842

14. S. P. Vendan , K. Sakthidhasan (2010) "*Reduction of Wastages in Motor Manufacturing Industry*" Jordan Journal of Mechanical andIndustrial Engineering Volume 4, Number 5, pp 579-590

15. Y O. Ram Mohan Rao, Dr. K Venkata Subbaiah, Dr. K Narayana Rao,T Srinivasa Rao (2011), "*Enhancing Productivity of hot metal in Blastfurnace -A case study in an Integrated Steel Plant*".International Journal of Engineering Science and Technology (IJEST).

Efficiency Enhancement of Solar Photovoltaic through Parabolic Dish Concentrator

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Abstract: The electricity is one of the significant driver for the development of any country. In different countries electricity is generated through different resources, but solar energy is one of the most important resource by which electricity is generated. It is quite cheap and free from environment pollutions. The solar energy is converted into electricity by photovoltaic panels. In this research the parabolic dish concentrator with sun tracking mechanism is used to increase the efficiency of photovoltaic solar panel. The output results of photovoltaic penal are analyzed with three different hardware setups to compare the efficiencies. The efficiencies of the respective static solar penal has the efficiency of 12.45%, sun tracking solar penal has 23.60% and the parabolic prototype has 31.12%. The efficiency of the prototype is 17.67% is greater than the static solar penal and 7.52% greater than the sun tracking solar panels.

1. INTRODUCTION

In present days energy has become a key driver for development of the world. In most of the countries electricity is generated by using fossil fuels and Pakistan also seems on the same track for electricity generation. The increased use of fossil fuels has aided in depletion of natural resources and raised prices which results into environmental threats and energy crises respectively.

Many research studies have been conducted to know the other sources of electricity generation so that environmental threats and energy crises are avoided and increased demand of electricity can be met effectively and economically which may be helpful in solving problems. In this connection, after extensive research, the solar power generation system has emerged as the best option to produce electricity less expensively and more environments friendly [1].Solar energy is the world's biggest energy source which is available in most part of the populated earth. Out of total output energy of sun which is 3.8×10^{20}MW, only 1.7×10^{11}MW energy reaches to earth[1-2].

There are various solar technologies in which solar radiations can be converted into useful energy. In solar photovoltaic technology the solar panels are used for the conversion of sunlight into electricity. Solar photovoltaic technology is utilized by non concentrated and concentrated photovoltaic systems. In non concentrated photovoltaic system, the solar radiations are coming directly on the solar penal while in concentrated system the solar radiations which are reflected on the focus point and that focus point the solar penal is located[3]. One of the problem in the in non concentrated solar power generation is that it has low efficiency [2][4].The experimental study was done by previous researchers for increasing the efficiency of the solar power generation systems. Michael[4] Enhance the efficiency of mini parabolic dish solar system in the addition of the propane/natural gas and storage batteries allows for 24- hour operation. Fareed. M. Mohamed [5] designed & fabricated parabolic concentrator according to theoretical data, used for medium temperature to achieve the water heating & solar steam applications. The operational system efficiency is 30% at mid noon time. In this research, the single axis tracking mechanism is done in which light dependent resistors (LDR) are used as a sensing device for to sense the location of sun and the dc gear motor is used for the rotation of the parabolic dish. Therefore the parabolic dish with sun tracking is designed to solve this problem. As the combination of sun tracking mechanism and parabolic dish with solar penal can produce power in the maximum efficiency. In various solar technologies solar radiations can be converted into useful energy, in order to get maximum power efficiency of solar cell, the sun has to be monitored from time to time when it appears and it is called sun tracking systems, the photosensitivity sensors as device were used almost all of them[7][8]. The main objective of this research is to increase the efficiency of solar photovoltaic by using the parabolic dish concentrator with the implementation of sun tracking mechanism.

2. HARDWARE DEVELOPMENT

There are different ways for increasing the efficiency of solar power generation systems, here the parabolic dish and sun tracking mechanism is used for the increase the power efficiency of the solar system. Following fig.1 shows the flow chart of the proposed research design.

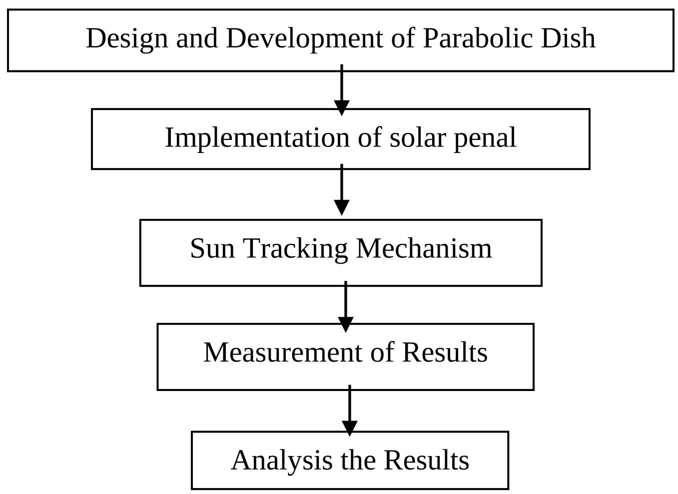

Fig. 1 Research Methodology.

Solar photovoltaic penal and parabolic dish are integrated into the charge controller circuit and the battery is charged through this controller which is turn, operate as a power supply for the controller circuit. The arrangement of the parameters of the prototype are shown in fig.2

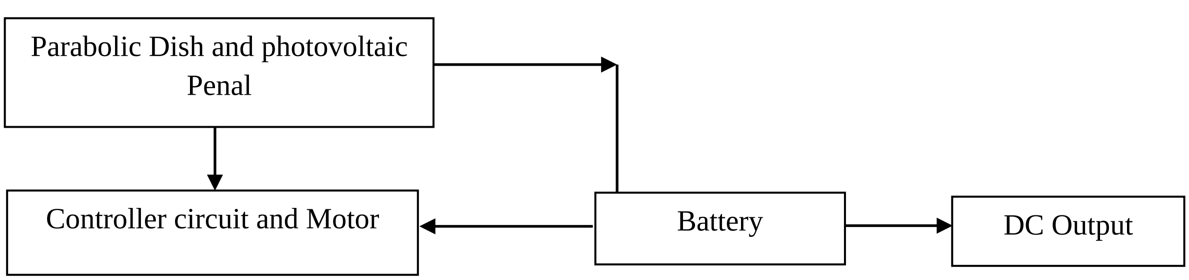

Fig. 2 System flow diagram.

Sun tracking mechanism is done in this project. Asthe LDRs gives signal to the arduino board and output of the arduino board is supplied to H-Bridge for to control the direction of dc motor, and dc motor is coupled with the frame of parabolic dish.

1.1 Design and Development of Parabolic dish

In solar concentrated technology the solar light is concentrated on the focal point by using different types of concentrators such as parabolic trough, central receiver tower, frensel lenses and parabolic dishes .The parabolic dish is constructed with galvanized steel sheet. The easiest way is to cut into sections joined to form a parabolic dish. Then a layer of glass fire is covered on its inner surface for reflectivity. In this research the parabolic calculator is used for the design and development of the parabolic dish, as the diameter (D) of dish is 4fts and depth (d) is 1 ft, then its focal length will be 1 ft.

$$F = D^2/16d = 1 \qquad \textbf{(1)}$$

Parabolic calculator version 2.0 is used to calculate the parameters of parabolic dish.The edge of parabolic dish almost lied in the same plane because of the focal length and depth is equal,therefore the eight sections are developed of parabolic dish.

After the designing of the sections of the parabolic dish, then galvanized sheet of $6ft^2$ with 0.3mm thickness is purchased from the local market. The galvanized material is selected because of it is easily available, less cost and good for the environment conditions [6].This sheet cut into different sectors, there are 64 sectors are formed. The four different sectors are punched and the single sector is formed. Therefore all other sectors are formed by this procedure. Now the formed sectors are punched and the parabola dish is developed. After the design and development the interior surface of parabolic dish is covered by reflective layer.

The selection of the reflective material is very important for improve the efficiency of the solar parabolic dish. FSEC solar library done the research on the reflective material, solar industry, aluminum industry catalogs the perfect material is done that has high optical reflectance and in the verity of environment conditions is very strong [6]. For high reflectivity, easily available and bear the ultra violet radiations and economically. The pure aluminum mirror polished is chosen because of less cost, high reflection and easily available in the local market of Pakistan. Fig.3 shows the developed parabolic dish.

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Fig.3 Designed and Developed Parabolic dish

1.2 Sun Tracking Mechanism

The control of operation in the project is done by the single axis solar tracking in which LDR sensors are used to control the input of the circuit. In controller circuit thearduino board is programmed with C+ language and connected to H-Bridge. The output of the controller circuit is connected with dc gear motor. Dc gear motor is coupled to the frame of parabolic dish solar penal.Controller circuit is shown below fig. 4.

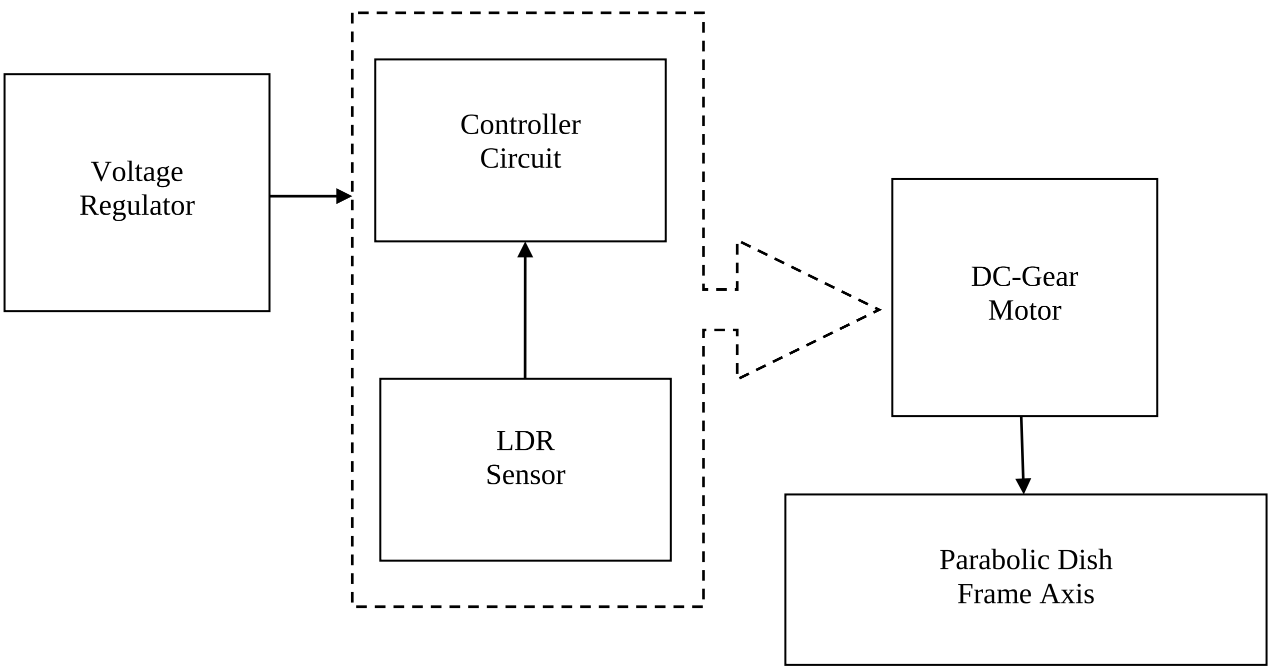

Fig. 4 Controller Circuit

Two LDR sensors are placed at the parabolic dish and wall between them is created. In case parabolic dish is not at right angle to the sun, the wall makes a shadow on any side of the light sensor. LDRs results are sent to Arduino board where the output resultsare compared with sensors threshold value.

Dc gear motor moves clockwise and anticlockwise in accordance to the direction of sun when the accumulated reading is less than the threshold value; otherwise motor will remain stationary.

The arduino UNO board was selected for the control the position of parabolic dish. This board is purchased from the local market. The arduino software was downloaded from computer. The program was done in this board by using this software. By using the USB cable arduino circuit was connected and the Arduino UNO circuit selected by clicking “Tools”. Clicking on “Upload” the program was uploaded and LED of circuit change the color when program is uploaded.

3. MEASUREMENT OF RESULTS

The experiment wasperformed atGulshan-e-Maymar Karachi city as shown in following map fig. 5on 17 January 2017. The prototype is placed at the roof of the house its front part is perpendicular to sun’s position. As the output voltage and current of the system can be measured.

Fig. 5 Map Location of Gulshan-e-Maymar Karachi.

The variables used for the analysis of the system are the static photovoltaic, sun tracking photovoltaic and the prototype itself. Voltage (V) and current (A) output of each setups were measured from 9:00AM to 4:00PM at every 10 minutes, the total 42 samples was yielded. The power output is calculated from the given data. The summary of the measurement is shown in following table 1.

Table 1. Hourly measurement of the hardware setups

Time	Static Solar Photovoltaic Penal			Sun Tracking Solar photovoltaic Penal			Prototype		
Time (hour)	Open Circuit Voltage (Volts)	Short Circuit Current (Amp)	Power Output (Watt)	Open Circuit Voltage (Volts)	Short Circuit Current (Amp)	Power Output (Watt)	Open Circuit Voltage (Volts)	Short Circuit Current (Amp)	Power Output (Watt)
9:00 AM	20.7	0.51	10.56	21.1	0.61	12.87	21.8	0.65	14.17
9:30	20.6	0.42	8.45	21.3	0.51	10.86	21.5	0.54	11.58
10:00	20.3	0.41	8.33	20.5	0.57	11.68	20.7	0.61	12.65
10:30	20.9	0.37	7.74	20.3	0.59	12.00	20.8	0.63	13.14
11:00	21.2	0.40	8.48	21.2	0.62	13.35	21.2	0.80	16.96
11:30	21.2	0.36	4.66	22.0	0.64	14.08	22.2	0.85	18.87
12:00 PM	20.9	0.22	5.60	20.9	0.43	9.00	20.9	0.55	11.50
12:30	20.9	0.31	6.50	21.2	0.58	12.30	21.3	0.68	14.50
1:00	21.3	0.43	9.16	21.5	0.44	9.46	22.0	0.55	16.50
1:30	20.8	0.36	7.50	20.8	0.49	10.20	22.0	0.75	12.10
2:00	18.6	0.33	6.14	19.7	0.81	15.96	21.4	0.85	18.20
2:30	21.1	0.32	6.75	21.7	0.52	11.28	22.3	1.02	22.75
3:00	20.0	0.20	4.00	21.2	0.87	18.44	21.5	1.40	30.10
3:30	20.3	0.33	6.70	21.0	0.75	15.75	21.7	0.95	20.62
4:00	20.1	0.27	5.43	20.7	0.45	9.32	20.9	0.55	11.50

The average voltage of static photovoltaic panel was 20.597 V and the average current is 0.345 A, produced average power was 7.066 W. The data obtained from the sun tracking photovoltaic panel mean voltage was 21.007 V and the average current was 0.592 A calculated. The average power 12.437 W was produced.

The output of prototype was calculated as average current is 0.759A, average voltage is 21.557 V and the mean power is 16.343 W which was 3.906 W greater than the sun tracking photovoltaic penal and 9.277 W high then static photovoltaic solar panel.

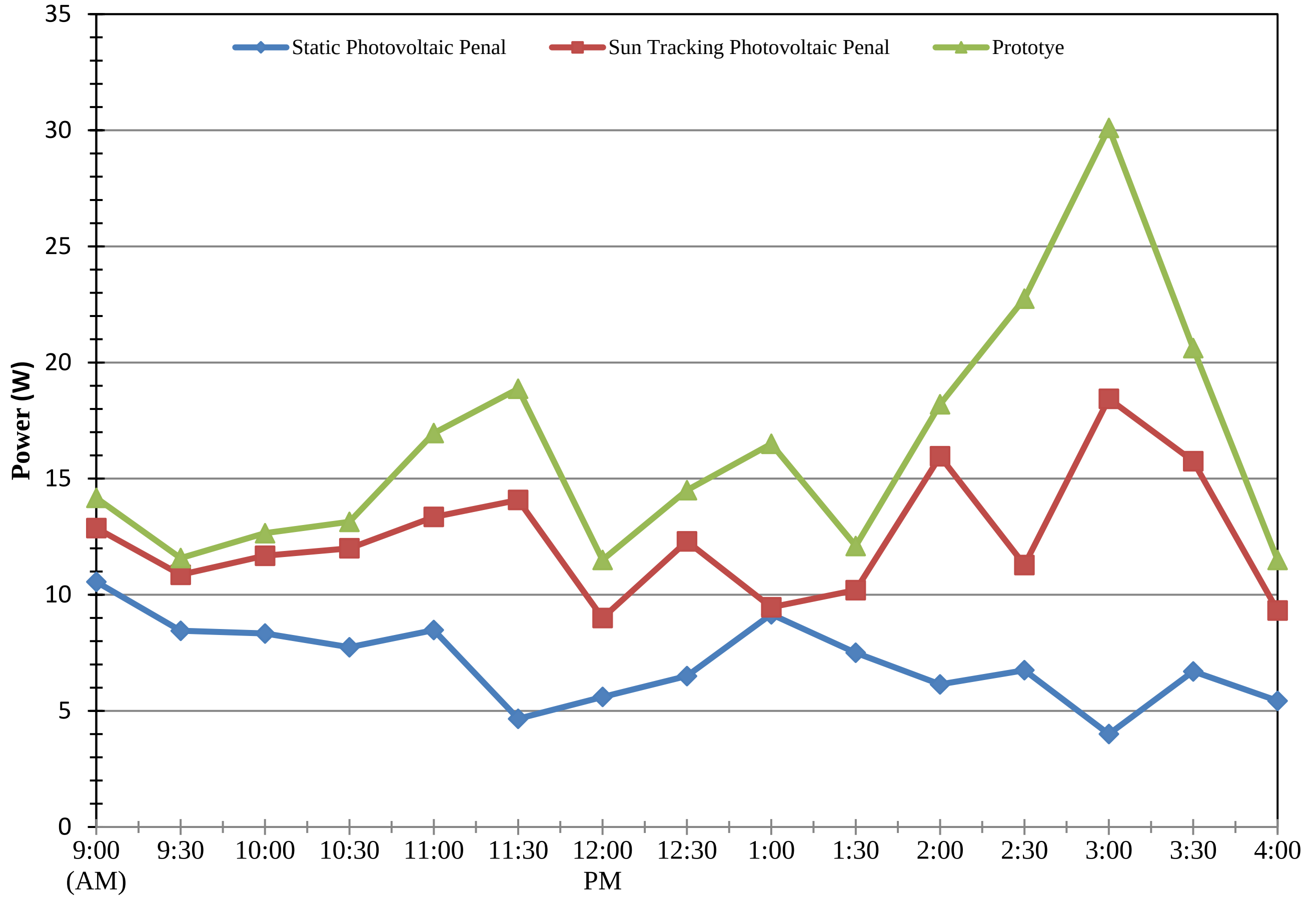

Fig. 6 Analysis of the Electric Power vs. Hour characteristics Curve.

3.1 Results Analysis

The results have been analyzed based on, solar Photovoltaic penal efficiency, percentage difference between three steps and the charging time of the battery. The results of the three setups were analyzed as under:

3.1.1 Efficiency of Photovoltaic Penal (ŋ)

The efficiency of the solar photovoltaic penal for each of the setups can be found by the formula:

Ŋ = (Power output in KW)/ (area of the solar penal) * 100% (2)

The efficiency of each setup is determined by using above formula and tabulated in the following table 2.

Table 2. Solar photovoltaic Efficiencies of three Setups.

Serial Number	Test Setup	Efficiency (%)
1	Static photovoltaic penal	13.45
2	Sun tracking photovoltaic penal	23.60
3	Prototype	31.12

In above table the efficiency of the prototype photovoltaic penal is 17.67% efficient then the static photovoltaic penal and 7.52% efficient then sun tracking photovoltaic penal.

3.1.2 <u>Percentage Difference</u>

The simple formula is used for find the percentage difference is given by

% difference = (Difference of two values)/Original value (3)

The percentage difference of each of the setups of voltage, current and power is calculated as follows

Table 3. Percent Difference

	Test setup comparison	Percentage Difference		
Serial Number		A (%)	V (%)	W (%)
1	Test setup 3 to Test setup 1	54.52	4.42	56.76
2	Test setup 3 to Test setup 2	21.96	2.52	23.90

Above table shows that the prototype is effectual. The system’s power has a percent difference of 56.76% and 23.9% against the output in the static and sun tracking solar penal, correspondingly.

3.1.2<u>Battery Charging Time</u>

The time before the projects battery is fully charged is obtained by using the formula:

$t = (5A.h)/I_{mean}*1.2$(4)

5A.h is the rated current of the battery, I_{mean} is the average current of the system, and 1.2 is the factor for loss efficiency of 20%.

By using above formula the difference charging time derived from three setups is summarized in following table VI.

Serial Number	Test Setups	Charging Time in hours
1	Static Solar Penal	12.07
2	Tracking Solar Penal	7.03
3	Prototype	5.49

Table.4 Charging Time.

The difference of charging time is computed as:

Setup 1 – Setup 3 = 12.07 – 5.49 = 6.58 hours

Setup 2 – Setup 3 = 7.03 – 5.49 = 1.54 hours

It is concluded that the battery used in the system is charged 6 hours and 34.8 minutes faster than the static photovoltaic panel's battery, and 1 hour 32.4 minutes quicker than the sun tracker photovoltaic solar panel's battery.

4. CONCLUSION

This research concluded that the design and function of the prototype is proven to be effectual. Sun tracking mechanism withparabolic dish increases the magnitude of current and power of solar photovoltaic penal. The output results of photovoltaic penal are analyzed with three different setups. As the static solar penal has the efficiency is 12.45%, sun tracking solar penal has 23.60% and the prototype has 31.12%. The efficiency of the prototype is 17.67% is greater than the static solar penal and 7.52% greater than the sun tracking solar photovoltaic panels. Meanwhile the battery used in the system is charged 6 hours and 34.8 minutes faster than the static photovoltaic panels battery, and 1 hour 32.4 minutes quicker than the sun tracker photovoltaic solar panel's battery.

5.Acknowledgement

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6. REFERENCES

[1] SafaSkouri,Salwabouadila, Sassi Ben Nasrallah. (2015). Estimating intercept factor of a solar parabolic dish with photogrammetric equipment. 6th International Renewable Energy Congress (IREC).

[2] S.M. Sajed Sadati, FassahatUllah Qureshi, Derek Baker. (2015). Energetic and economic performance analyses of photovoltaic, parabolic trough collector and wind energy systems for Multan, Pakistan. Sustainable Environment and Energy Systems (SEES), Middle East Technical University, Ankara, Turkey ,Renewable and Sustainable Energy Reviews, V. 47, pp844–855.

[3] Nilo M, Timothy M, John William F. (2013). Utilization of Cassegrain Feed Parabolic Antenna Design in Increasing the Efficiency of Photovoltaic Module. 7th IEEE International Conference on Communication and Control, Environment and Management (HNICEM).

[4] Michael A. Soderstrand, Sung Baek Lee. (2013). Mini-Dish Based Hybrid Concentrated Solar Power (CSP) System for Home Use. Invited paper, Peter Chung, Solar Power Energy System.

[5] fareed. M . Mohammed, Auatf. S .jassim, Yaseen. H. Mahamood, Mohamad A.K.Ahmed. (2012). Design and study of Portable Solar Dish Concentrator. International Journal of Recent Research and Review, Vol.III.

[6] John Harrison. (2001). Investigation of Reflective Materials for the Solar Cooker, Florida Solar Energy Center.

[7] Sumera Jabbar, Amara Munir, Prof. Dr Nasurullah Khan. (2012). Design of Parabolic Heat Collector. General paper of the COMSETS Institute of Information and Communication Technology, Islamabad.

[8] Lwin Lwin Oo, Nang Kaythi Hlaing. (2010). Microcontroller Based Two Axis Solar Tracking System. Second IEEE International Conference on Computer Research and Development.

[9] Eklas Hossain, RizaMuhida, and Ahad Ali. (2008). Efficiency Improvement of Solar Cell Using Compound Parabolic Concentrator and Sun Tracking System. IEEE Electrical Power & Energy Conference .

[10] Zhu, L-Yan. (2002). Making a Parabolic Reflector Out of a flat Sheet, Solar Cookers International (SCI). Annuals Report.

STUDY OF PHOTODIODE SENSOR USED FOR COLOR RECOGNITION IN OBJECT SORTING MACHINE

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Abstract: The study of a sensor, utilizing Arduino, is carried out in order to observe the testing conditions (I.e. Frequency, Light and Wave Length) of photodiode sensor to use it for color recognition of RGB in object sorting machine.

1. INTRODUCTION

Sorting of object is vital issue of computer integrated manufacturing system. It is not very notable statement but its associations for the food and recycling industry are of great importance. The processing and sorting of material, job or object is required they found difficulty in material processing as well as handling of it like to inspect the harvested food , or in recycling industry where the wasted material is of unknown color. Relevant to present work automated sorting are acquired for sorting color. Three different colors (RGB) by the help of Photo Diode Sensor. An integrated system is also used to help PLC to change frequency of colors to switching action.

2. LITERATURE REVIEW

Investigation with automatic sorting equipment initiated right after World War II and color sorting machine acquire early recognition in the food industry. Mandate for automatic sorting machine continues to rise due to the accelerating expenses of hand sorting coupled with the advanced quality requirements being executed on food procedures. There is also an upturn understanding of the importance of sorting in the decrease of health risks arising from polluted food, whether because food itself or the existence of external bodies (e.g. stone or wood), and the avoidance of linked product liability claims which are mounting intensely in both number and value [1].

3. SENSORS

A sensor is a part of transducer that changes the response of the transducer to a readable format by getting a signal. Usually it changes the recognized signal in alternative energy (i.e. Electrical Signals to Analog/Digital Response)

3.1 PHOTODIODE SENSOR

It is a semi-conductor device that changes optical input into frequency and current by absorbing photons. Even if

there is no optical signals still response is generated in the form of frequency. Photodiodes consists of integral lenses, light filters and may possess unique sized surface areas.
Diodes which are particularly used as a photodiode, instead of p-n Junction use PIN Junction[2]

3.1.1 PRINCIPLE OF OPERATION

When an energized photon strikes the diode, electron-hole pair is generated known as inner photo-electric effect. In case the absorption take place in depletion region or nearby, these movers are removed by integral electric field of the depletion are. Then the holes are attracted to the anode and electron to the cathode and current is generated[3]

3.1.2 PHOTODIODE SENSOR USED IN SORTING MACHINE FOR COLOR DETECTION

The sensor use for color detection is light to frequency convertor sensor TCS3200 Arduino as shown in fig: 1 (a) 1 (b) and its functional block diagram is shown in fig: 1 (c)

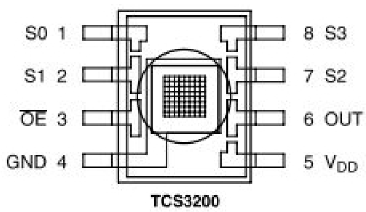


Fig: 1 (a) Photodiode TCS3200

Fig 1 (b) Photodiode TCS3200

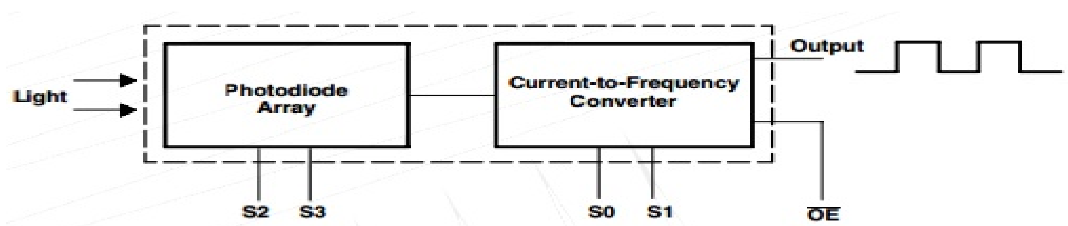


Fig 1 (c) its functional block diagram

3.1.3 TERMINAL FUNCTION

Below given table shows the terminal functions of the Photodiode Sensor

Table 1. Terminal Function

TERMINAL		I/O	DESCRIPTION
NAME	NO.		
GND	4		Power supply ground. All voltages are referenced to GND.
$\overline{OE}$	3	I	Enable for f_o (active low).
OUT	6	O	Output frequency (f_o).
S0, S1	1, 2	I	Output frequency scaling selection inputs.
S2, S3	7, 8	I	Photodiode type selection inputs.
V_{DD}	5		Supply voltage

3.1.4 SELECTION OPTION

Below given table shows the terminal functions of the Photodiode Sensor

S0	S1	OUTPUT FREQUENCY SCALING (f_o)
L	L	Power down
L	H	2%
H	L	20%
H	H	100%

S2	S3	PHOTODIODE TYPE
L	L	Red
L	H	Blue
H	L	Clear (no filter)
H	H	Green

Table 2. Selection Option

3.1.5 RECOMMENDED OPERATING CONDITIONS

Below given table shows the recommended operating conditions.

Table 3. Operating Conditions

		MIN	NOM	MAX	UNIT
Supply voltage, V_{DD}		2.7	5	5.5	V
High-level input voltage, V_{IH}	V_{DD} = 2.7 V to 5.5 V	2		V_{DD}	V
Low-level input voltage, V_{IL}	V_{DD} = 2.7 V to 5.5 V	0		0.8	V
Operating free-air temperature range, T_A		−40		70	°C

4. CONTROL DEVICES

In any automated system, the control parameters are used to perform serial tasks and to attain it, any sensible devices are required to take decisions adequately. Microprocessor is a main key element to perform intelligent operations like sorting of object. In the present work Arduino microcontroller and PLC are used for Sorting of objects, their details are following;

4.1 A PROGRAMMABLE LOGIC CONTROLLER (PLC)

A control method that continuously observe the input and give feedback according to programmed conditions.

4.1.1 ARCHITECTURE OF PLC

The simple architecture of a PLC contains following key components-

- The Processor Module
  All the communication is done in the processor Module.

- The Power Supply
  It is usually a different module used to power other modules.

- I/O Modules
  The categories of I/O modules compriseseparate (on/off), analog , and special .

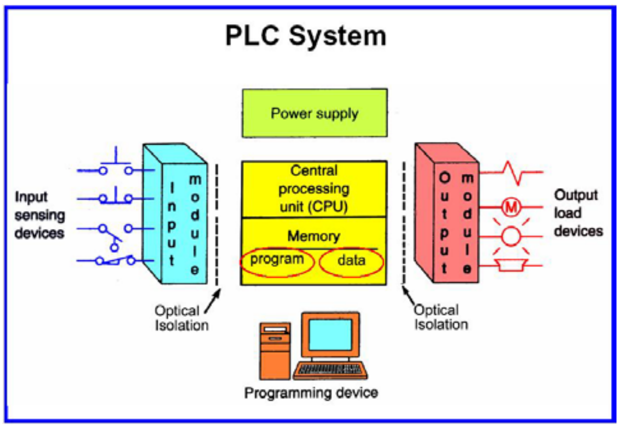


Fig. 2. PLC System

4.1.2 PROGRAMMING FORMATS

We use a general format like those of companies having a major share of the PLC market at present. Experience has shown that when a person beams to program one type of PLC, he/she can easily master other PLC systems, even though the formats differ somewhat.

Some of the factors that vary between formats are nomenclature, numbering, scheme, and screen appearance. Nomenclature descriptions are covered in examples in individual chapter. Another formal variation is in the numbering formats of contacts, outputs and registers. These formats include letters, numbers or a combination of both. Individual PLC operating manuals explain the various designation functions and registers.[4]

4.1.3 LADDER DIAGRA

Diagrams are usually used for non-electronic circuits. They are sometimes called the elementary diagrams or line diagrams. Sometimes they are considered a subtype of schematic diagrams. The term ladder diagrams are used in this article. Why these diagrams are called ladder diagrams? They look like a ladder in a way. You start at the top of the ladder and generally work your way down.

Two types of ladder diagrams are used in control systems. This section concentrates on control ladder diagrams with only a fundamental explanation of the power ladder diagram.

Mitsubishi F series of PLCs precedes input elements by an X and output elements by a Y and uses the following number:

Inputs : X400-407, 410-413

X500-507, 510-513

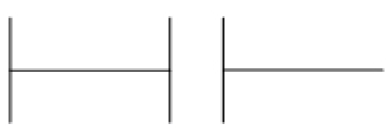
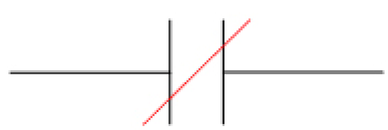
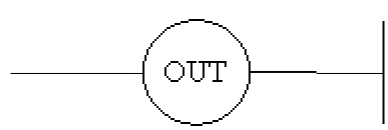
(24 possible inputs)

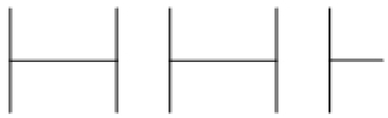
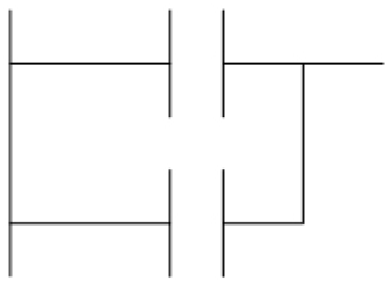
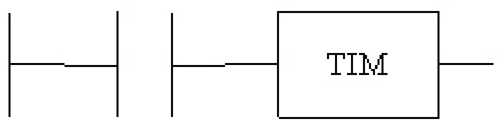
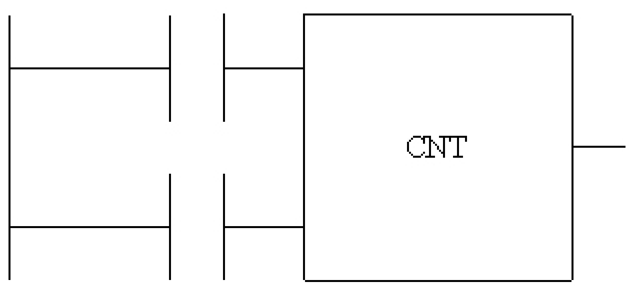
Outputs: Y430-437

Y530-537

(16 possible outputs)

Table 4. Typical basic instructions set.

PLC Symbol	Name	Relay Circuit Symbol	Function
LOD	Load		Reads the I/O status after storing an intermediate result.
NOT	Not		Inversion
OUT	Output		Output

AND	And		Logical AND
OR	Or		Logical OR
TIM	Timer		Timer
CNT	Counter		Counter

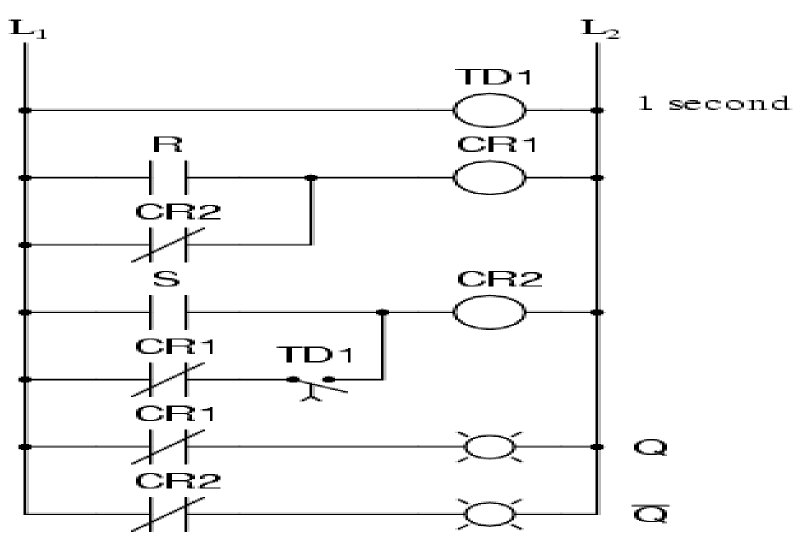


Fig 3. Ladder Diagram

4.1.4 PLC OPERATION

A PLC constantly read a program and respond accordingly. Typically there're more than 3 steps yet we may emphasis over significant parts. Normally the remaining are modernizing the current internal counter values and timer values testing the system . Fig 4.1.6 shows the flow diagram of PLC operation.

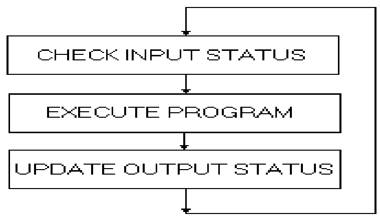


Fig 4.Flow diagram of PLC Operation

4.1.5 PLC INPUT INSTRUCTIONS

As we said in the introduction, there are a number of types of inputs that turn function on and off. The inputs are called by different names by various manufacturers. The inputs are called inputs, words, functions and instructions. Such as examine ON and examine OFF. In this book we call them inputs. The various types of inputs include:

1. Normally open contact. When this contact closes, the function carries out some kind of action.

2. Normally closed contact. When this contact opens, the function carries out some kind of action.

3. Latch/unlatch system. Actuating the latch input turns the function on or causes it to change state

4. Differentiation up or rising-edge actuation. This involves turning the function on for one scan time at the leading edge of an input signal patter.

5. Differentiation down or falling-edge actuation. This involves turning the function on for one scan time at trailing edge of a signal patter.

5. MICROCONTROLLER

An integral chip comprising a processor core, memory and programmable i/o. Microcontrollers are fabricated for embedded application in comparison to the microprocessor used in general purpose application.

5.1 ARDUINO MICROCONTROLLER

It is a microcontroller board works on the principle of the ATmega328 (datasheet). It has 14-digital i/o pins , 6 for PWM outputs, 6 for analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. as shown if fig. 5 ; simply link it with a PC through USB cable or connect it with a AC-to-DC device or battery to power.

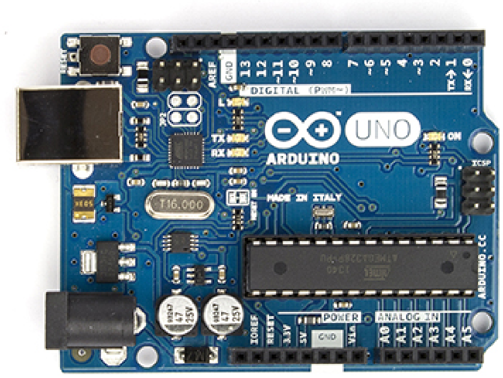


Fig.5. Arduino ATmega328

It is unique because it doesn't have FTDI USB to Serial Drive Chip, in place of that it uses ATMEGA 16U2

5.1.1 POWER

The Arduino Uno provided current with an peripheral power supply or through the USB connection..
Outer power is either from an AC-DC convertor or adapter etc. The connector are linked by stopping a 2.1mm focus positive connect to the board's energy jack. Leads from a battery can be embedded in the Gnd and Vin stick headers of the POWER connector.
The board works on an external supply of 6 to 20 volts. On the off chance that provided with under 7V, be that as it may, the 5V stick may supply under five volts and the board might be shaky.

5.1.2 MEMORY

The ATmega328 possess 32 KB (0.6KBis utilized for boot loader). It likewise does have 2.0 KB of SRAM and 1.0 KB of EEPROM

5.1.3 PROGRAMMING

The Arduino Uno is programmed in Arduino software (download). Select "Arduino Uno from the Tools and then

Board menu. The ATmega328 on the Arduino Uno comes returned with a boot loader that allows you to upload new code to it without the use of an external hardware programmer. It converse by the original STK500 protocol .

5.1.4 PHYSICAL CHARACTERISTICS

2.70” and 2.10” are the most extreme length and width of the microcontroller. 4 screw gaps(0.16”) permit the board to be connected to a surface.

5.1.4 ARDUINO PROGRAMMING FORCOLOR SENSING

```
#include <Metro.h>  // library

#include <math.h>

intcolor_window=3;

intActuatorInterval= 1500;

intActuatorGap= 2500;

int ActuatorGap2 = 2500;

intPulseInterval= 100;

Metro calc = Metro(1400);

Metro processdata = Metro(50);

Metro TcsTrigger = Metro(10);

Metro ActuatorTrigger = Metro(ActuatorInterval);

Metro Actuatoroff = Metro(ActuatorInterval+
PulseInterval);

Metro ActuatorTrigger2 = Metro(ActuatorInterval +
ActuatorGap);

Metro Actuatoroff2 =
Metro(ActuatorInterval+ActuatorGap+
PulseInterval);

Metro ActuatorTrigger3 = Metro(ActuatorInterval +
ActuatorGap + ActuatorGap2);

Metro Actuatoroff3 =
Metro(ActuatorInterval+ActuatorGap +
ActuatorGap2+ PulseInterval);

int s0=8,s1=9,s2=10,s3=11; // port definition of color
sensor

int out=2;

intRActuator =6;

intGActuator =5;
```

```
Serial.begin(115200);

pinMode(s0,OUTPUT);

pinMode(s1,OUTPUT);

pinMode(s2,OUTPUT);

pinMode(s3,OUTPUT);

pinMode(RActuator,OUTPUT);

pinMode(GActuator,OUTPUT);

pinMode(BActuator,OUTPUT);

pinMode(RActuator2,OUTPUT);

pinMode(GActuator2,OUTPUT);

pinMode(BActuator2,OUTPUT);

}

void TCS()

{

digitalWrite(s0,HIGH);

digitalWrite(s1,HIGH);

attachInterrupt(0, ISR_INTO, CHANGE);

}

void ISR_INTO()

{

counter++;

}

intRaverage = 0;

intBaverage = 0;

intGaverage = 0;

void loop()     //  call function

{
```

```
TCS();

if(TcsTrigger.check()){

Tcstrigger();

 }

if(red == false && green== false && blue
==false)

 {

if(processdata.check()){

void TCS()

{

digitalWrite(s0, HIGH);

digitalWrite(s1, HIGH);

attachInterrupt(0, ISR_INTO, CHANGE);

 }

void ISR_INTO()

{

counter++;

}

intRaverage =0;

intBaverage =0;

intGaverage =0;

void loop()     //  call function

{

TCS();

if(TcsTrigger.check()){

Tcstrigger();
```

```
{
if(red == false && green== false && blue ==false)
 {
if(processdata.check()){
procedata();
 }
if(calc.check()){
ledup();
 }
 }
if(ActuatorTrigger.check())
 {
if(red)
  {
Serial.println("RED");
digitalWrite(RActuator,HIGH);
red=false;
  }
 }
if(Actuatoroff.check())
 {
digitalWrite(RActuator,LOW);
 }
if(ActuatorTrigger2.check())
 {
if(blue)
  {
Serial.println("BLUE");
digitalWrite(BActuator,HIGH);
blue=false;
  }
 }
if(Actuatoroff2.check())
 {
digitalWrite(BActuator,LOW);
 }
if(ActuatorTrigger3.check())
 {
if(green)
  {
Serial.println("GREEN");
digitalWrite(GActuator,HIGH);
green=false;
  }
 }
if(Actuatoroff3.check())
 {
digitalWrite(GActuator,LOW);
 }
}
voidTcstrigger() //  data acquisition
{
flag++;
if(flag==1){
digitalWrite(s2,LOW);
digitalWrite(s3,LOW);
countR=counter;
digitalWrite(s2,HIGH);
digitalWrite(s3,HIGH);
  }
else if(flag==2){
countG=counter;
digitalWrite(s2,LOW);
digitalWrite(s3,HIGH);
  }
else if(flag==3){
countB=counter;
digitalWrite(s2,LOW);
digitalWrite(s3,LOW);
flag=0;
  }
counter=0;
}
void procedata()     // data processing
{
staticintRinput[5] ={
    0,0,0,0,0         }
,Binput[5] ={
    0,0,0,0,0         }
,Ginput[5] ={
    0,0,0,0,0         };
```

```
for(int i = 4;i > 0;i–){

Rinput[i] = Rinput[i-1];

Binput[i] = Binput[i-1];

Ginput[i] = Ginput[i-1];

  }

if(countR< 2500)

Rinput[0] = countR;

else

Rinput[0] = Rinput[1];

if(countB< 2500)

Binput[0] = countB;

else

Binput[0] = Binput[1];

if(countG< 2500)

Ginput[0] = countG;

else

Ginput[0] = Ginput[1];

Raverage = 0;

Baverage = 0;

Gaverage = 0;

for(int i = 0;i <= 4;i++){

Raverage += Rinput[i];

Baverage += Binput[i];

Gaverage += Ginput[i];

  }

Raverage /= 5;

Baverage /= 5;

Gaverage /= 5;

}

void ledup()    // data output

{

intledvalueR = Raverage;

intledvalueG = Gaverage;

intledvalueB = Baverage;

Serial.print("R:");

Serial.print(Raverage,DEC);

Serial.print(" ");

Serial.print("B:");

Serial.print(Baverage,DEC);

Serial.print(" ");

Serial.print("G:");

Serial.print(Gaverage,DEC);

Serial.print(" ");

if(Raverage - 30 >Gaverage&&Raverage - 30
>Baverage)

  {

red=true;

blue=false;

green=false;

  }

if(Gaverage -
color_window>Baverage&&Gaverage -
color_window>Raverage)

  {

red=false;

blue=false;

green=true;

  }

if(Baverage -
color_window>Gaverage&&Baverage -4
>Raverage)

  {

red=false;

blue=true;

green=false;

  }

}
```

6. RESULTS

Sorting of object based on colors configurations.

The Photodiode sensor TCS3200 is used to convert light to frequency for detecting three colors RGB and gives output in square waves. Interfacing of color sensor is with Arduino Microcontroller. We set color sensor in 100% frequency and on that range it gives us following color frequencies with the standard recommendation that have been shown in the table below.(Operating Characteristics at VDD = 5 V, TA = 25°C, S0 = H, S1 = H)

Table 5

PARAMETER	TEST CONDITIONS	CLEAR PHOTODIODE S2 = H, S3 = L			BLUE PHOTODIODE S2 = L, S3 = H			GREEN PHOTODIODE S2 = H, S3 = H			RED PHOTODIODE S2 = L, S3 = L			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
f_O Output frequency	$E_e = 47.2\ \mu W/cm^2$, $\lambda_p = 470$ nm	12.5	15.6	18.7	61%		84%	22%		43%	0%		6%	kHz
		(4.7)	(5.85)	(7)										
	$E_e = 40.4\ \mu W/cm^2$, $\lambda_p = 524$ nm	12.5	15.6	18.7	8%		28%	57%		80%	9%		27%	
		(4.7)	(5.85)	(7)										
	$E_e = 34.6\ \mu W/cm^2$, $\lambda_p = 640$ nm	13.1	16.4	19.7	5%		21%	0%		12%	84%		105%	
		(4.9)	(6.15)	(7.4)										

We synchronized microcontroller with PLC by the action of relays through transistor because the Arduino operating voltage is 5v and relay operating voltage is 12DCvolt. Output of color sensor invoke respective relay and that relay gives input to the PLC.

7. REFERENCE

[1] Low, J.M.; Maughan, W.S.; Bee, S.C.; Honeywood , M.J. (2001). "Sorting by colour in the food industry". In Kress-Rogers, Erika; B. Brimelow, Christopher J. *Instrumentation and sensors for the food industry* (2nd ed.). Woodhead Publishing.

[2] De Lima Monteiro D.W., Bonnaud O. and Morimoto N. (2009) *Microelectronics Technology and Devices.* [Online]. Available at: *https://books.google.com.pk/books?id=q6ZyT7A68C4C&pg=PA397&lpg=PA397&dq=papers+Diodes+which+are+particularly+used+as+a+photodiode,+instead+of+p-n+Junction+use+PIN+Junction%5B&source=bl&ots=1VRS8_8lpT&sig=wjLbuJcD2u1eW61Qq9Tu7B4CidY&hl=en&sa=X&ved=0ahUKEwjXwN2Oxu_RAhWItI8KHVqNCSAQ6AEIKjAD#v=onepage&q=papers%20Diodes%20which%20are%20particularly%20used%20as%20a%20photodiode%2C%20instead%20of%20p-n%20Junction%20use%20PIN%20Junction%5B&f=false* (Accessed: 15th January 2016)

[3] AZoOptics () *Photodiode - Working Principle and Applications,* Available at: *http://www.azooptics.com/Article.aspx?ArticleID=809* (Accessed: 9th January 2016).

[4] Rathore A.S () *Basic plc-programming,* Available at: *http://www.slideshare.net/arvindsinghrathore14/basic-plcprogramming* (Accessed: 9th January 2016).

INCREASING THE EFFECTIVENESS OF PERIODIC MAINTENANCE USING CONDITION MONITORING TECHNIQUES AND OPERATIONAL DATA

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Abstract: This research was conducted at early production facility (EPF) Hala gas processing plant, Pakistan petroleum limited, TandoAdam, Sindh, Pakistan. The purpose of the study was to optimize the periodic maintenance by using condition monitoring technique. In this technique a vibration analyzer was used to detect the unpredictable failure of critical rotating machines. Two critical rotating machines i.e. radiator fan and amine charge pump were chosen to collect the data individually by placing vibration sensors on the equipment and readings of vibration velocity in (mm/s) were taken at multiple directions such as vertically, horizontally and axially of radiator fan and amine charge pump at the location of driving and non-driving end side. Collected data was processed into Benstone fieldpaq-II isee Software to diagnose the nature of faults via vibration pattern. Different faults of machines were observed causing to machine vibrate excessively such as bearing failure, rotor imbalance; belts worn-out and coupling halve looseness. The faults of rotary machines were repaired before they failed by scheduling maintenance during non-working hours. Estimated revenue loss per hour of downtime was calculated in order to reduce unscheduled downtime, production loss and to provide the feeling of safety and reliability to all employees. The revenue loss was 16.7 % for four hours of down time.

1. INTRODUCTION

The demand for the modern industry is increased to work at high reliability, low risk of environmental and human safety while processes are operated at their maximum yield. The complexity in both industrial machinery and production systems have increased because of rapid change in technological development. Without condition monitoring techniques, it is difficult to predict machines failure and to identify the problems timely [1].

Early Production Facility (EPF) Hala gas processing plant is installed with different rotating machines at different units of the plant and their availability plays an important role whether it is in operation or standby which helps to run the plant continuously without any disturbance of the processes parameters. If any rotating machine fails, the whole plant's systems become uncontrolled and resulting in plant shutdown. Hence, it is important to implement condition monitoring in order to reduce the breakdown by continues monitoring. This research study was conducted at Early Production Facility (EPF) Hala gas processing plant by choosing two critical rotary machines i.e. amine charge pump and radiator fan in order to recognize the faults of machines component prior to fail. With the help of vibration analyzer, the data was collected by placing the vibration sensors separately on each unit after that a collected data was put into Benstone fieldpaq-II isee Software to get vibration patterns (vibration spectrums) and the problems of machines were identified such as coupling halve looseness, bearing failure, belt worn-out and unbalance rotor causing to machine vibrate excessively. After noticing these faults, a proper maintenance was carried out before equipments fail and soon after machines were put back into service for further investigation. Estimated revenue loss per hour of downtime was calculated in terms of PKR. The revenue loss was 16.7 % for four hours of down time.

A satisfactory level of system reliability and reduce operating cost can be ensured by an effective maintenance program. To compare with traditional maintenance techniques, the risk of catastrophic system failure can be reduced by condition monitoring techniques and quantifies the real need of equipment and systems [2]. Health based monitoring of machinery are attempted through the condition monitoring techniques on condition measurements that do not interrupt the normal operation of machine [3].

Expensive downtime spares inventory, maintenance labor cost and hazardous conditions can be reduced by prognostics promises significantly [3]. The current state of complex systems and their operating environments are accurately detected by the condition monitoring techniques and use that information for maintenance and prognosis activities [2]. Vibration analysis is a technique, which is being used to track the condition of machine during operation so as to reduce the downtime and maintenance cost simultaneously [4]. In the current state of art, an efficient condition monitoring system which not only detects the faults but it can also predict an upcoming failure of equipment [5]. The revenue loss was 16.7 % for four hours of down time.

2. RESEARCH METHODOLOGY

This research was conducted at Early Production Facility (EPF) Hala gas processing plant, Pakistan Petroleum Limited TandoAdam, Sindh, Pakistan. Before conducting this research study, the permission was taken from the higher management of Pakistan Petroleum Limited then two critical rotary machines were chosen for analyzing the data i.e. amine charge pump and radiator fan. The data was gathered by placing the vibration sensors on the machines individually at multi directions such as vertically, horizontally and axially at location of pumps, fan & motor's driving and non-driving end. Subsequently, the collected data was put into Benstone fieldpaq-II isee Software in order to identify the nature of faults by generating the vibration patterns and maintenance actions were carried out for the repair of equipments. Estimated revenue loss per hour of downtime was calculated in order to reduce unscheduled downtime, production loss and to provide the feeling of safety and reliability to all employees. The revenue loss was 16.7 % for four hours of down time.

3. RESULTS AND DISCUSSION

It is very essential for all industries to provide an effective maintenance to their assets in order to keep them in a good condition during operation. The better performance of machines could result in better quality of products and which helps to increase the economy of industry and to develop the country as well. Vibration analysis technique was chosen to analyze and investigate the unpredictable failure of machine by using vibration analyzer.

Before rectification spectrum

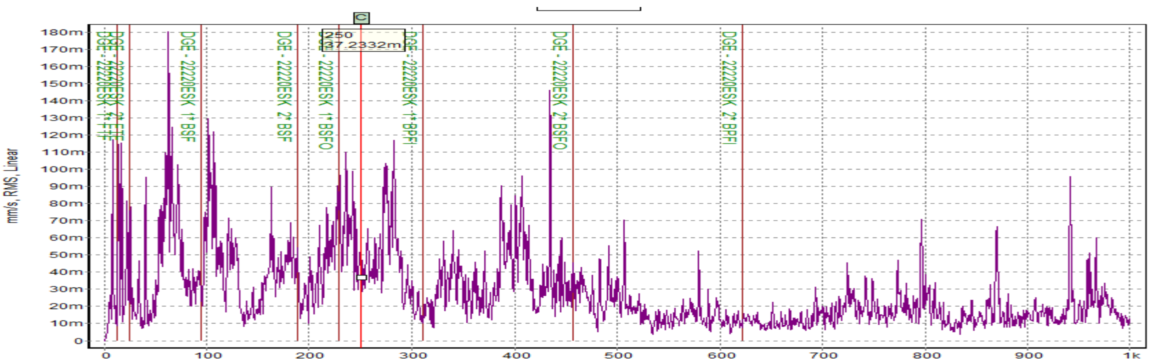

Figure 1. Defective bearing

Table1 reflects the collected data from radiator fan. Readings were taken at different positions such as vertical, horizontal and axial. In serial #1 the vertical and horizontal readings were taken at location motor non driving end side. Similarly, in serial #2 readings were taken at location motor driving end side vertically, horizontally and axially. In this way remaining readings of serial #3 & 4 were taken at location fan driving & non-driving end side. Collected data was analyzed by putting into Benstone fieldpaq-II isee Software to diagnose the nature of problem by generating the spectrum which is shown in figure: 1. However, the problem was detected via Fast Fourier Transformer (FFT) bearing frequency fault. Consequently, the pulley side bearing's cage was found defective which was then replaced by new one.

Table 1. Data before rectification of problem

Radiator Fan (Bearing problem)				
S/no	Location	Readings in Velocity (mm/sec)		
		Vertical	Horizontal	Axial
1	Motor non driving end	0.5	0.4	
2	Motor driving end	0.5	0.6	0.5
3	Fan driving end	1.6	2	0.4
4	Fan non driving end	1.8	2.3	

After rectification spectrum

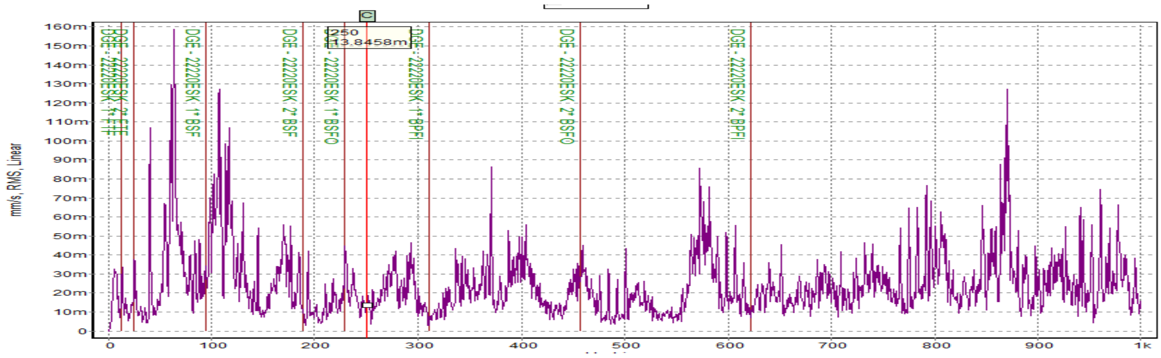

Figure 1. Healthy bearing

After replacing bearing, the machine was put back into service and again vibration analyzer was used for the satisfaction. The readings were taken in a similar way vertically, horizontally and axially at location of fan & motor's driving and non-driving end side. The data was collected as shown in table: 2 and this data was again put into Benstone fieldpaq-II isee Software for further investigation of problems. According to the spectrum no such indications were observed and this graph shows the acceptable values of vibration which allows machine to run without any abnormality

Table 2. Data after rectification of problem

S/no	Location	Readings in Velocity (mm/sec)		
		Vertical	Horizontal	Axial
1	Motor non driving end	0.5	0.4	
2	Motor driving end	0.5	0.6	0.5
3	Fan driving end	1	0.7	0.4
4	Fan non driving end	1.2	0.9	

Before rectification spectrum

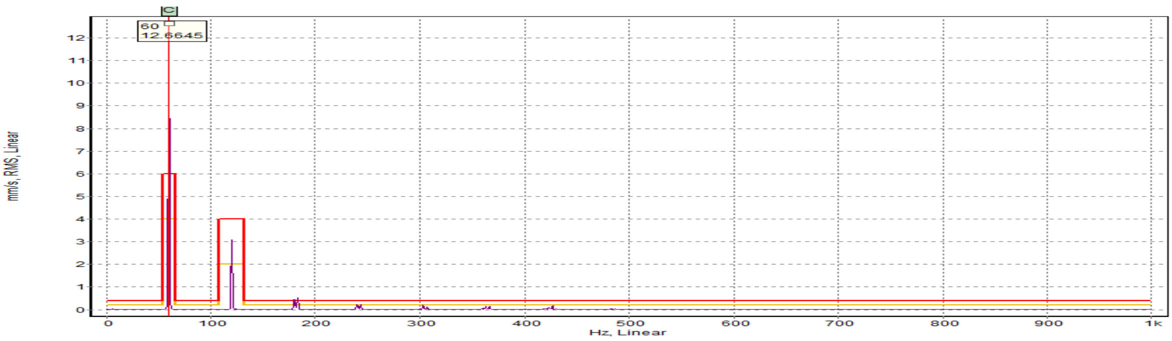

Figure 1. Coupling looseness

Similarly, another machine i.e. amine charge pump was taken due to its excessive vibration; the vibration analyzer was used to detect the faults and this activity was carried out before problem's rectification. With the help of analyzer vibration velocity readings were taken vertically, horizontally and axially at location pump and motor's driving & non-driving end side which are shown in table 3. Similarly, the accumulated data was put into Benstone fieldpaq-II isee Software in order to know the nature of faults. The spectrum graph was generated in software and the problem was diagnosed as coupling looseness that was resulting in misalignment and the spectrum graph as shown in figure: 3

Table 2. Data before rectification of problem

Amine Charge Pump (Misalignment Problem)				
S/ no	Location	Readings in Velocity (mm/sec)		
		Vertical	Horizontal	Axial
1	Motor non driving end	9.538	5.732	
2	Motor driving end	6.485	7.4	14.7
3	Pump driving end	7	8	13.5
4	Pump non driving end	6.6	8.3	

Before rectification spectrum

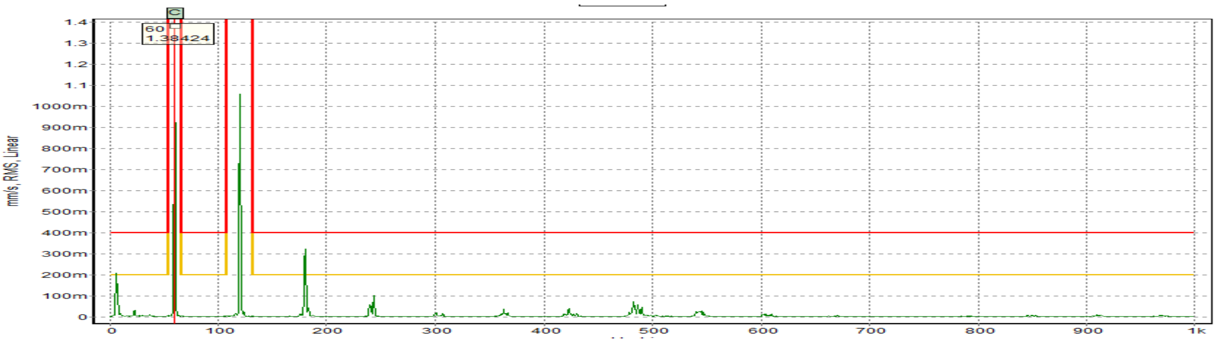

Figure 4. Retightened coupling

After retightening coupling halves, the machine was put back into service and vibration analyzer was used for further satisfaction. With the same method vibration velocity readings were taken at vertically, horizontally and axially at location pump & motor's driving and non-driving end side as shown in table 4. The collected data was put into Benstone fieldpaq-II isee Software in order to identify the nature of faults by generating spectrum. During analyzing the data no such faults were observed and machine found satisfactory.

Table 2. Data after rectification of problem

S/no	Location	Readings in Velocity (mm/sec)		
		Vertical	Horizontal	Axial
1	Motor non driving end	1.7	2.335	
2	Motor driving end	2.135	3.225	2.552
3	Pump driving end	3.264	2.925	2.294
4	Pump non driving end	2.325	2.243	

3.1 Machines Downtime and Production loss

Estimated revenue loss per hour of downtime was calculated of each machine separately in terms of PKR. It was found that 16.7% of revenue loss occurred per hour for the machine down time. The projected downtime considered 4 hours based on past experience. With implementation of condition monitoring techniques the breakdown time can be reduced significantly.

4. CONLUSION AND RECOMMENDATION

This research was conducted with an aim to provide the concept of optimizing periodic maintenance by using condition monitoring techniques at Early Production Facility (EPF) Hala gas processing plant, TandoAdam, Pakistan Petroleum Limited. It was observed that most of the critical rotating machines were not working properly due to poor maintenance which could result in machines failure such as bearing failure, coupling looseness, rotor imbalance and foundation looseness. For the reason, this study was conducted on two critical rotary machines i.e. amine charge pump and radiator fan. These machines were analyzed with the help of vibration analyzer detector by placing some vibration sensors on machines inboard and outboard in order to take vibration velocity readings in (mm/sec) vertically, horizontally and axially. Thereafter a collected data was analyzed in Benstone fieldpaq -II isee software for the identification of problem. For this reason, all machines are required to implement the condition monitoring techniques so as to increase performance, reliability and availability of machines and to avoid unscheduled downtime, spare cost, hazardous conditions and production loss.

5. ACKNOWLEDGEMENT

Firstly, I am very much thankful to my advisor Prof. Dr. Murlidhar, for the continuous support of my master study and related research, for his immense knowledge and motivation. All the time his exemplary guidance helped me throughout my research work. During working with him it was a great experience and extremely knowledgeable for me.

6. REFERENCES

[1] Peng, Ying, Ming Dong, and Ming Jian Zuo. "Current status of machine prognostics in condition-based maintenance: a review." *The International Journal of Advanced Manufacturing Technology* 50.1-4 (2010): 297-313.

[2] Liu, Xiao, et al. "Condition-based maintenance for continuously monitored degrading systems with multiple failure modes." *IIE Transactions* 45.4 (2013): 422-435.

[3] Li, Lei, et al. "Notice of Retraction a fast development framework for condition-based maintenance systems." *Mechanical and Electronics Engineering (ICMEE), 2010 2nd International Conference on*. Vol. 2. IEEE, 2010.

[4] Karabay, Sedat, and Ibrahim Uzman. "Importance of early detection of maintenance problems in rotating machines in management of plants: Case studies from wire and tyre plants." Engineering Failure Analysis 16.1 (2009): 212-224.

[5] Singh, Dheeraj, and Qing Zhao. "Symbolic Analysis of Hilbert-Huang spectrum of Vibration data for condition monitoring of rotating machines." *IFAC-PapersOnLine* 48.21 (2015): 1426-1431.

[6] Jardine, Andrew KS, Daming Lin, and DraganBanjevic. "A review on machinery diagnostics and prognostics implementing condition-based maintenance." *Mechanical systems and signal processing* 20.7 (2006): 1483-1510.

[7] Vanli, O. Arda. "A failure time prediction method for condition-based maintenance." *Quality Engineering* 26.3 (2014): 335-349.

[8] Heng, Aiwina, et al. "Rotating machinery prognostics: State of the art, challenges and opportunities." *Mechanical systems and signal processing*23.3 (2009): 724-739.

[9] Mahantesh, Nadakatti, ParidaAditya, and Uday Kumar. "Integrated machine health monitoring: a knowledge based approach." *International Journal of System Assurance Engineering and Management* 5.3 (2014): 371-382.

[10] Dagnew, AbiotTarekegn. "Optimization of periodic maintenance using condition monitoring techniques and operational data." (2012).

[11] Guillén, Antonio J., et al. "A framework for effective management of condition based maintenance programs in the context of industrial development of E-Maintenance strategies." *Computers in Industry* 82 (2016): 170-185

[12] Wang, Wenbin, and Huiying Wang. "Preventive replacement for systems with condition monitoring and additional manual inspections." *European Journal of Operational Research* 247.2 (2015): 459-471.

[13] Neves, Maxstaley L., Leonardo P. Santiago, and Carlos A. Maia. "A condition-based maintenance policy and input parameters estimation for deteriorating systems under periodic inspection." *Computers & Industrial Engineering* 61.3 (2011): 503-511.

[14] Han, Y., and Y. H. Song. "Condition monitoring techniques for electrical equipment-a literature survey." *IEEE Transactions on Power Delivery* 18.1 (2003): 4-13.

EFFECT OF AMBIENT AIR TEMPERATURE AND HEAT LOAD VARIATION ON PERFORMANCE OF AIR COOLED HEAT EXCHANGER IN PROPANE CYCLE IN GAS PROCESSING PLANT

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Abstract: To assess the effect of air flow rate requirement on Air cooled heat exchanger used in propane cycle in gas processing plant analytical method is used. The performance of Air cooled heat exchanger is analyzed by varying ambient inlet temperature and mass flow rate at different heat loads. The analytical method helps in figuring out the variations in heat load and ambient air in the inlet temperature. The ambient air inlet temperature is presented analytically by periodic relation, therefore the analytical method is used to determine the effect by varying and constant values of air flow temperatures and heat loads through the fines tubes of air cooled heat exchanger. The mathematical results are obtained to assess the performance of air cooled heat exchanger located at Hala gas processing plant Tando Adam Sindh Pakistan.

1. INTRODUCTION

In Hala gas processing plant, the most common heat exchangers used are fin-fan air coolers. The initial three phase separation (gas, condensate and water separation) occurs in inlet separator, for better separation the gas is first cooled in a fin-fan cooler. Hydrocarbon dew point is achieved using mechanical refrigeration unit (MRU) as a cooling device which itself contain a fin-fan air condenser.

The process of heat transfers from a low temperature to high temperature by adding up mechanical energy to the system. It basically lowers the temperature of a substance below its surrounding temperature [1]. It works on the principle that liquid refrigerant absorbs heat when converted to vapor phase and heat is extracted when the vapor phase is changed back to liquid [2].

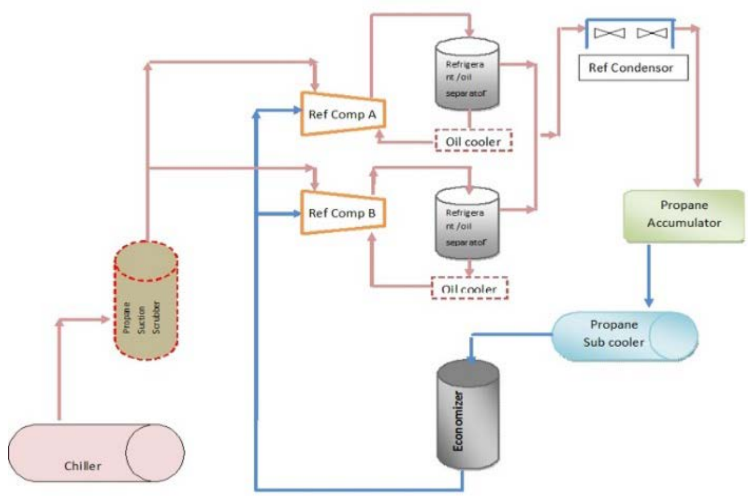

Figure 1: Refrigeration system

To start the cycle from vapor phase, the refrigerant propane from suction scrubber is compressed to the intermediate pressure (first stage compression), the super feed vapor from economizer enters the compressor where the two feeds mixes inside the compressor and compressed to high pressure. The refrigerant is condensed at high pressure with a fin-fan air cooler. The condensed liquid flows down to propane accumulator which collects the liquid refrigerant until it flows to the throttling section. The refrigerant in liquid phase is sub cooled in propane sub cooler, the cold medium is NGL from LTS through gas-liquid exchanger. The vapor phase refrigerant enters the suction scrubber and recompressed again, thus completes the cycle.

Mostly when a well-found source of water is not available, air coolers are used to play the role in industrial applications [3]. For an economical benefit and operational reasons, sometimes air cooled exchangers are put at the top of the priorities – the reason being that the whole process which includes; pumps, water cooling systems and water conditioning system accumulate a variety of costs like capital cost and maintenance cost [4]. The rise in temperature can be controlled by installing louvers on the ACHE to maintain the required temperature [5].

The analytical method is used to determine the operational performance of force draft fan Air cooler used as condenser in Gas Processing Plant. This mathematical approached is presented to analyze the effect of ambient air temperature with required air mass rate with heat loads by varying the values respectively.

2. ABOUT THE COOLER

The working principle of ACHE is very simple, as the hot stream (propane) flow in the tubes then cold air is passed through the tubes containing extending fins for increasing heat transfer coefficient. It uses ambient air to cool the fluid and the extracted heat is expelled into the environment [6]. There are various types of ACHE, depends on the air being pushed or pulled. Force draft fan which requires lower horse power, better accessibility to fan and tube bundle [7]. The primary parts of a forced draft-ACHE are shown in Figure 2.

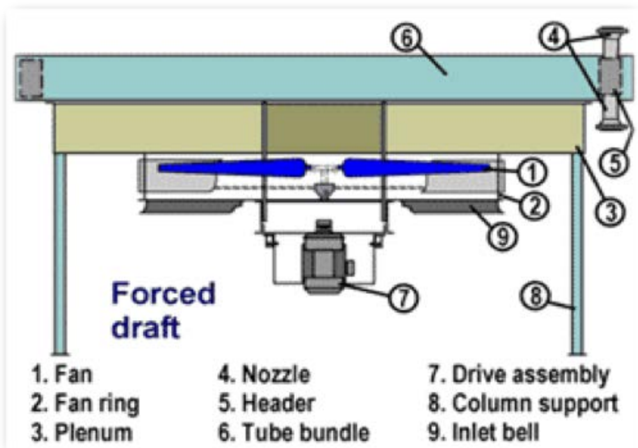

Figure 2: Force draft fan cooler.

In a broader sense, the key design parameter of air-cooled heat exchanger (ACHE) has the temperature difference approach, which means outlet temperature process is subtracted by cooling air temperature. Moreover, the effective mean temperature difference becomes crucial and gains more effect for the reason that it has tiny heat capacity when match up with water cooling system, if the cooling base being used is air. So choosing a design ambient temperature is the most important factor that affects the size and eventually cost of the ACHE [8]. By comparison, it has been implied that although the capital cost for air-cooled heat exchanger is higher than the water-cooled exchanger and operating cost is significantly low, thus choosing air cooling system considered a best option. Continuing, the problems like fouling and corrosion that inherent in water cooling system are all terminated in the process of air cooling [9].

The primary usage of fin and tubes as concrete heat exchangers is in direct condensers of air-cooled systems in the power plants. The attributes such as heat transfer and air-side flow of fin and tubes performs a crucial role while evaluating performance of condensers [10].

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Even though the variable speed fans are adaptable to an optimum speed of fans, they can also gain maximum plant efficiency possible and at all times as well, granted they maintain a tight fan speed control [11].

3. AIR-COOLED HEAT EXCHANGER BASIC EQUATIONS

The heat-transfer equations and energy balance of air cooled heat exchanger can be calculated by given equations [12].

$$Q = mC_p\Delta T \quad (1)$$

$$Q = U_{OX} \times A_X \times \mathrm{MTD} \quad (2)$$

Heat gained by cooling air stream: (3)

$$Q = W_{air} \times (C_p)_{air} \times (t_{out}\text{-}t_{in})$$

Mean temperature difference MTD: (4)

$$MTD = \frac{[(T_{in}\text{-}t_{out})\text{-}(T_{out}\text{-}t_{in})]}{\ln\left[\frac{T_{in}\text{-}t_{out}}{T_{out}\text{-}t_{in}}\right]}$$

Here, Q = heat load,
MTD = Mean temperature difference
$(C_p)_{air}$ = specific heat of air
m = mass flow rate
T_{in} = propane inlet temperature
T_{out} = propane outlet temperature
ΔT = temperature difference
W_{air} = mass flow rate of air
t_{in} = ambient inlet temperature
t_{out}= ambient outlet temperature
$\lambda_{propane}$= latent heat of propane
$(C_p)_{propane\ vapor}$= specific heat of propane vapor
$(C_p)_{propane\ liquid}$= specific heat of propane liquid

4. RESULTS & DISCUSSIONS

Air cooler is used in the Mechanical refrigeration unit in Gas processing plant, Hala Gas Processing Plant located at Tando Adam Sindh Pakistan is selected as a case study. The propane is used in Mechanical refrigeration unit and the condenser is fin fan cooler which cool and condense the refrigerant using air as a base. To condense the refrigerant at low pressure, refrigerant (propane) must be cooled at required temperature. The operating data sheet and physiochemical are used for this case.

The mathematical calculations were carried out by using process control parameters with the help of HYSIS software to investigate the behavior and performance of Force draft fan cooler at constant & variable values of heat load (Q) and inlet air temperature (t_{in}).

Table 1: The operating data sheet and physiochemical chart.

Variables	Values
$W_{propane}$	2855 kg/hr
T_{in}	79.44 °C
T_{out}	34.47 °C
$\lambda_{propane}$	317 kJ/kg
$(C_p)_{propane\ vapor}$	2.081 kJ/kg°C
$(C_p)_{propane\ liquid}$	3 kJ/kg°C
Q	11.69×10^5kJ/hr
W_{air}	8.33×10^5kg/hr
$(C_p)_{air}$	1.01 kJ/kg°C
t_{in}	30 °C
t_{out}	31.4 °C

In graph 1 the effect of ambient air temperature (t_{in}) on force draft fan cooler was calculated analytically in which the mass flow rate (W_{air}) of ambient air was calculated at different inlet temperatures by keeping the values constant of heat load Q and t_{out}. It is observed that as temperature of inlet ambient air (t_{in}) increases, the mass flow rate of air also increases by keeping heat load (Q) constant. In graph 2 the effect of ambient air temperature (t_{in}) on ACHE is calculated by varying the heat load (Q) at different values which shows the trend of mass flow rate at different heat loads, Q_1= when the heat load is low then effect of ambient air is not significant. Q_2 & Q_3 = when the heat load requirement increases then change in ambient air temperature drastically increases mass flow rate (W_{air}).

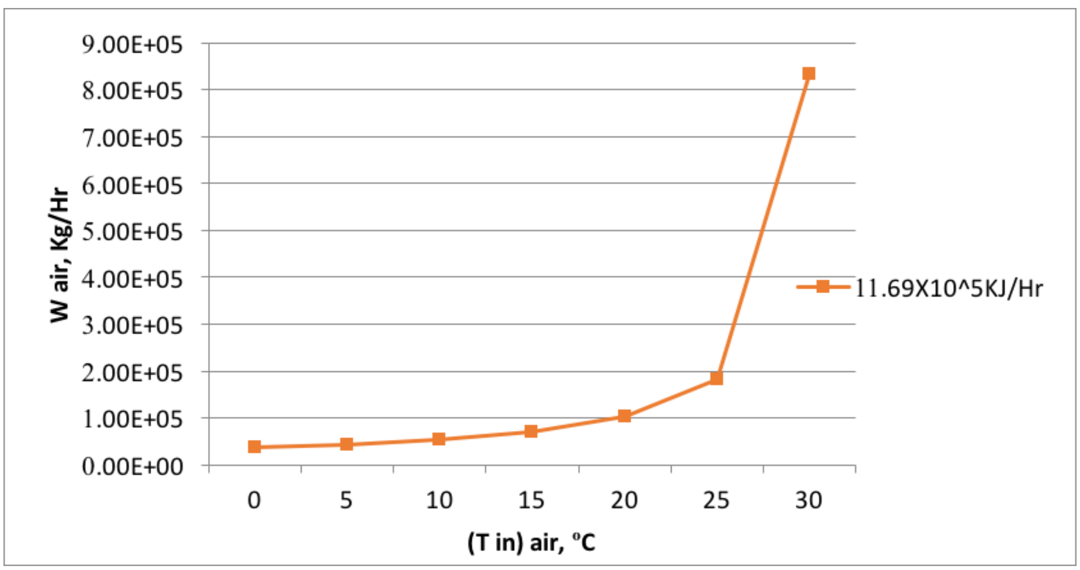

figure 3: Air flow variation at constant Heat load

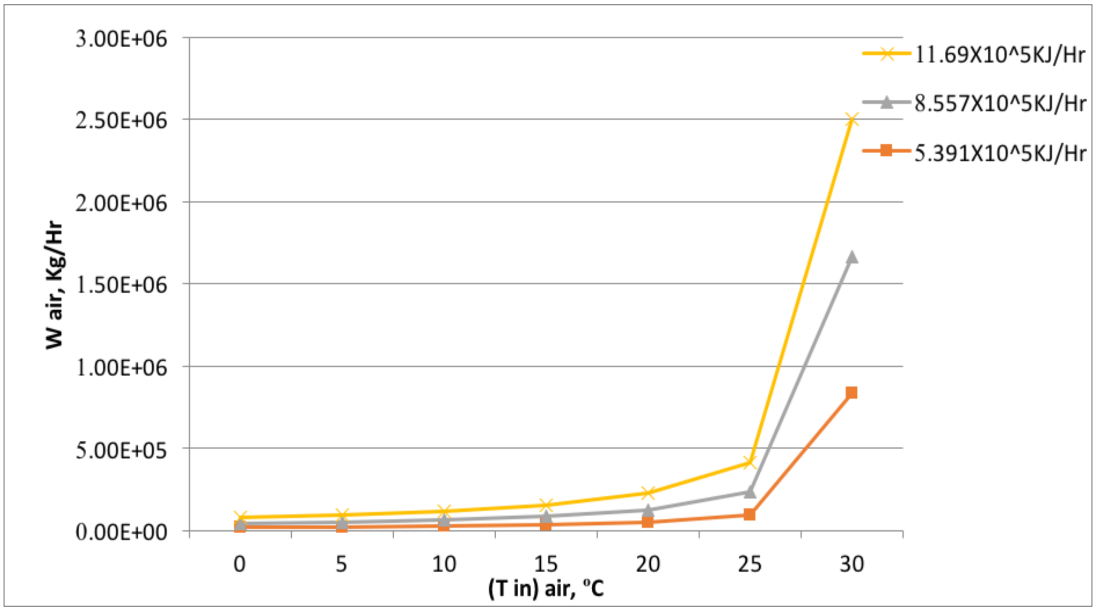

Figure 4: Air Flow Variation at Different Heat Load

5. CONCLUSION:

In this paper analytical method is used to analyze the impact of ambient air inlet temperature on the performance of AHCE. This analytical method is used to calculate the mass flow rate (W_{air}) by varying inlet ambient air temperature (t_{in}) at different heat loads (Q). From various calculations it can be observed that by changing both inlet air temperature and heat load, the mass flow rate of air also increases with raise in inlet ambient temperature and heat load respectively. The impact of inlet air temperature rises along with air mass flow rate but as the heat load and ambient inlet temperature increases change in mass flow rate drastically increases. It means that at low temperature less variation in air mass flow rate and at high ambient air inlet temperature more variation occurs. Moreover, it was found that in summer season effect of inlet air temperature has great influence on performance of Air cooler as compared to winter season.

6. REFERENCES

1. Meyer CJ, Kröger DG. “Plenum chamber flow losses in forced draught air- cooled heat exchangers”, Appl Therm Eng, pp:875–93, 1998 & Hall, London, United Kingdom.

2. British Petroleum Company (BP). “BP statistical review of world energy (UK)”, British Petroleum Co.; 2010.

3. Speight JG. “Natural gas: a basic handbook (TX, USA): Gulf Publishing Co pp:239, 1st edition, 2007.

4. Butterworth D, “Steam power plants and process condensers”. In: Kakac S, editor. “Boilers, evaporators and condensers”. New York (USA): John Wiley & Sons, Inc.; pp:848, 1991.

5. Stewart M, Lewis OT. “Heat exchanger equipment field manual: common operating problems and practical solutions”. Gulf Professional Publishing, 1st edition, pp. 488, 2012,

6. Breber G. “Comparison of the air-cooler model performance with forced and induced draft. AC-8-HTRI”; 1992.

7. Branan. “Rules of thumb CR for chemical engineers”. Houston (TX, USA): Gulf Publishing Co.; 1994.

8. American Petroleum Institute, “Air-Cooled Heat Exchangers for General Refinery Service,” API Standard 661, Fifth Edition, March 2002.

9. Weifeng He, Dong Han, Chen Yue, Wenhao Pu, Yiping Dai. “Mechanism of the air temperature rise at the forced draught fan inlets in an air-cooled steam condenser”. Applied Thermal Engineering, pp:355–63, 2014.

10. Manassaldi JI, Scenna NJ, Mussati SF. “Optimization mathematical model for the detailed design of air cooled heat exchangers”. Energy pp:734–46, 2014.

11. Li Li, Xiaoze Du, Lijun Yang, Yan Xu, Yongping Yang.,” Numerical simulation on flow and heat transfer of fin structure in air-cooled heat exchanger” Applied Thermal Engineering 59., pp77-86., 2013.

12. Moore, J., Grimes, R., & Walsh, E. J., “Performance analysis of a modular air cooled condenser for a concentrated solar power plant”., ASME 2012 International Mechanical Engineering Congress and Exposition., pp. 715-724., November 2012.

Linear programming approach in optimization of Production Quantities (A Case Study of Dewan Farooque Motors Limited)

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Abstract: The mathematical programming is widely used technique for the optimization of production planning decisions to integrate the wide range of production activities while considering the cost and demand of the product in the industrial environment. In our experience most of companies do not have the unique production planning system and many difficulties arise to manage the resources, capacities and stocks. Whereas the procedures used in the formal production planning system do not works for the optimization of production decisions. This research paper provides methodology for the optimization of production quantities by using the mathematical programing approach which is acceptable for the short term/medium term production planning when demand of the product is deterministic in nature. The variety of mathematical programming techniques are available for the optimization but the focus of this study is most reviewed technique linear programing which entails the objective function of maximization of total profit that subjected to the variety of constraints (workforce level, time units, and quality levels) in the form of linear equations and inequalities. The purpose is to generate the optimum production quantities that provides the baseline for scheduling of production and each raw component over the finite planning horizon as to hedge against the delay in demand. Finally, solution is tested in the environment of automobile company for testing the reliability and validity of model.

Keywords: optimization, production quantities, linear programming, Automobile Company

1. INTRODUCTION

Literature shows that 10.2% of the total employment of the companies are directly engaged in the automotive sector and very small number of companies have the economic relevance to the automotive industry (Volling et al, 2013). Whereas Staeblein and Aoki, (2015) indicates that, the performance of automobile sector is greatly affected by the decisions regarding the optimization of production quantities due to the integration of production activities across the manufacturing environment (inventory, human resource, marketing and finance). Shapiro, (1993); Grossmann and Gosálbez (2010); Sadok, (2013), discussed, applications of mathematical programming approach in different categories of production planning (tactical, strategic and operational) for the optimization of production activities in process, discrete and job-order manufacturing. Thomas and Clain, (1993) defined the optimization of production quantities, as the operational approach of determining the tentative production quantities to be produced in the next several time periods subject to the number of production constraints (workers, facilities, plant capacity) to meet the demand of product in a planning horizon. The concept of optimization of production quantities is to be addressed for well over 30 years with the different titles such as, aggregate production planning, planning of production inventories and workforce, production capacity planning (Thomas and Clain, 1993; Shapiro, 1993; and Rota et al., 1997). The number of mathematical programming approaches are developed mainly: linear programming (LP) , mixed integer linear programming (MILP), dynamic programming (DP), fuzzy programming (FP), stochastic programming (SP) for the optimization of all cause-effect relationships in various production activities but the linear programming-based modeling is the most widely used technique which is reviewed in vast majority of the work related to the optimization of production quantities (Delgado et al., 1990; Shapiro, 1993; Spitter et al., 2005 Fahimnia, 2008, Sohier, 2006; and Filippi et al., 2017). Likewise, extensive number of simulation techniques are developed such as genetic algorithms, heuristic, metaheuristics, hybrid and other advanced mathematical programming languages (AMPL) for the solution of various types of mathematical models **(**Sohier, 2006**;** Fahimnia, 2008**;**Ghorbanzad et al., 2012**).**

2. LITERATURE REVIEW

By the end of 1980s, Hackman and Leachman (1989), put forward the first literature review about the concept of optimization of production quantities by means of LP/MILP models with regards to the number of production constraints subjected by the minimization of total cost of the production. Hackman and Leachman (1989), also establish a first framework for the LP based optimization of production quantities in the different manufacturing environments. After having the framework, several authors have contribute such as; Sohn, (2004); Sohier, (2006); Yang et al. (2009); `Alfieri and Matta, (2012); Lusa et al., (2012); Ghorbanzad et al. (2012); and Filippi et al., (2017), have developed LP/MILP based mathematical programming models for the optimization of production quantities in various types of industrial environments (multi-plant, multi-product, multi-warehouse) under various conditions of lead time and demand.

Similarly, Wang and Liang, (2004); Wang and Liang (2005); Mula et al., (2006) a; Mula et al., (2006) b; Ben et al., (2016), Entezaminia et al. (2016) and Gholamian et al., (2015), developed LP/MILP based fuzzy and Stochastic mathematical models for the optimization of aggregate production planning to achieve the inclusions of uncertainty in the multi-plant, multi-product and multi-warehouse industrial environments. Conversely, Grubbström and Huynh, (2006) and Lu et al., (2015), used Mixed Integer non-Linear Programming (MINLP) approach for the optimization of integrated production planning activities by the objective of minimizing the total cost which is subjected by various production constraints (assignments to the machines, resources usage capacity, flexibility in the matching of process, flexibility in products, and backlogs) in the larger steel plant of china.

Moreover, Martin et al. (1993), developed LP based model for the optimization of planning, warehousing and inventory related operations in the glass manufacturing sector. Furthermore, Costa et al., (2014), proposed LP base model for the solution of integrated supply chain planning system, in the steel sector. Whereas, Volling et al., (2013) and Staeblein and Aoki (2015), apply the simulation and mathematical modeling approach for the order-driven planning in the automobile sector.

3. SCOPE OF PAPER

The focus of this research paper is to apply LP based mathematical modelling approach that precisely define the objective function and some set of constraints related to the production activities for the optimization of production quantities in the automobile sector. The solution of the model is the optimum production quantities that provide the baseline for;

i. Production scheduling (days/weeks/months)
ii. Production Control at the end of planning period
iii. Material scheduling (days/weeks/months)
iv. Control the backlogged quantity at the end of planning period

It is also important to point out here that, the company of applications of this study may also be the other assembly line production systems beside the automobile assembly plant.

4. RESEARCH METHODOLOGY

The research methodology used in this study is threefold. Firstly literature review, In this regard we conduct many searches by using the main keywords of the study and obtained the sufficient number of searches. After that, required searches are filtered by using AND operator to connect the more focused keywords. Further ahead we searched more recent relevant papers from 2016 up to now, by applying the same keywords and combinations of keywords. In particular, we found seven surveys related with optimization of production quantities (Hackman and Leachman, 1989; Sohn, 2004; Sohier, 2006; Yang et al., 2009; `Alfieri and Matta 2012; Lusa et al., 2012) and also check the references to be used by the authors and citations of the paper. Finally, we looked for the papers that have cited the significant contribution in the topic e.g., (Sohier, 2006 and Ghorbanzad et al., 2012). This allowed us finding up-to-date research in this field (e.g., Filippi et al., 2017). Cross checking of citations of all the articles we compiled consisted of 24 journal articles, 4 conference proceedings, 2 books and 1 master thesis, 1 PhD thesis. The articles came from 11 different journals and sources are, International Journal of Production Economics (9 references), European Journal of Operational Research (5 references), Computers and Chemical Engineering (2 references), International Journal of Production Research (2 references), Computers and Industrial Engineering (1 reference), Robotics and Computer Integrated Manufacturing (1 reference), Fuzzy Sets and Systems (1 reference), International Journal of Contemporary Business(1 reference), Chinese Journal of Chemical Engineering (1 reference), and the Journal of Manufacturing Systems (1 reference). Secondly, the LP model to be used for the optimization of production quantities is formulated with regards to the production constraints and the objective function by using the real data of automobile assembly plant. Finally, the proposed model is executed by means of TORA software and the solution is tested for its reliability and validity in the environment of automobile assembly plant.

5. FORMULATION OF LP MODEL

The formulation of LP model is managed into three sections. First, develop the assumptions for the model. Second, the formulation of objective function that is the maximization of the total profit and the production constraints (man-hours, quality level, time units) by assuming the fixed policy. Finally, the execution of model by means of TORA software to check the validity of model in the company environment.

It is mentioned above that, this study is the case study of automobile company. Suppose that, the company has i number of different assembly lines and provides the single product from each different assembly lines i where

$i = 1,2,...,n$

x_i = optimum production quantities of product *i*

c_i =price co-efficient of product *i*

$c_{i,j}$ = constraint *j* for product *i*

b_j = Limit of constraint *j*

5.1 Assumptions

The model is based on the following assumptions:

i. The demand of the products is deterministic in nature
ii. The objective function and the respective constraints are linear
iii. The objective function and constraints follow the fixed policy

5.2 Formulation of Objective function and Constraints

The objective function used in the proposed model is to maximize the total profit for the single period of time e.g. month and follow the linear property with respect to the profit per unit (Sohn, 2004; Jolayemi and Olorunniwo, 2004; Pergher and Teixeira, 2017). The objective function subjected to that of constraints is given hereunder.

$$Z_{\max} = \sum_{i}^{n} c_i x_i$$

Subjected to: (1)

$$\sum_{i,j}^{n} b_{i,j} x_{i,j} \leq b_j$$

The constraints incorporated in the model are hereunder:

i. the balanced equation of Gross man-hours
ii. the balanced equation of Defect Per Unit (DPU)
iii. the balanced equation of Unit Per Hour (UPH)

5.2.1 Objective function

In general the profit per unit in automobile industries is fixed as the 6% of the price per unit as shown in Table 1.

Table 1. Profit per unit

Profit	**Product 1**	**Product 2**
Price/unit (PKR)	750000	866666
Profit/unit(PKR)	45000	53000

From Table 1

$$Z\max = 45000X_1 + 53000X_2 \tag{2}$$

5.2.2 Gross man-hours per unit

Shapiro (1993); Radulescu and Radulescu (2007), defined as the product of workforce and working hours in a planning horizon divided by number of units produced in that interval of time. The derived constraint from the definition is given in Table 2.

Table 2. Man-hours per unit

Description	**Product 1**	**Product 2**
Total Gross Man-hours/ month	37400	48000
Gross Man-hours/unit	22	24

From Table 2

$$22X_1 + 24X_2 \leq 85400 \tag{3}$$

5.2.3 Defects per unit (DPU)

Shapiro (1993); Tang and Lu, (2007), described as the total defects occur in the planning horizon divided by the total units produced in the same interval of time. The summary of derived constraint is given in the Table 3.

Table 3. Defects per unit (DPU)

Description	**Product 1**	**Product 2**
Total defects per month	20400	28000
Defects per unit (DPU)	12	14

From Table 3

$$12X_1 + 14X_2 \leq 48400 \tag{4}$$

5.2.4 Unit per hour (UPH)

Shapiro (1993); Wang and Lin, (2002) described as the total working hours in a planning horizon divided by the number of units produced in that internal of time. The summary of Unit per hour is given in Table 4.

Table 4. Units per hour (UPH)

Description	Product 1	Product 2
Total Units	1200	1400
Total time (hours)	216	216
UPH	5.5	7.5

From Table 4

$$5.5X_1 + 7.5X_2 \leq 24200 \quad \textbf{(5)}$$

5.2.4 Model summary

The model should determine the optimum number of production quantities which incur to the maximization of total profit for the each product in a single period of time i.e. month. The summary of model is given in Table 5.

Table 5. Model Summary

Objective function: Total profit	$Z\max = 45000X_1 + 53000X_2$ **Subject to:**
Constraint I: Gross Man-hours/unit	$22X_1 + 24X_2 \leq 85400$
Constraint II: Defects/unit	$12X_1 + 14X_2 \leq 48400$
Constraint III: Units per hour	$5.5X_1 + 7.5X_2 \leq 24200$

5.3 Execution of model

The Fig. 1 shows the architecture of the proposed model which provides the mechanism for the execution requirements of the model. The proposed software for the execution of the developed model is the TORA software. However the other modelling language MPL v4. 11 (USA, 2000) which also use the various relational data bases (Microsoft Access, SQL, Informix, Oracle etc.) to systemize the data with lesser adjustments. This provides the environment for the transparent data validity and tools for the data integrity to handle large amount of the data. Also, this helps for updating data by providing easy access on corporate data which in turn will be required for the execution of the model and also provides very good results for the standard production planning system which should update the inputs periodically for the rolling of planning horizon. The re-execution of model needs the update of inputs.

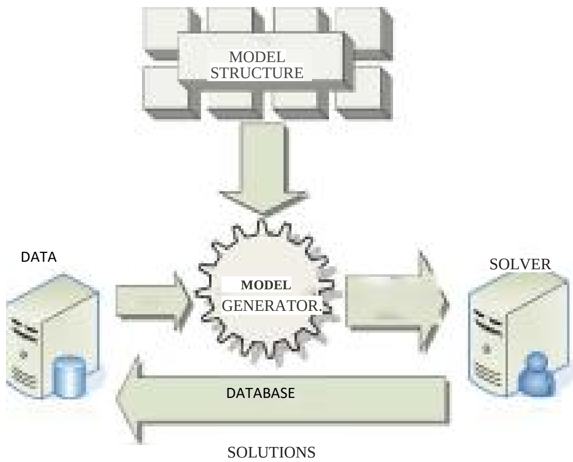

Figure 1. Models architecture

6. CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

As the literature shows that most of the companies do not have the unique approach for integrating the various production activities across the company. So that, mathematical modelling is the adequate approach of integrating the various production activities for the optimization of production resources. As the automobile assembly companies producing the many number of products and uses the thousands of smaller parts and sub-assemblies in their manufacturing environment. Hence the LP based mathematical modelling approach has been used for the optimization of production quantities by meeting the demand of product in the given planning horizon and also to avoid the stock out issues by having the effective control on the production resources. It is also important to point out that the proposed model is a solid and efficient option with condition of deterministic demand where the use of Fuzzy models are not very much realistic. This study has been conducted under some certain circumstances which originates the directions for the future research as given hereunder.

(i) The proposed models should be supplemented with another model to carry out the tasks of detailed production programming or sequence.

(ii) Other types of constraints could be incorporated, such as, process capability, equipment capability, inventory levels.

(iii) To consider the various types of uncertainties, such as, uncertainty in demand, uncertainty in lead times and uncertainty in quality variations

(iv) Extension of the models for the Enterprise Resources Planning (ERP).

(v) To use various types of information systems for the input data.

(vi) The proposed model in this paper may be converted into the construction blocks for as a decision support system for the aggregate production planning with imprecise data.

Furthermore, new versions of the proposed models can be formulated by considering the formulation and solution methods proposed in (Delgado et al, 1990). Finally, it would also be desirable to demonstrate the utility in the area of production planning in various types of production systems due to the great potential mathematical modelling.

7. REFERENCES

1. Alfieri A.; Matta A. (2012), " Mathematical programming formulations for approximate simulation of multistage production systems," *European Journal of Operational Research*," *V.* 219, N. 3, pp. 773-783

2. Ben O.; Ammar, Guillaume R.; Thierry C. (2016), "MRP parameter evaluation under fuzzy lead times" *Proceedings of 8th IFAC Conference on Manufacturing Modelling, FAC-PapersOnLine*, V. 49, No. 12, pp. 1110-1115

3. Costa C. M.; Machuca M. M.; Benedito E., Corominas A. (2014), "A review of mathematical programming models for strategic capacity planning in manufacturing," *International Journal of Production Economics*, V.153, pp. 66-85

4. Delgado M.; Verdegay J.L.; Vila M.A. (1990), "Relating different approaches to solve linear programming problems with imprecise costs", *Journal of Fuzzy Sets and Systems*. V.37, pp. 33-42.

5. Entezaminia A.; Heydari M. Rahmani D. (2016), "A multi-objective model for multi-product multi-site aggregate production planning in a green supply chain: Considering collection and recycling centers,"*Journal of Manufacturing Systems*, V.40, No.1, pp. 63-75

6. Fahimnia B. (2008), ""Modeling and Optimization of Aggregate Production Planning - A Genetic Algorithm Approach," *International Journal of Mechanical, Aerospace, Industrial, Mechatronic and Manufacturing Engineering* V.2, No.9, pp.1064-1069.

7. Filippi C.; Mansini R.; Stevanato E. (2017), "Mixed integer linear programming models for optimal crop selection,"*Computers & Operations Research*," V. 81, pp. 26-39

8. Grossmann I.E.; Gosálbez G.G. (2010), "Scope for the application of mathematical programming techniques in the synthesis and planning of sustainable processes," *Computers & Chemical Engineering*, Volume 34, Issue 9, pp.1365-1376

9. Gholamian N.; Mahdavi I.; Moghaddam R.T.; Amiri N.M. (2015), "Aggregate production planning with multiple objectives in a fuzzy environment,"*Applied Soft Computing*, V. 37, pp. 585-607

10. Ghorbanzad Y.; Eshlaghy A.T.; Kazemi M.A. (2012), "Optimization of Production Planning Using Mathematical Model of Behnoush Iran Company," Interdisciplinary Journal of Contemporary Research In Business, V.4, No.5, pp.845-856.
11. Grubbström R.W.; Huynh T.T.T (2006), "Multi-level, multi-stage capacity-constrained production–inventory systems in discrete time with non-zero lead times using MRP theory," *Proceedings of the 17th Production Research International Conference*, V.101, No. 1, pp. 53-62

12. Hackman S.T.; Leachman R.C. (1989), "A General Framework for Modeling Production," *Journal of Management Science*, V.35, No.4, 1989, pp.478-495.

13. Jolayemi J.K.; Olorunniwo F.O. (2004), "A deterministic model for planning production quantities in a multi-plant, multi-warehouse environment with extensible capacities,"*International Journal of Production Economics*, V. 87, No.2, pp. 99-113

14. Lu S.; Su H.; Johnsson C.; Wang Y.; Xie L. (2015), " Modeling and optimization methods of integrated production planning for steel plate mill with flexible customization," *Chinese Journal of Chemical Engineering*, V. 23, No. 12, pp.2037-2047

15. Lusa A.; Costa C.M.; Machuca M.M. (2012), "An integral planning model that includes production, selling price, cash flow management and flexible capacity," International Journal of Production Research, V. 50, No. 6, pp.3-63

16. Mula J.; Poler R.; Garcia J.P. (2006) a, "MR P with flexible constraints: A fuzzy mathematical programming approach," *Fuzzy Sets and Systems*, V.157, No.1, pp. 74-97

17. Mula J.; Poler R.; Sabater J.P.; Lario F.C. (2006) b, "Models for production planning under uncertainty: A review," *International Journal of Production Economics*, V. 103, No.1, pp. 271-285

18. Pergher I.; Teixeira A. (2017), "A multi-attribute decision model for setting production planning parameters," *Journal of Manufacturing Systems*, V. 42, pp. 224-232

19. Radulescu M.; Radulescu C. Z. (2007), "A Multi-objective Programming Model for Production Planning Under Environmental Constraints," *IFAC Proceedings,* V.40, No.18, pp. 771-776

20. Rota K.; Thierry C.; Bel G. (1997), "Capacity constrained MRP system: a mathematical programming model integrating firm orders, forecasts and suppliers", Universite Toulouse II Le Mirail. Departament d'Automatique,

21. Sadok T.; Zied H.; Nidhal R. (2013), "Optimal production planning for a manufacturing system: an approach based on PA ," *Proceedings of 7th IFAC Conference on Manufacturing Modelling, Management, and Control*, International Federation of Automatic Control, June 19-21, 2013, Saint Petersburg, Russia

22. Shapiro J.F. (1993), "Chapter 8 Mathematical programming models and methods for production planning and scheduling," *Handbooks in Operations Research and Management Science*, V.4, pp. 371-443

23. Sohier E. (2006), "Modelling a Complex Production Scheduling Problem- Optimization Techniques," Master Thesis, Department of Interaction and System Design, School of Engineering Blekinge Institute of Technology, Sweden.

24. Sohn S.J. (2004), "Modeling and Analysis of Production and Capacity Planning Considering Profits, Throughputs, Cycle Times, and Investment," PhD Thesis, Department of Industrial and Systems Engineering, Institute of Technology, Georgia

25. Spitter J.M.; Hurkens C.A.J.; de Kok A.G.; Lenstra J.K.; Negenman E.G. (2005), "Linear programming models with planned lead times for supply chain operations planning," *European Journal of Operational Research*, V. 163,No. 3, pp. 706-720

26. Staeblein T., Aoki K. (2015), "Planning and scheduling in the automotive industry: A comparison of industrial practice at German and Japanese makers," *International Journal of Production Economics*, V. 162, pp. 258-272

27. Tang L.; Liu G. (2007), " A mathematical programming model and solution for scheduling production orders in Shanghai Baoshan Iron and Steel Complex," *European Journal of Operational Research*, V. 182, No. 3, pp. 1453-1468.

28. L.J., Clain J.O. (1993), "Chapter 7 An overview of production planning," *Journal of Logistics of Production and Inventory*, V.4, pp. 333–370

29. USA (2000), "Maximal Software Corporation, MPL modelling system," Release 4.11, USA, 2000

30. Volling T.; Spengler T.S. (2011), “Modeling and simulation of order-driven planning policies in build-to-order automobile production,” *International Journal of Production Economics*, V.131, No.1, pp. 183-193

31. Volling T.; Matzke A.; Grunewald M.; Spengler T.S (2013), “Planning of capacities and orders in build-to-order automobile production: A review,” *European Journal of Operational Research*, V. 224, No. 2, pp. 240-260

32. Wang K.J.; S.H. Lin (2002), “Capacity expansion and allocation for a semiconductor testing facility under constrained budget,” Journal of Production Planning & Control V.13, No.5, pp. 429-437.

33. Wang R.C.; Liang T.F. (2004), “ Application of fuzzy multi-objective linear programming to aggregate production planning,” *Computers & Industrial Engineering*, V. 46, No.1, pp. 17-41

34. Wang R.C., Liang T.F. (2005), “Applying possibilistic linear programming to aggregate production planning,” *International Journal of production Economics*, V. 98, No. 3, pp.328-341

35. Yang S.J.; Yang F.C.; Wang K. J.; Chandra Y. (2009), “ Optimizing Resource Portfolio Planning For Capital-Intensive Industries Under Process-Technology Progress,” *International Journal of Production Research*, V. 47, No.10, pp.2625-2648.

USING MULTI SERVER QUEUEING MODEL TO IMPROVE HEALTHCARE DELIVERY AT OPTIMUM SYSTEM COST OF MALE OPD AT CIVIL HOSPITAL HYDERABAD, SINDH – PAKISTAN

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Abstract: Queue is the common occurrence of daily life in Hospitals. When the number of patients exceed the number of doctors then the queue is formed. Queuing models are used to study queue systematically. Queue or waiting line at hospitals are associated with waiting cost of patients, when patients are made to wait in the hospitals are supposed to pay some amount for being idle. This research aimed to evaluate the queuing system at Male Medical outdoor patient department at civil hospital Hyderabad. The data was collected for one week. The Parameters of this study were arrival time, service time, departure time, number of doctors (servers), waiting cost and service cost. The data was analyzed by using TORA optimization Software and MS -excel spread sheets. Analyses indicated that continuing the OPD with three doctors will not be optimum because of high total system cost i.e., waiting cost, service cost. Results shows optimum total system cost and Suggested servers (Doctors) would be increased from three servers to four.

Keywords. Que, waiting cost, serving cost, servers.

1. INTRODUCTION

Queue is the common occurrence in daily life at Hospitals (Bastani , 2009), especially in outdoor patient department (OPD). When the number of patients exceed the number of doctors then the queue is formed (Green l, 2011). Queuing models are used to study queue systematically. Queue or waiting line at hospitals are associated with waiting cost of patients, when patients are made to wait in the hospitals. Outdoor patient department is one of the most visited at hospital and it is also the very initial contact of a patient with a hospital staff to get service. The major problem faced by the patients in OPD is overcrowded queues which result in delay for patients to consult the doctor (Winston, 2004). Patients waiting for long time to receive medical services which results as waiting costs to them (Ikwunne and Onyesolu, 2016). Poor health services are acting as obstacles against the overall development of Pakistan (Saima Mustafa, 2015). Queueing theory is widely used in service organizations for analysis and modeling of processes that involve waiting lines (Olorunsola et al., 2014). In recent years it has been sought to apply queuing theory techniques in health care services (Varma, 2016). It is required to increase the customer satisfaction by reducing the queue and making service delivery efficient (Fomundam and Herrmann, 2007). Queuing analysis is the mathematical approach to simplify the queuing problems (Kembe.,etal 2012). Data of this research work was carried out in the male medical OPD at civil hospital Hyderabad, in order to optimize the total system cost, keeping in view the waiting of patients and service costs.

2. RESEARCH METHODOLOGY

Data was collected from the medical OPD of Civil Hospital Hyderabad. Data collection parameters were arrival time of the patient in the hospital and leaving time of the patients from hospital, opportunity cost and service cost (salary of doctors). This data was collected for one week of time. The model was based on the following assumptions according to the queuing theory;

1. The servers are doing at their full capacity
2. Discipline of queue will be on first come, first served (FCFS) basis
3. Here server means doctors not any other medical personnel.
4. Service rate doesn`t depends on length of the line; service provider is not going faster because of longer line.
5. The mean arrival rate (λ) must be greater than that of service rate.
6. There isn`t limited number of queue (infinite).
7. Lambda (λ= Poisson probability distribution) will be calculated for Arrivals (patients per unit time).
8. Average or Meu (μ) will be calculated to have exponentially distributed service times.

2.1 THE M/M/S MODEL

It is supposed that the patient's arrival follows the poison probability distribution at the mean arrival rate (λ) patients per unit time. As defined earlier that the patients in the system will be served on the basis of first come, first served basis. The serving times are exponentially distributed with the mean of patients per unit time and number of servers (s).
Following cases may happen if there are n number of patients at the time at any point.

- If n < S means number of customers/patients are less than doctors, then there will be no formation of queue and the number of servers will not be busy. Therefore, service rate will be $\mu_n = n\mu$; $n < s$.
- If the value of $n \geq S$, It means the number of patients are more than doctors or servers, in this case all of the servers will be busy and the overall service rate (**μ**)will be given by this equation $\mu_n = S\mu$; $n \geq S$.

Where,

μ = Service rate per unit time.
λ = Rate at which the patients arrive at OPD.
S = Number of servers.
n = Number of patient's
P_o = probability of when there are zero customers/patients in the system.
Ls= Number of the patients in the system
Wq = Expected time of the patient that he/she spends while remaining in queue.
Lq= Number of patients in the que
Wq = Expected time of the patient that he/she spends while remaining in queue.
Ws = Expected time of the patient that he/she spends while remaining in the system.

2.2 COST EVALUATION

For the evaluation and determination of the optimum number of the servers, it is necessary to consider the two opposing costs i.e. Service cost & opportunity cost for making the decision for optimum the system cost. Therefore, these two types of the costs are incorporated in the study as mentioned below;

1. **Service cost:** The cost that is paid by the hospital administration in terms of salary to the doctors.
2. **Opportunity cost:** waiting cost of the patients.

Economic analysis of the cost will help the management to make a balance between the increase of service cost by providing better service and decreasing waiting cost of the patients that incurs for waiting in the hospital.

Expected Service Cost $E(S_c) = SC_s$ --- (1)

Cost paid by the customers / patients due to waiting in the system

$E(W_c) = (\lambda W_s) * C_w$ ----------- (2)

Where

λ = Arrival rate
W_s = mean time that any patient is supposed to stay is the system

On summing up equations (1) and (2) we have,

Estimated Total Costs $E(TC) = E(S_c) + E(W_c)$ ---------------------------- (3)
Estimated Total Costs $E(TC) = SC_S + (\lambda W_s) C_w$ --------------------------- (4)

3. Data Analysis

Data was analyzed in two phases; Firstly, variables i.e., arrival rate (**λ**), service rate (**μ**) and number of servers (**c**) were put in the TORA software for obtaining the performance measures (Figure: 1); Secondly; the data was further put into the Microsoft (MS) excel to calculate the costs i.e., service cost, opportunity cost, and total system cost. (Table. 2). Then the graphs were plotted in MS excel (Fig. 2, 3, 4 and 5).

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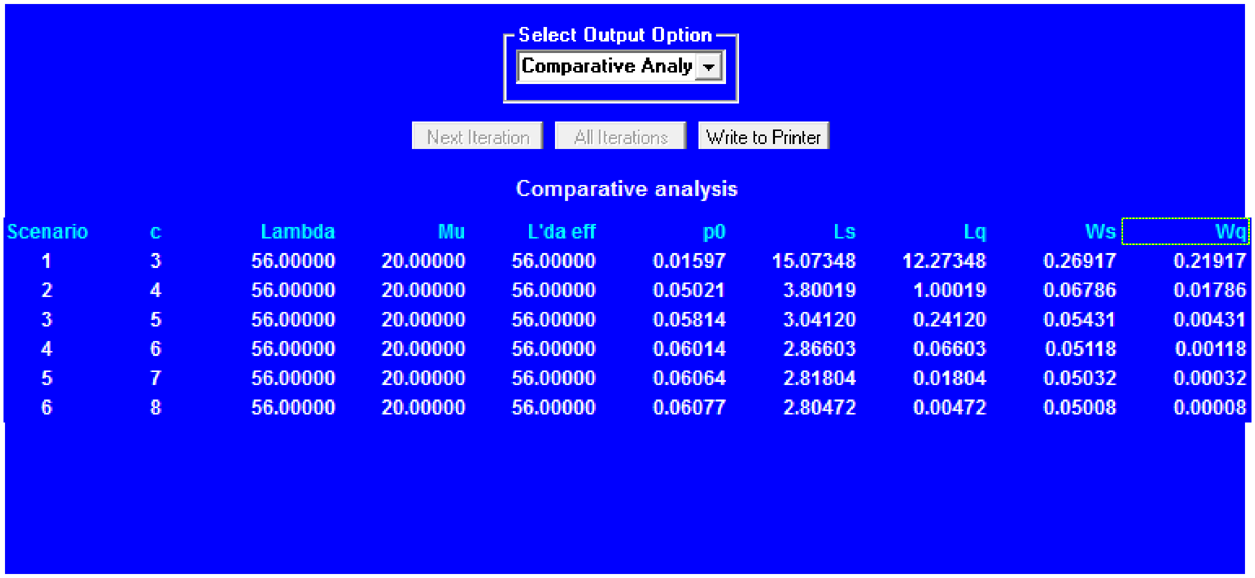

Select Output Option

Comparative Analy

Next Iteration

All Iterations

Write to Printer

Comparative analysis

Scenario	c	Lambda	Mu	L'da eff	p0	Ls	Lq	Ws	Wq
1	3	56.00000	20.00000	56.00000	0.01597	15.07348	12.27348	0.26917	0.21917
2	4	56.00000	20.00000	56.00000	0.05021	3.80019	1.00019	0.06786	0.01786
3	5	56.00000	20.00000	56.00000	0.05814	3.04120	0.24120	0.05431	0.00431
4	6	56.00000	20.00000	56.00000	0.06014	2.86603	0.06603	0.05118	0.00118
5	7	56.00000	20.00000	56.00000	0.06064	2.81804	0.01804	0.05032	0.00032
6	8	56.00000	20.00000	56.00000	0.06077	2.80472	0.00472	0.05008	0.00008

Figuer.1 Performance measures of the queuing data collected from the Male medical OPD of civil hospital, Hyderabad

Table 2. Summary of queuing model outputs

Servers/Doctors (s)	*3*	*4*	*5*	*6*	*7*	*8*
Arrival rate	56	56	56	56	56	56
Service Rate	20	20	20	20	20	20
Utilization Factor	93.3%	**70%**	56%	46.6%	40%	35%
Probability that system will remain idle	0.016	**0.05021**	0.058	0.0601	0.60564	0.061
*Expected number of patients in the system **(hr.)***	15.07	**3.80019**	3.042	2.866	2.81804	2.804
*Expected number of patient in the queue **(hr.)***	12.27	**1.00019**	0.241	0.6603	0.01804	0.005
*Expected waiting time of the patient in the system **(hr.)***	0.27	**0.07**	0.054	0.051	0.0503	0.058
*Expected time patient spend in the queue **(hr.)***	0.22	**0.02**	0.004	0.0011	0.00032	0.008
*Total System cost /hr. **(PKR.)***	6761.2	**4407.6**	5026.4	5810.21	6629.93	745.4

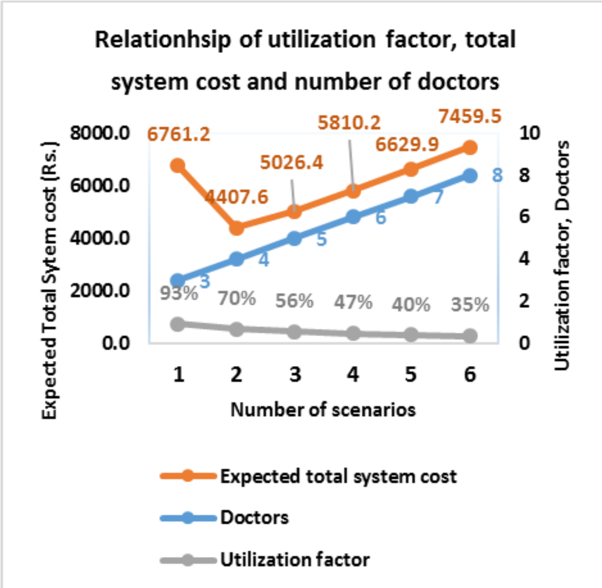

Fig. 2
Relationship of utilization factor, total system cost, and service level/number of doctors

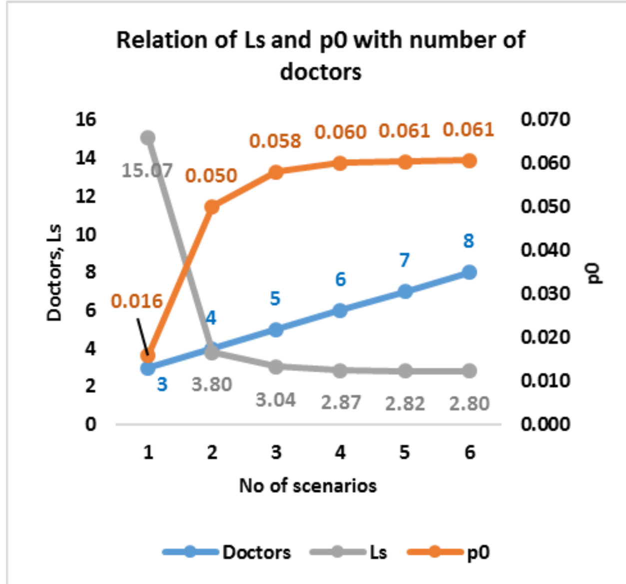

Fig. 3
Relationship of expected number of customers/patients in the system (ls), probability of the system to remain idle p0, number of doctors

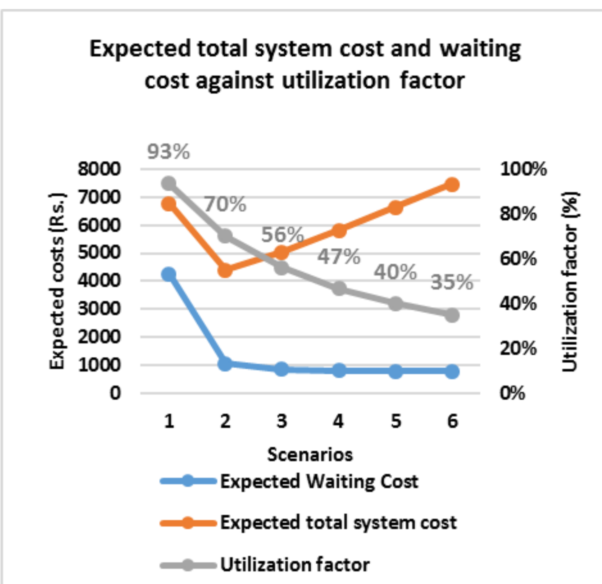

Fig. 4
Relationship of total system cost, waiting cost, and utilization factor

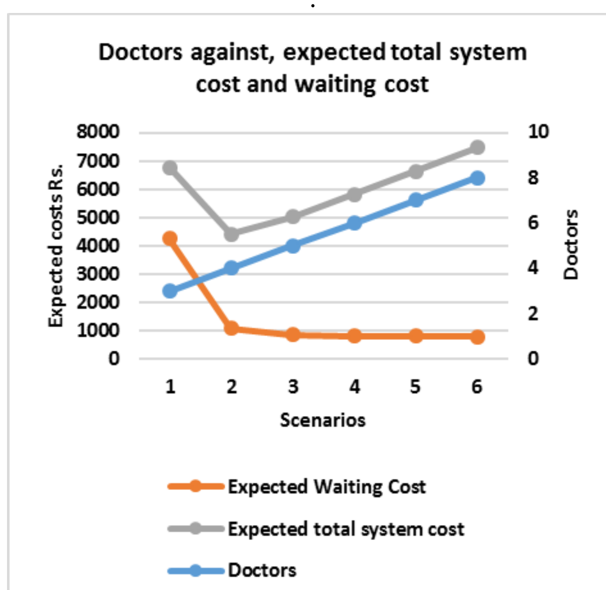

Fig. 5
Relationship of expected total cost, number of doctors and expected waiting cost

4. Results and Discussion.

Results indicated that the total system cost of Male Medical OPD Civil hospital Hyderabad with 3 doctors was PKR. 6761.2/hr. with overutilization of doctors as, 93.3%. Queuing length/waiting line of the patients and overutilization of doctors could be reduced to optimum service level at optimum total system cost i.e., Service cost and waiting cost were achieved. If one number of doctor was increased i.e., from 3 to 4 doctors (servers) then the total system cost decreased from PKR. 6761.2/hr. to PKR. 4407.6/hr., with utilization factor i.e., 70%. It can be seen in the fig: 2 that, probability of the system to remain idle is continuously increasing with increasing number of doctors and on the same time the number of customers in the system (Ls) is inversely proportional to the number of doctors and probability of the system to remain idle. It should also be noted that patients' average waiting time in the system (Ls) and in the queue (Lq), congestion in the system (Ls) is also decreasing at this service level. If the number of doctors was to be increased further, then the other variables i.e., Utilization factor, Wq, Lq, p0, Ls, Ws went on decreasing but the total system cost came out with increasing ratio as discussed in table: 2, fig: 1, fig: 3 and fig: 4.

Since the study aimed to find out the optimum service level at the OPD. Perhaps the optimum service level could be achieved at the point, where the waiting cost and service cost remain optimum, keeping in view that the waiting time of the patents should be also be optimized. Therefore, the optimum service level would be achieved if the OPD management hires one more doctor.

Figure.1 and Table 2. Shows average arrival rate of patient per unit time and average service rate per unit time, expected number of patients in the queue, expected waiting time of patient in the system, expected time patient spend in the que, probability of system to be idle, utilization factor and total system cost. i.e., service cost, waiting cost.

Similarly, graphs show in figure 2, 3, 4 and 5 that the optimum service level (optimum system cost) achieved when the servers are 4 instead of 3 servers (Doctors). Overutilization of doctors could be reduced with increasing the number of servers (Doctors). Graphs show the relationship between servers, utilization of doctors, total system cost and number of patients.

5. CONCLUSION

Results reflect that present service level of 3 doctors at the Male Medical OPD Civil hospital, the total system costs were PKR. 6761.2/hr. with their utilization factor of 93.3%. If one number of doctor is increased i.e., from 3 to 4 servers with total system cost PKR. 4407.6/hr. and 70% utilization factor. It should also be noted by using this model the patients' average waiting time and congestion in the system is also decreasing at this service level.

6. REFERENCES

1) Bastani, P., 2009. A queuing model of hospital congestion. Distribution. Simon pp. 33-37
2) Fomundam and Jeffrey Herrmann 2007. Survey of queuing theory applications in health care, ISR Technical Report, pp.5-18.
3) Green.L. Yih, Y., 2011. Queuing theory and modeling. Handbook. Health. Delivery. Syst., pp.1-22
4) Tochukwu A. Ikwunne and Moses O. Onyesolu 2016. Optimality Test for Multi-Sever Queuing Model with Homogenous Server in the Out-Patient Department (OPD) of Nigeria Teaching Hospitals, pp. 2-9.
5) Kembe, M.M., Onah, S., 2012. A Study of Waiting and Service Costs of A Multi-Server Queuing Model In A Specialist Hospital. Ijacst 1, 19-23
6) Saima Mustafa and S. un Nisa 2015. A Comparison of Single Server and Multiple Server Queuing Models in Different Departments of Hospitals, Journal of Mathematics Vol.47(1)(2015) pp.73-80.
7) Olorunsola, S.A., Adeleke, R.A, Ogunlade, T.o, 2014. Queuing Analysis of Patients Flow in Hospital. IOSR J. Math. 10, 47-53.
8) Varma, S.P., 2016. Waiting Time Reduction in a Local Health Care Centre Using Queuing Theory, ISOR pp.12, 95–100.
9) Winston, W.., 2004. Queuing Theory. Operation Research 1051–1144.

IMPACT OF AGE AND EXPERIENCE OF DRIVERS ON DRIVING ANGER

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Abstract: An empirical study was carried out to analyze the influence of age and experience of drivers on driving anger. Data was collected through a questionnaire of AAA foundation. 144 responses were collected from the drivers with the use convenience sampling technique from the students and teachers of Mehran university of Engineering and Technology, Jamshoro, who used to drive regularly. Further data collected was analyzed in two stages. Firstly reliability of the data was gauged with a well-known research technique Cronbach's alpha to measure the internal consistency of the scales. At the second stage, descriptive statistic techniques were used to analyze the data. The results indicated that level of anger decreases with the increase in experience of drivers in all groups and similarly anger decreases with the increase in age except age group of 38-42 years.

1. INTRODUCTION

Anger is one of the negative emotions and is resembled with the feeling of irritation (Mizell, 1997) and annoyance. However driving anger can be explained as the anger which occur in any traffic encounter (Hennessy, 2016) i.e. traffic congestions, anonymity and hostile gestures (Deffenbacher et al., 2003), road rage (Roberts and Indermaur, 2005). Driving anger is the kind of emotion that is experienced behind the vehicle`s steering wheel, it is more probable at the time when drivers are previously under stress or pressure (Priyanka and Aditi Usha Tigga, AIBAS, Aimity University, Gurgaon, Haryana, 2015)**.** Furthermore it causes the origination of confrontational aggression and suggest offender to harm another person (SWOV Institute for Road Safety Research, 2012)(Deffenbacher et al., 2003)(Schafer, 2015)**.** It is injurious in all the ways i.e., socially, physically as well as psychologically (Priyanka and Aditi Usha Tigga, AIBAS, Aimity University, Gurgaon, Haryana, 2015). Anger has been indicated as a significant element of aggressive driving in an incident in which an angry driver deliberately kills the people on the road in response to the occurrence of dispute in traffic (Mizell, 1997). High anger drivers not only put themselves in the high risk of crash but they likely make other driver to be the victim of this (Deffenbacher et al., 2016).

According to (Underwood et al., 1999) anger is in with the positive correlation with the number of accidents. Furthermore the effects of anger are not restricted to the boundaries of highways but it`s effects are also experienced on the post travelling life of drivers i.e., family relations (Deffenbacher et al., 2003). People of younger age are found to be angrier than older aged group (Roberts and Indermaur, 2005). On the other hand it is also reported that driving anger decreases with the increasing age (Deffenbacher et al., 2016).

The present research aims to measure the anger level of the drivers (teachers and student) of Mehran University of Engineering and Technology, Jamshoro, Sindh, Pakistan, keeping in view the age and experience and their impact on the driving anger. Although sufficient literature is available to explore the driving behavior in terms of anger but in the context of Pakistan it is required to conduct the study to add some literature which can reflect the angry driving behaviors of inhabitants of corresponding country.

2. METHODOLOGY

2.1 Data Collection and analysis

Data was collected by using the convenience sampling technique and the data collection instrument was questionnaire as provided by Dr. Larson [aaafoundation.org]. The questionnaire was consisted of two section i.e., demographics and anger variables. Demographics i.e., age, experience. Furthermore, anger variable section consisted of 10 questions. For anger responses, respondents were provided with the four points scale as used by Dr. Larson in his study i.e., 0= never, 1= sometimes, 2=often, 3= always. The same scale was used to summarize the data which was proposed by 'Dr. Larson'. Statistical package for social sciences (SPSS) version 18 was used as the tool to analyze the data. Data was analyzed in two stages, firstly reliability of the data was checked using Cronbach alpha. Secondly, the descriptive statistical techniques (frequency, percentage, mean and standard deviation) were used to analyze the data.

3. RESULTS AND DISCUSSIONS

The result is consisted of four sections. Demographics section presents the demographics characteristics of the respondents i.e., age and experience. Second and third and fourth section present the measurement of anger and the relationship of age and experience with driving anger responses respectively.

3.1 Demographics

This study was conducted in 144 drivers (i.e., students and teachers) of Mehran university of Engineering and technology, Jamshoro. Responses were taken from the drivers of different age and experience as shown in fig: 1 and 2. The age was categorized in the five age groups i.e., (18-22), (23-27), (28-32), (33-37), (38-42), (43+). It can be seen in the fig: 1 that (18-22) age group has the greater percentage (55.56%) as compared to other age groups, the reason is quite clear That data has been collected from the university and students were more as compared to teachers; that's why this group bear large frequency. Similarly, in fig: 2 the respondents having experience (0-6) years have more percentage than other groups because this group belongs to younger generation and those are mostly students.

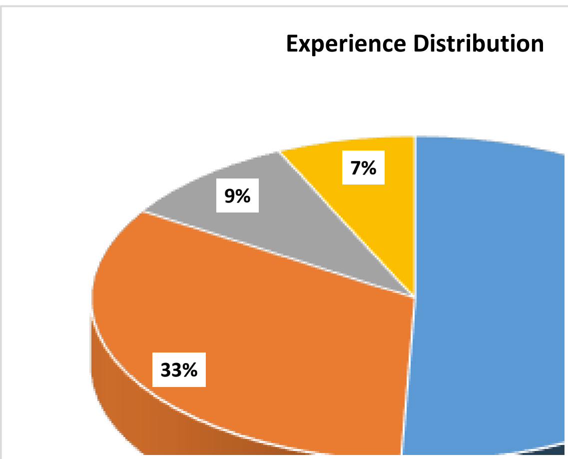

Figure 1. Age Distribution

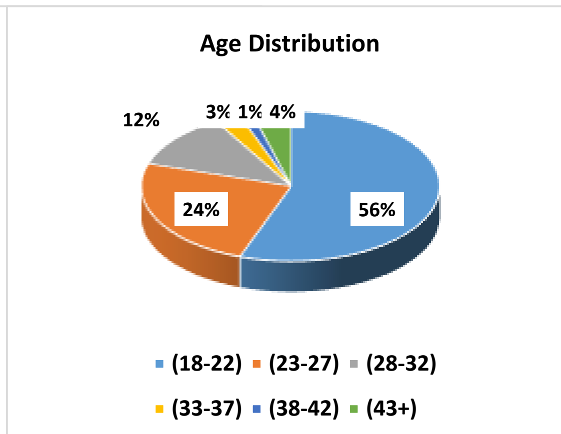

Figure 2. Experience Distribution

3.2 Measurement of Anger Among respondents

Respondents were given following ten question to respond for measurement of anger among them.

Descriptive Statistics				
S.No	Question	Mean Score	Std. Deviation	Median
1	I get angry at fast drivers.	1.35	0.901	1.00
2	I get angry at slow drivers	1.45	0.960	1.00
3	I get angry when any driver over taking.	1.08	1.061	1.00
4	I get angry at malfunctioning.	1.68	0.929	2.00
5	I get angry at traffic jam	1.92	1.061	2.00
6	Spouse or friends tell me to calm down.	1.31	0.918	1.00
7	I get angry at tailgaters	1.47	1.115	1.00
8	I get angry at my passengers.	0.76	0.975	0.00
9	Get angry at malfunctioning spotlights.	1.85	0.861	2.00
10	Get angry when multilane highway narrows.	1.64	0.980	1.00

Table: 1 Table 1 shows the mean and standard deviation values for all the questions asked from respondents to measure the anger.

There was the anger among all the respondents as mean for all anger questions asked was in between 1 and 2, which reflects that they get angry sometimes and often respectively.

3.3 Impact of age on driving anger

The plotted graph in fig: 3 shows the mean of scores on y axis and the x axis shows the questions. It can be seen that the mean of anger responses for the lowest age group (18-22) is the highest in the six questions i.e., Q1, Q3, Q4, Q5, Q9, Q10 as shown in fig: 3. Second age group (23-27) has secured the highest mean score in three questions i.e., Q2, Q6, Q7. Third age group (28-32) has got the highest mean score in two questions i.e. Q7 and Q8. Fourth age group (33-37) has secured the lowest score in 8 questions whereas the las age group (38-42+) has secured the highest mean score in only one question i.e., Q2. It is quite difficult to interpret and summarize the results of the graph that is shown in fig: 2 that`s why another graph which is plotted in fig: 4 which gives out mean anger score of all the ten variables taken from each of the age group

Note: Error bars in all the graphs indicate the standard deviation of the questions.

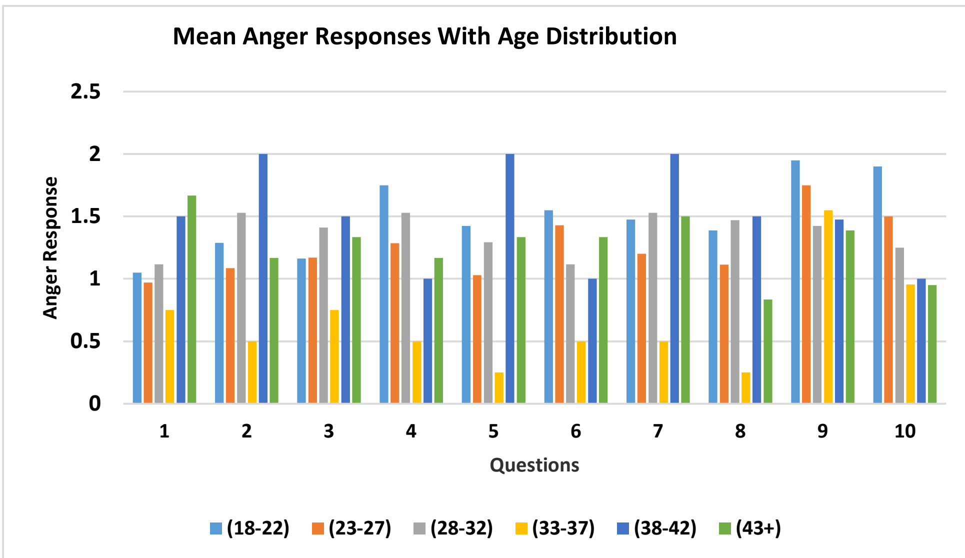

Figure 3. Anger Response with age Distribution

Keeping in view the above discussions let us have a look at figure: 4 which ranks anger level of all the groups by comparing the total mean calculated from the averages of 10 questions of each of the groups. Fig: 2 indicates that the angriest age groups is 18-22 (with mean score 1.60 which is highest). Then the second age group 23-27 has secured the mean of 1.31 (2nd highest), 28-32 and 33-37 have secured the average score of 1.26 and 0.50 respectively. The last groups which is 38-42+ has secured mean score 1.18.

Now it can be concluded that the anger levels decrease with the increase in age. In previous studies it has been underlined that age has negative correlation with the anger (Sullman et al., 2014) with aggressive driving behavior (Fallis, 2013). (Wickens et al., 2011) Reported that the youngest people have more driving aggression (anger) as compared to older age groups. (Roberts and Indermaur, 2005) Reported that younger people (boys) were underlined to be more aggressive and violent on the roads as compared to the older drivers.

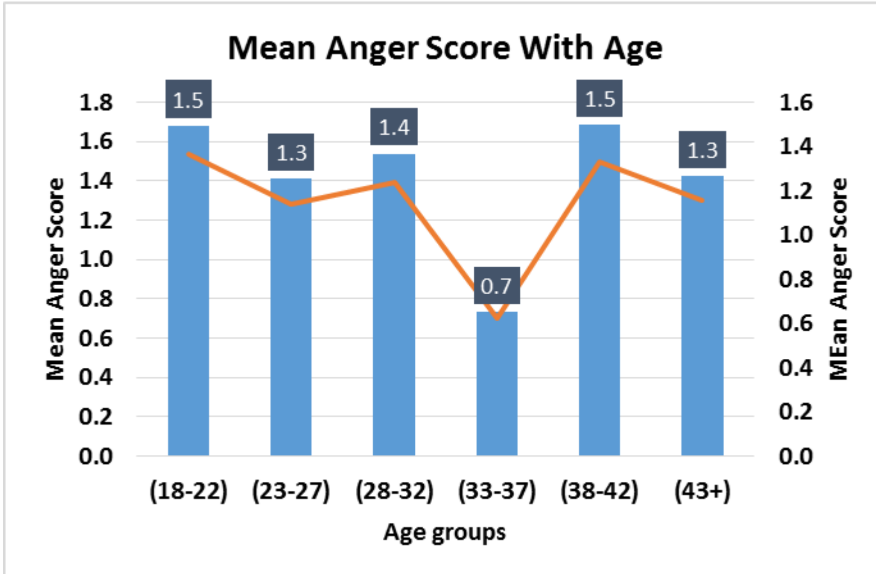

Figure 4. Mean Anger Score with age

3.4 Impact of experience on the driving anger

Similar to above analysis, experience was analyzed to have an impact on the driving anger. According to the level of experience, four groups were formed i.e., (1) 0-5, (2) 6-10, (3) 11-15, (4) 15+. The participant`s percentage can be seen in the fig: 4. Graph as shown in fig: 5 shows the mean score of all the variables from all the age groups, it is confusing to rank the groups on order of anger levels. Therefore, another graph is plotted shown in fig: 6 to make it simpler and easily interpretable.

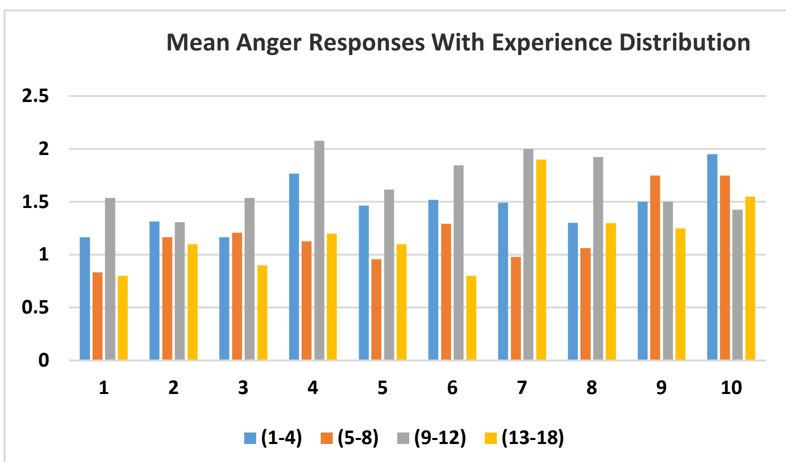

Figure 5. Anger with Experience

From fig: 6 it can be concluded that the drivers with less experience have high level of anger whereas drivers having more experience have low levels of anger. As reported by (Fallis, 2013) (Wickens et al., 2011) that the older adults engage less driving aggression (anger) because of their more driving experience. These results support first hypothesis which was that the driving anger level decrease with the increase in experience.

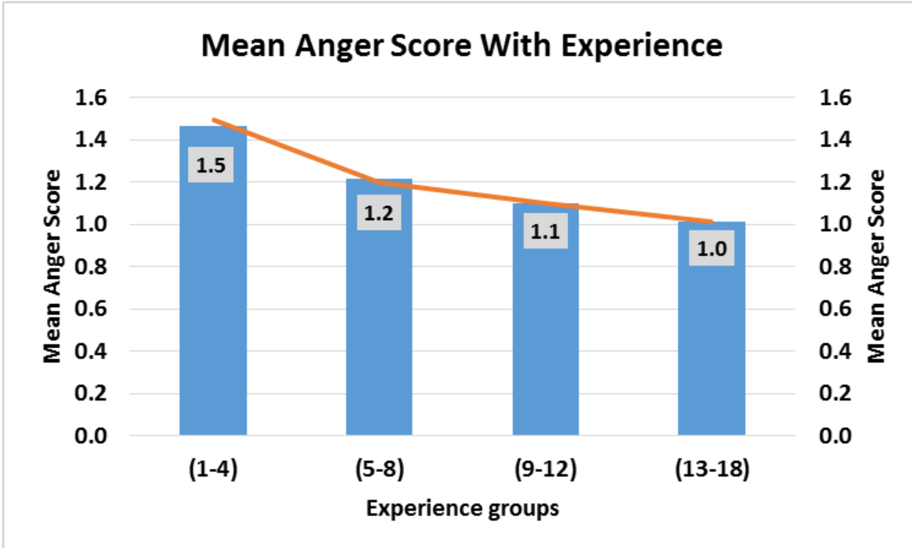

Figure 6. Mean Anger Score with Experience

4. Conclusion

Results indicated that the younger people are angrier/aggressive than the older people. More experienced drivers are less angry or aggressive as compared to the less experienced drivers. Hence it came to be true that with the increase in driving experience and age the anger level decreases. However, this study was conducted in the boundaries of Mehran University of Engineering and technology. The only literate drivers were focused in the data collection procedure and data was not collected in congested traffic situation these are the limitations of the study.

5. REFERENCES

1. Deffenbacher, J.L., Lynch, R.S., Filetti, L.B., Dahlen, E.R., Oetting, E.R., 2003. Anger, aggression, risky behavior, and crash-related outcomes in three groups of drivers. Behav. Res. Ther. 41, 333–349. doi:10.1016/S0005-7967(02)00014-1
2. Deffenbacher, J.L., Stephens, A.N., Sullman, M.J.M., 2016. Driving anger as a psychological construct: Twenty years of research using the Driving Anger Scale. Transp. Res. Part F Traffic Psychol. Behav. 42, 236–247. doi:10.1016/j.trf.2015.10.021
3. Fallis, A.., 2013. PERSONALITY FACTORS, AGE, AND AGGRESSIVE DRIVING: A VALIDATION USING A DRIVING SIMULATOR. J. Chem. Inf. Model. doi:10.1017/CBO9781107415324.004
4. Hennessy, D.A., 2016. Are narcissists really angrier drivers? An examination of state driving anger among narcissistic subtypes. Transp. Res. Part F Traffic Psychol. Behav. 42, 267–275. doi:10.1016/j.trf.2016.06.025
5. Mizell, L., 1997. Aggressive Driving : Three Studies. AAA Found. Traffic Saf.
6. Priyanka and Aditi Usha Tigga, AIBAS, Aimity University, Gurgaon, Haryana, I., 2015. Driving Anger and Mindfulness among young Adults 3, 537–541.
7. Roberts, L., Indermaur, D., 2005. Boys and Road Rage: Driving-Related Violence and Aggression in Western Australia. Aust. N. Z. J. Criminol. 38, 361–380. doi:10.1375/acri.38.3.361
8. Schafer, K., 2015. The Road Rage and Aggressive Driving Dichotomy : Personality and Attribution Factors in Driver Aggression.
9. Sullman, M.J.M., Stephens, A.N., Yong, M., 2014. Driving anger in Malaysia. Accid. Anal. Prev. 71, 1–9. doi:10.1016/j.aap.2014.04.019
10. SWOV Institute for Road Safety Research, 2012. Anger, aggression in traffic, and risky driving behaviour, SWOV Fact Sheet.
11. Underwood, G., Chapman, P., Wright, S., Crundall, D., 1999. Anger while driving. Transp. Res. Part F Traffic Psychol. Behav. 2, 55–68. doi:10.1016/S1369-8478(99)00006-6
12. Wickens, C.M., Mann, R.E., Stoduto, G., Ialomiteanu, A., Smart, R.G., 2011. Age group differences in self-reported aggressive driving perpetration and victimization. Transp. Res. Part F Traffic Psychol. Behav. 14, 400–412. doi:10.1016/j.trf.2011.04.007

CONDITION MONITORING OF INDUSTRIAL ROLLING-ELEMENT BEARINGS USING TEMPERATURE AND ACOUSTIC EMISSION ANALYSIS

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Abstract: Industrial rolling element bearings are important and basic component of rotating machines i.e. induction motors. Induction motors are used worldwide as workhorse in industries. Although, these devices are reliable, subject to many types of faults. According to IEEE motor reliably study bearing faults are frequent fault in motors. This paper, presents condition monitoring of bearings with temperature and acoustic emission analysis using FGPA board. These methods are widely used for fault analysis and are also applicable to bearings in generators or other machineries. The experiment is conducted on 0.5 HP single phase induction motor with healthy and unhealthy bearings to analyse difference in both cases. Spartan 3E is used in the experiment to acquire temperature and acoustic data. The acquired data is analysed with ChipScope tool and Discovery device. The practical results show that Temperature and acoustic emission analysis are effective techniques to diagnose the bearing fault at early stage.

1. INTRODUCTION

The rolling element bearing component plays a critical part in rotational machines; its functionality is directly related to the operational performance and consequently the reliability and safety of these machines and relevant systems (Yung et al. 2015). Condition monitoring of bearings is very vital because it helps in circumventing the huge production losses, breakdown and long life for rotating machines (Shashidhara et al. 2013). The location of faults and their rigorousness must be detected by bearing condition monitoring schemes. Induction motor is main components and pillars of industrial processes and has bearing as a major component in it. Their strength, low cost, easy repair and flexibility make them general in many applications from home to refined industrial equipment, which are mostly available for their integration commercially and industrially (Yepez et al. 2009)(Pavel et al.2013). According to an IEEE motor reliably study, bearing faults are the most common fault in electric motors. Bearing faults appears upto 41%, stator faults 37% and rotor fault 10% (Narwade at el. 2013).

There are many condition monitoring methods are usually applied to detect the various types of induction motor fault, including chemical monitoring, thermal monitoring, vibration monitoring, current monitoring techniques. Some of techniques such as current signature limited to machines having some electrical parts like IM motors while some methods have limitation of not detecting faults at early stages like vibration analysis (R. Patel et al. 2006). Temperature and acoustic emission are most popular methods for fault analysis and are also applicable to bearings used in generators or other industrial machineries. The biggest advantage of acoustic sensing method is probably that it has ability of detecting the earliest cracks/faults of the system and their subsequent growth, making possible fault detection before any other existing monitoring methods (Jose 2014). This research focuses on real time detection of bearing faults through harmonics frequency identification and thermal analysis.

In this paper, Fourier spectral analysis is done by Fast Fourier Transform (FFT) on sound data to extract the frequencies components appear in normal and abnormal conditions of bearings. In this study, Spartan 3E FPGA is used to acquire a temperature and sound sensors signals data. Sound spectrum is analysed on Xilinx XhipSxope tool temperature changes are plotted using Digilent Discovery device.

2. SYSTEM OVERVIEW

The main purpose of this research is to perform simultaneous data acquisition process as well as apply signal processing algorithms and display its outcome on a computer for visualize or indication of some physical parameter with use of existing visualization tools. The physical construction for this project requires six main components: Temperature sensor, Acoustic Sensor, DAC, ADC, Nexys2 FPGA board, and PC. Both the DAC and ADC will be physically connected to the Nexys2 through its I/O ports. Figure 1 shows the overall system design of research. Temperature and acoustic sensors are embed on the sides of motor bearing. The analog data of sensors are converted into digital data with 2 channel ADC.

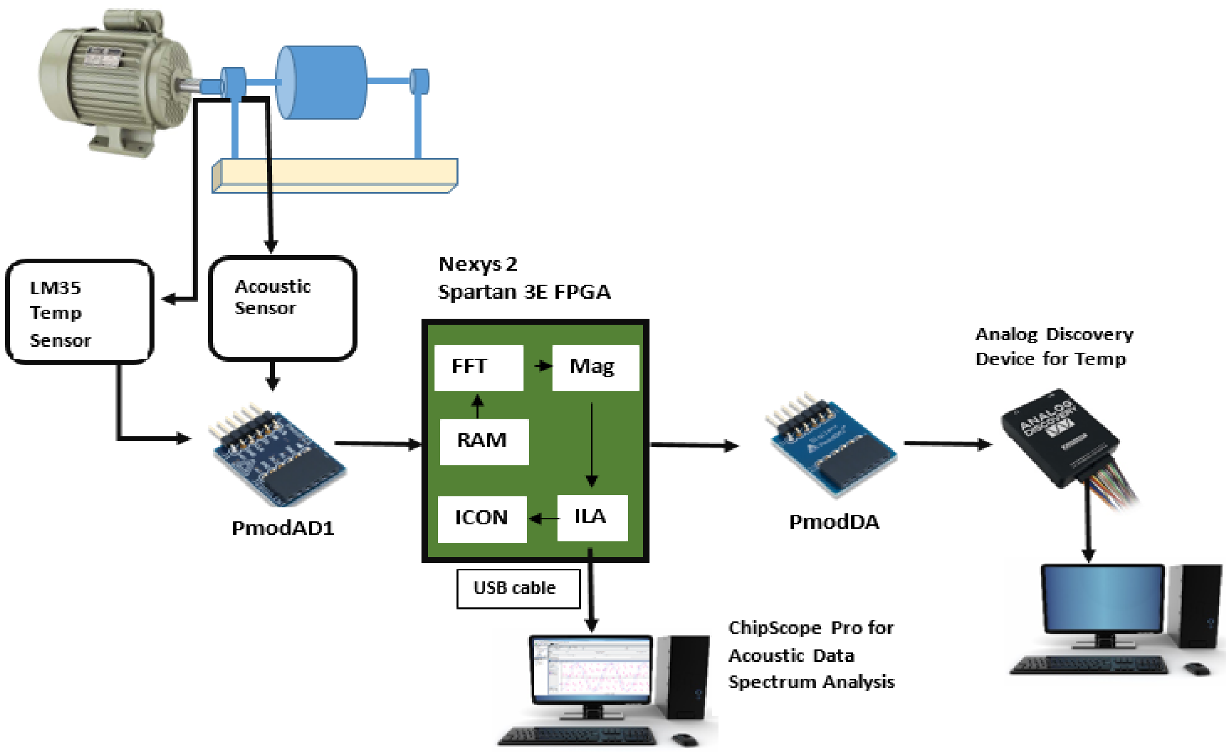

Figure 1. FPGA based system design

In this research, Nexys 2 Spartan 3E FPGA board is used. LM35 temperature sensor interfaced with FPGA board using ADC, with the help of DAC temperature changes are analyzed on Digilent Discovery Device. On the other channel of ADC, acoustic sensor is attached and the output of ADC is interfaced with FPGA board to capture acoustic data in order to perform FFT (Fast Fourier Transform) operation on acoustic data for fault analysis. FFT operation is performed with Xilinx Soft IP Cores. The result of FFT is combination of real and imaginary data so magnitude of FFT result is calculated with CORDIC IP cores. A spectrogram is combination of different frequencies of signal, one of the implementation methods of spectrogram is using FFT to get the frequency components and then calculate the amplitude of the FFT. The resultant FFT magnitude spectrum is analyzed on the Xilinix ChipScope Pro tool. This amplitude result shows how much of each frequency is in the input signal.

3. EXPERIMENTAL SETUP

The hardware setup designed for this research is shown in Figure 2. The test setup consists of a shaft with a dead weight which is similar to inside rotor of an induction motor and weighs about 2kg. The Shaft is supported by two deep groove ball bearings (ZMCO-6304-ZZ) and connected to an induction motor through a flexible coupling. Two bearing seating on the shaft are ground and hardened.

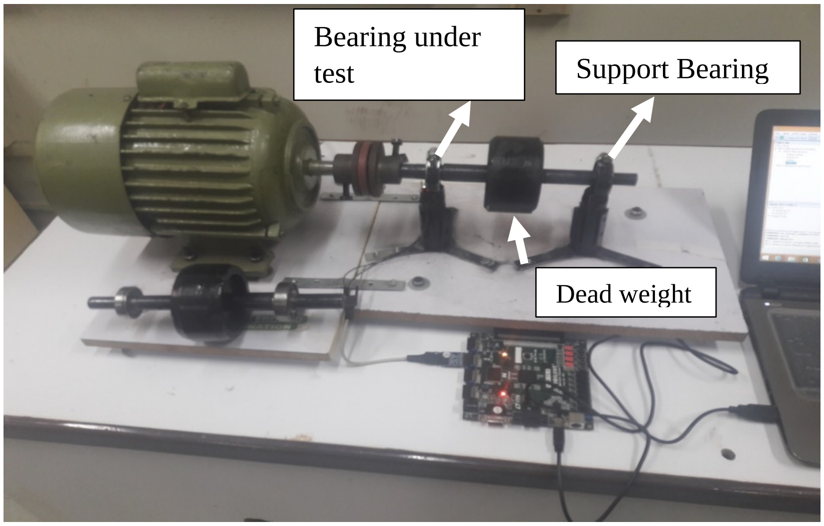

Figure 2. Hardware setup of experiment

3.1 PmodeAD1 (ADC)

VHDL code was instantiated to execute the analogue to digital conversion using PmodeAD1 ADC; requiring Inter IC Communication (I2C) protocol signals. Some of features of ADC are two 12-bit A/D Inputs**,** Simultaneous A/D conversion at up to one MSa per channel and Capable of excelling in even the most demanding audio applications (ADC official: 2016).

As PmodeAD1 is a 12 bit ADC, it is supplied with 3.3 V and its step size is calculated by dividing its supply or reference voltage 3.3 Voltage by 2^{12} or 4096, which results to 0.805 mV. The analog sound signal is converted and stored into RAM for FFT operation. The temperature sensor LM35 generates 10 mV per degree centigrade change in temperature Gaikwad (2013). For change is one centigrade temperature LM35 changes its output value by 10mV. ADC output for one ^{o}C is obtained by dividing sensor output with the step size 0.805mV. At 1 ^{o}C, sensor output is 10mV and ADC output will be 12.5. These digital output values again converted into analog data and plotted on Discovery device.

3.2 Pmode DA (DAC)

The Pmod DA2 is a 12 bit Digital-to-Analog converter. It has very low power consumption and ability to concurrently convert two separate channels of digital data provided over an interface similar to SPI (DAC Official 2016).

3.3 Acoustic sensor:

KY-038 Microphone sound sensor as shown in Figure 3 is used in this research. It is four pin module, two pins are used for 5V supply and two for analog and digital data output. It has capability to detect sound ranges from 20 to 20 khz. (KY-038).

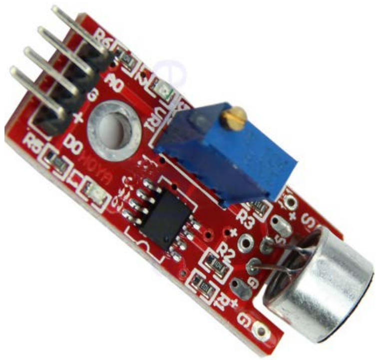

Figure 3 Acoustic Sensor

ISBN: 978-969-7710-01-0

The specifications of the test bearing used in the experiment are tabulated in Table 1 and the bearing used is shown in Figure 4.

Figure 4 ZMCO-6304 Bearing in healthy condition

Table 1: Specifications of the test bearing.

Sr.No	Features	Detail
1	Bearing Type	ZMCO-6304-ZZ
2	Number of Balls	7
3	Outside diameter	52mm
4	Inside diameter	20mm

4. SYNTHESIS RESULTS OF THE VHDL MODULES

Schematic diagram was declared as top level module of this research, it contains ADC, DAC, FFT, FFT Signal Control, and RAM and magnitude calculator VHDL modules. Figure 5 shows the Register Transfer Level (RTL) results for ADC and DAC.

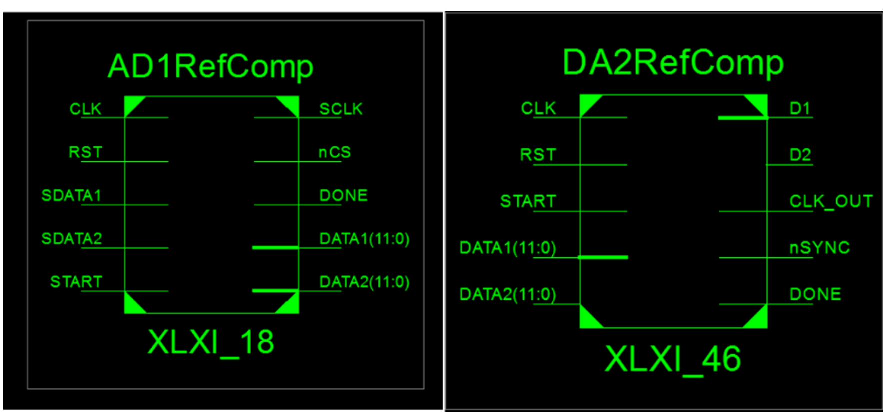

Figure 5. ADC and DAC Top Schematic

4.1 FFT IP Core Implementation in Spartan 3E FPGA and ChipScope

There are different implementation methods for FFT IP core on Xilinx FPGAs. The FFT core uses the Radix-2 and Radix-4 decompositions for calculating the Discrete Fourier Transform. In this research, Pipelined Streaming I/O is used because it offers continuous processing by using several butterfly processing engines. FFT core has basic clock, start, real and imaginary data and forward/inverse FFT inputs. There are some input and outputs as control signals to make the FFT core operational. Figure 6 shows FFT signal control module. The start control signal is kept high before the first input sample is presented at input. After keeping start signal high, at rising edge of clock we have to send all 1024 input samples one by one. As loading of samples are started FFT core count the samples and counting appears at input index till it gets to the 1024. During the computation of FFT busy signal goes high during this time none of input sample is accepted by FFT. DV signal goes high when data is presented at the output and fwd_inv is kept high for forward FFT computation.

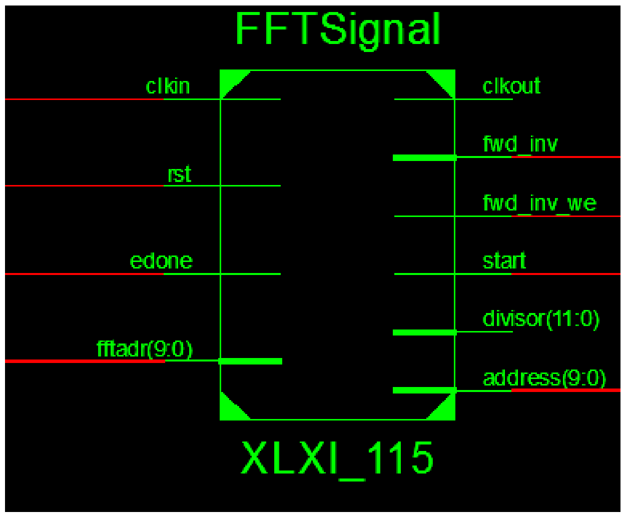

Figure 6. FFT Control Signal Module

Figure 7 shows block diagram of connections of RAM, FFT and ChipScope Pro core connections. FFT loads 1024 points stored ADC data from RAM. FFT presents 1024 points at output but 512 are mirror of first 512 points. After calculating magnitude of FFT data is plotted on ChipScope tool.

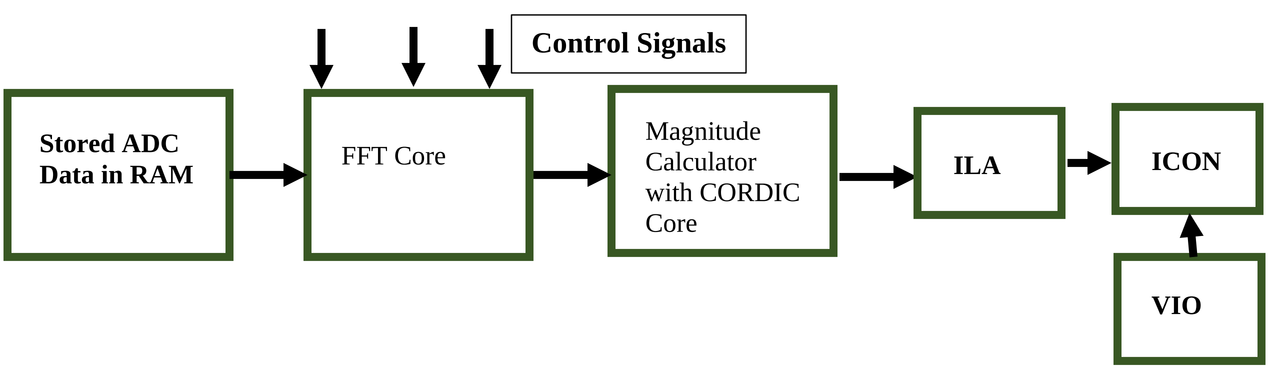

Figure 7. Block diagram RAM, FFT and chipscope cores connection

To be able to visualize the output amplitude of FPGA FFT in the analog format, it is needed to initialize the ChipScope basic cores. Internal Logic Analyzer (ILA) and Virtual Input Output (VIO) cores have been used and connected to the main Integrated Controller (ICON) core. In ILA core, a trigger signal is a signal that we want to monitor or debug in order to verify their working so it is needed to define how many trigger signals are going to monitor. Whenever a trigger is added to an ILA core, it is also needed to define the length of each trigger signal. In this research 13 bit trigger is used for amplitude visualization because magnitude of 12 bit real and imaginary data can never go beyond 13 bits.

5. EXPERIMENTAL RESULTS

5.1 Temperature Analysis

In order to analyze temperature changes on bearing during motor operation LM35 sensor is attached to healthy and unhealthy bearing surface. For results motor operation was continued up to nine minutes at room temperature of 28 Celsius to analyze temp changes for both healthy and unhealthy conditions. Figure shows temperature variation over nine minutes of motor operation. Healthy bearing result clearly shows that there is smooth and small variation in bearing temperature. Hence, change of temperature is approximately 6.2 ^{o}C in 9 minutes.

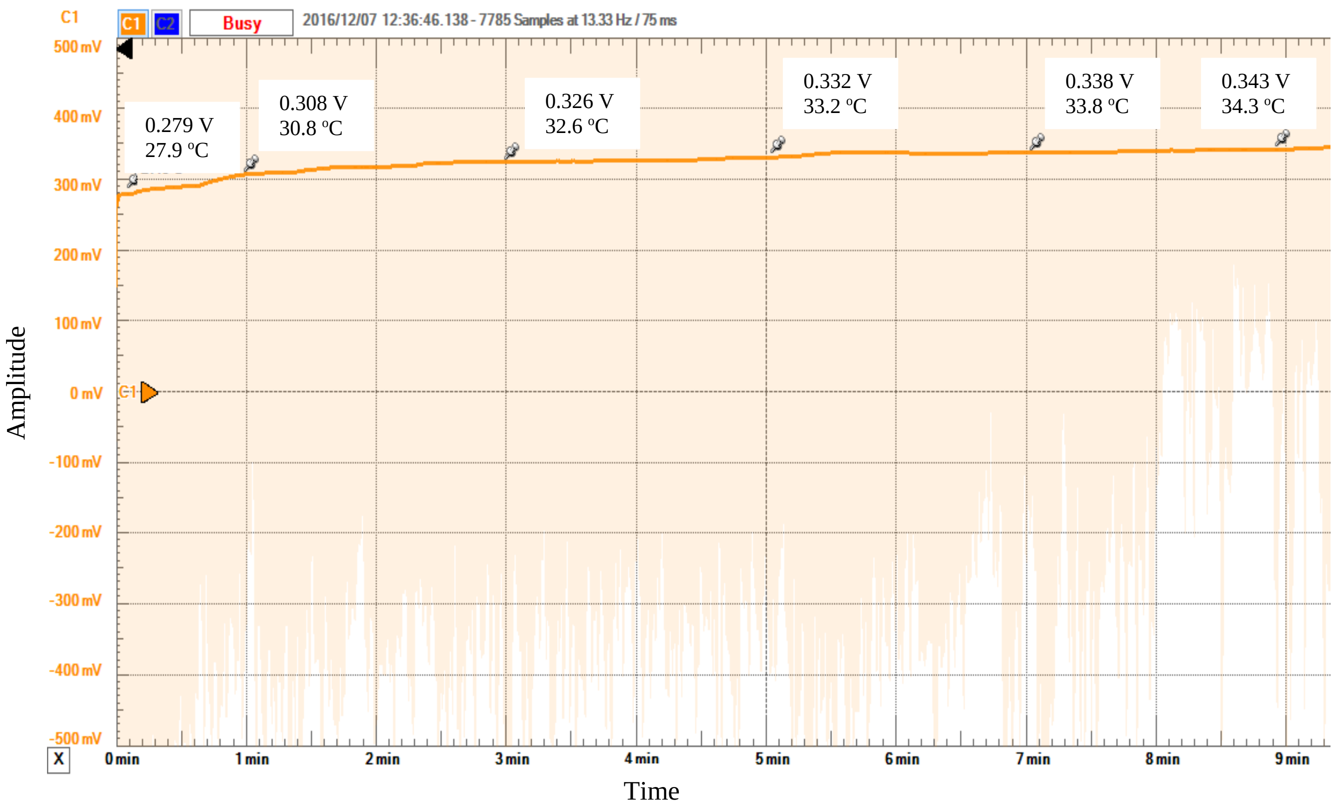

Figure 8. Healthy bearing temperature variation with time

For the analysis of temperature and sound variation in faulty condition the spacing between balls is disturbed to make an unhealthy bearing as shown in Figure 9.

Figure 9. Unhealthy bearing

Experimental result of temperature changes of unhealthy bearing is shown in Figure 10. The temperature of unhealthy bearing changes rapidly. In 5 minutes of operation temperature reaches at 43.8 Celsius and maximum temperature goes up to 46C in 9 minutes duration. The change is temperature is approximately 14 C. Results clearly show that change of temperature during 9 minutes operation are 6.2 and 14 Celsius respectively this show the unhealthy bearing temperature rapidly changes with time than healthy bearing.

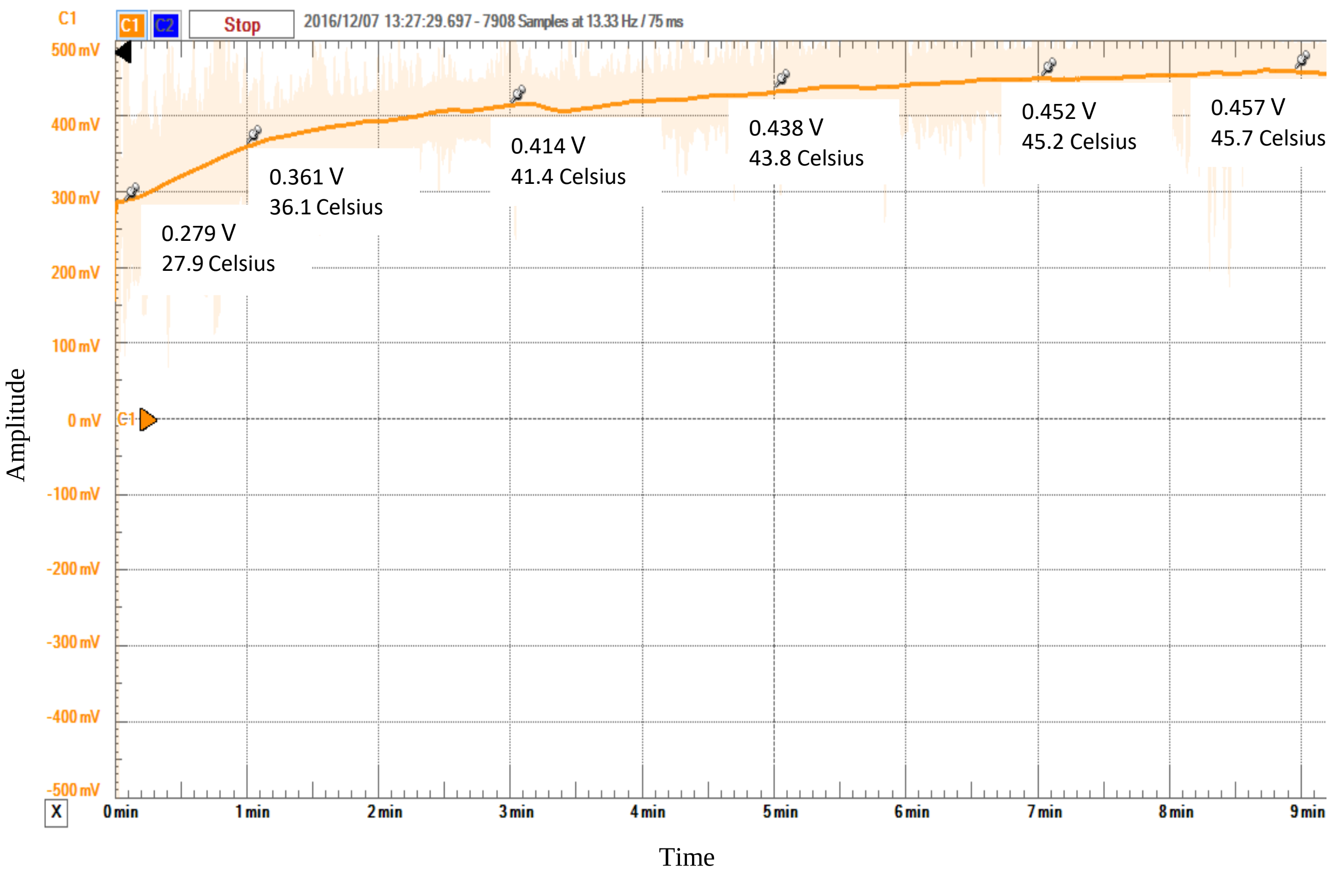

Figure 10. Faulty bearing temperature variation with time

5.2. Acoustic Sensor Results

Using Microphone, raw acoustic signals are obtained for good healthy and unhealthy conditions of bearing. These signals are stored in RAM for processing. The stored data then processed using 1024 point FFT Algorithm for spectral analysis. Acoustic signals of good bearings are shown in Figure 11. In Figure 11, shows that there is one spike along the length of the signal. There is one frequency component appearing in the ChipScope graph. Horizontal axis of graph represents no of sample ChipScope have to capture as FFT of 1024 points result in 512 points (other 512 points are mirror of first 512 points), last 512 points can be neglected. Horizontal axis represents ADC amplitude. Raw data of time domain signal is saved in a excel file from ChipScope. FPGA FFT results of healthy and unhealthy conditions are verified with FFT performed in MATLAB. ChipScope doesn’t provide options to display frequencies and doesn’t provide options to set horizontal and vertical labelling so, MATLAB is used to identify frequency components and labelling the graphs. Figure 12 shows FFT performed in MATLAB for verification of FPGA FFT and frequency analysis. Hence it is clear from Figure and results of MATLAB and FPGA are same and at 600 hz single peak appears.

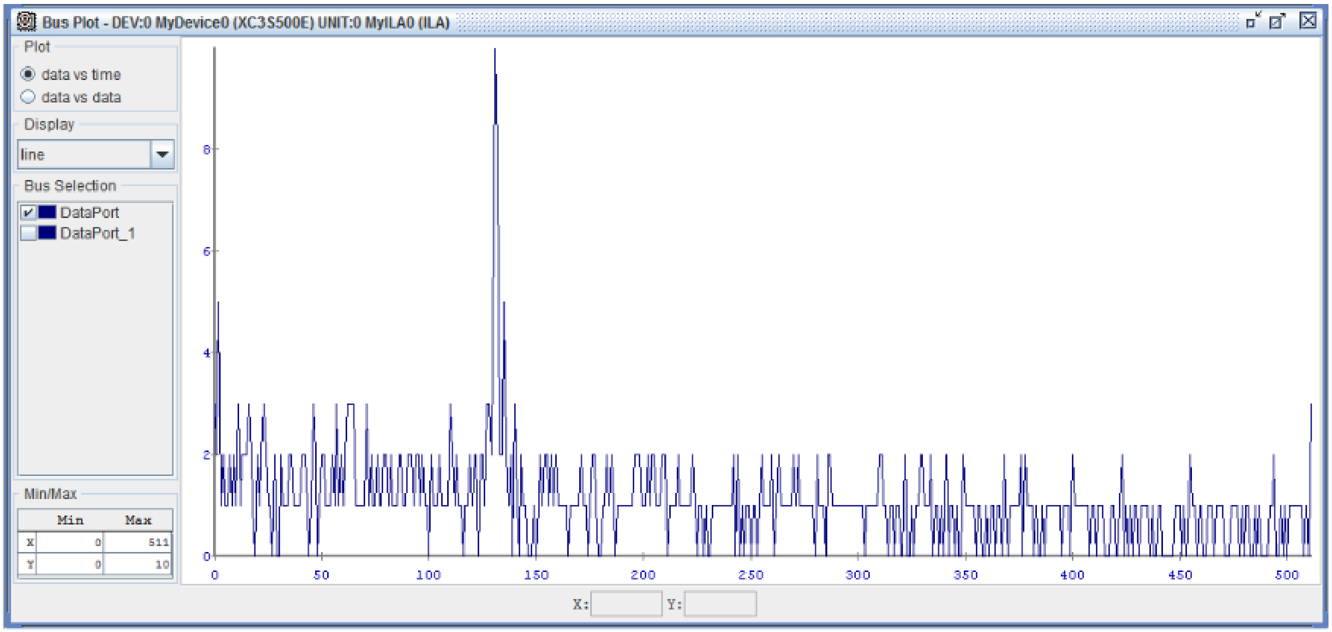

Figure 11. Frequency spectrum of healthy bearing in Xilinix ChipScope Pro tool

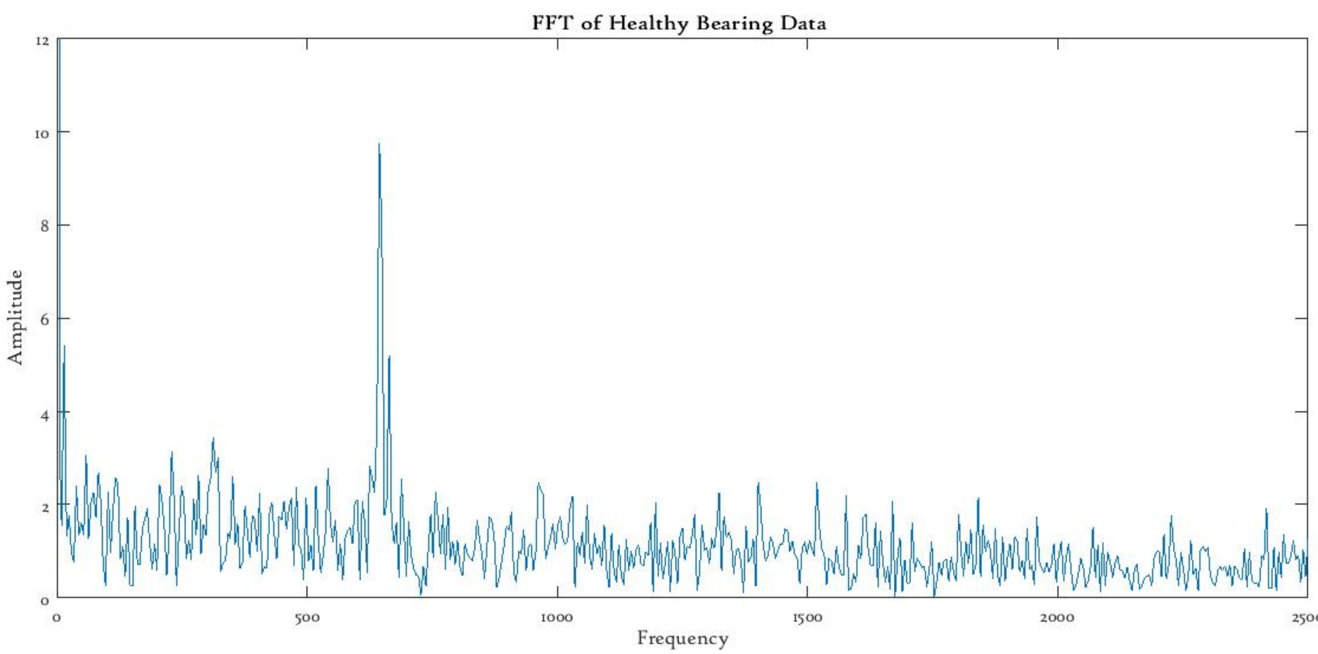

Figure 12. FFT computed using MATLAB function of healthy bearing

Figure 13 shows acoustic spectrum of unhealthy bearing, it is clear from figure that two extra frequencies are appearing and the amplitude of basic frequency peak is also higher as compared to healthy bearing. Figure 14 is MATLAB results of unhealthy bearing. This is clear from results that in case of any damage occurs in bearings sound of bearing also changes. Thus, extra frequencies component at 300 and 700 Hz are also appearing in spectrum.

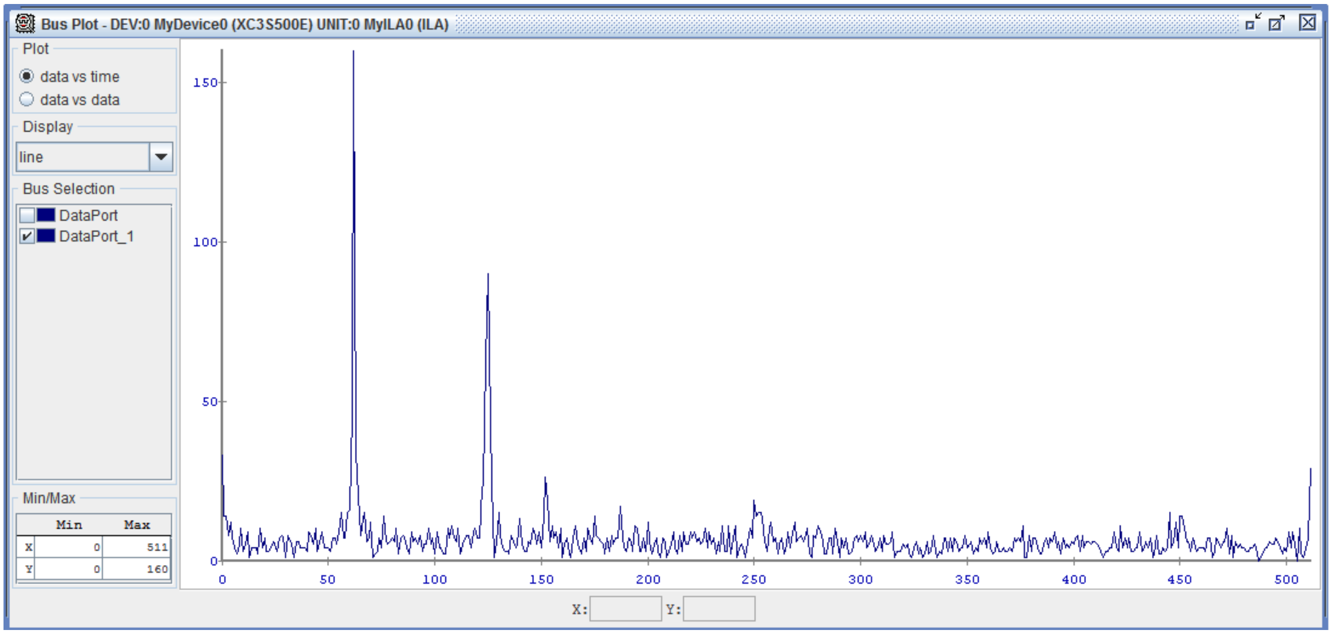

Figure 13. Frequency spectrum of unhealthy bearing in Xilinix ChipScope Pro tool

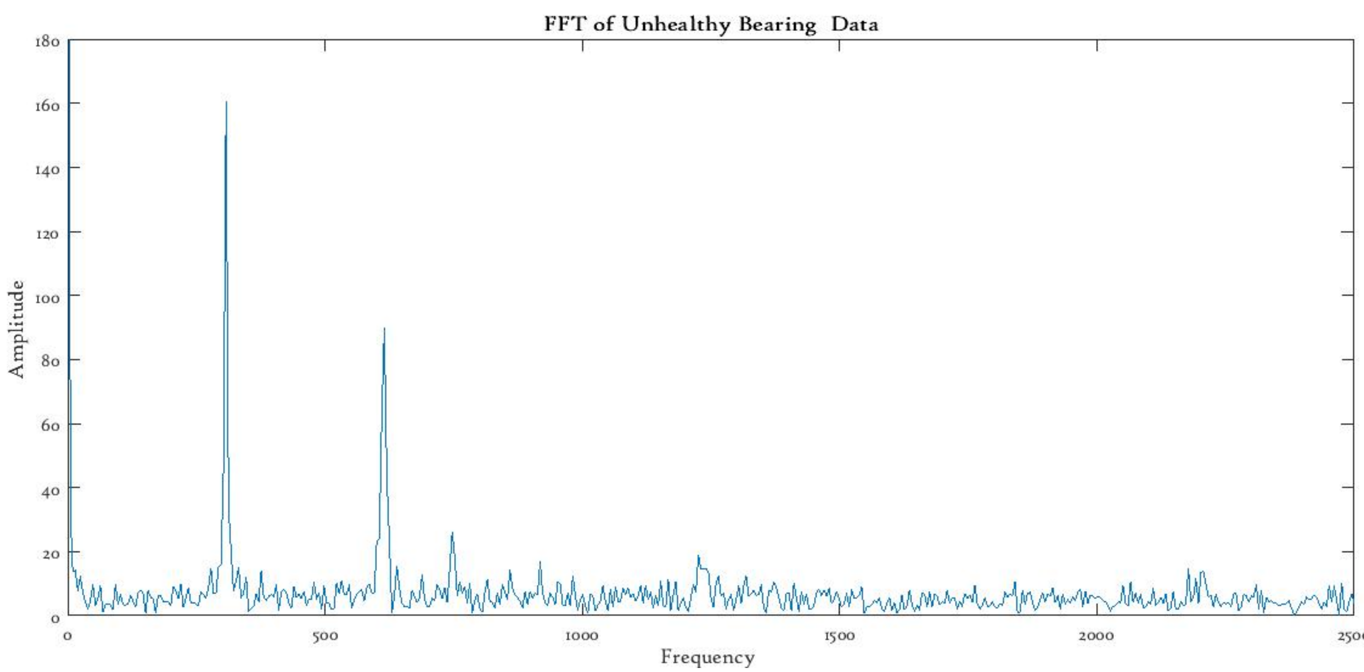

Figure 14. FFT computed using MATLAB function of unhealthy bearing

6. CONCLUSION

In this work, we have developed a real time setup for condition monitoring and fault diagnosis of bearings in induction motor operating in variety of operating conditions. We have used acoustic and temperature sensor to detect the normal and faulty condition and monitored through ChipScope FPGA in Xilinx. ChipScope is easy and effective tool to analyze time domain signal and frequency spectrum thus need of extra software and hardware is avoided. Results of temperature and acoustic data clearly shows that there large variation occurs in temperature any when any fault occurs in bearings extra frequency components appeared. The practical results show that temperature and acoustic emission analysis are effective techniques to diagnose the bearing fault at early stage. Therefore, early detection will result in a reduction of overall production costs by means of reduction in productive lines stoppage, and increment of the industrial efficiency.

7. FUTURE RECOMMENDATION

We can add controller that can act as per the condition monitored through FPGA also short FFT/ wavelet transform can be used to identify any run time condition monitoring. Use of neural Network and Fuzzy Logic Techniques can also be utilized for real time decision making according to type of faults.

8. REFERENCES

1. ADC & DAC: Official Diligent store website, last retrieved on 15 March 2016, from http://store.digilentinc.com/.

2. Gaikwad P.K. (2013). Field Programmable Gate Array based Simultaneous Temperature-Visualization on Video Graphics Array Monitor for Multi-Sensor Data Acquisition System. *International Journal of Advanced Computer Research (ISSN (print): 2249-7277 ISSN (online): 2277-7970) Volume-3 Number-3 Issue-11.*

3. Jose de Jesus Rangel-Magdaleno (2014.)FPGA-Based Broken Bars Detection on Induction Motors Under Different Load Using Motor Current Signature Analysis and Mathematical Morphology" IEEE Transactions on Instrumentation And Measurement, VOL. 63, NO. 5.

4. KY-038 Microphone: Datasheet sound sensor module, last accessed on 5 March 2016, from smartme.unime.it/datasheets/rumore-ky-038.pdf.

5. Narwade. Sumit, Prasad Kulkarni, C.Y.Patil. (2013). Fault Detection of Induction Motor Using Current and Vibration Monitoring. International Journal of Advanced Computer Research (ISSN (print): 2249-7277, ISSN (online): 2277-7970), Volume-3 Number-4 Issue-13 December-2013.

6. Pavale .Manoj B., K. J. Amrutkar (2013). International. A Survey Paper on FPGA-Based Broken Bar Detection of Induction Motor Using Motor Current Signature Analysis Journal of Science and Research (IJSR), ISSN (Online): 2319-7064.

7. R. Patel, S. P. Gupta and V. Kumar (*2006)*. Real-Time Identification of Distributed Bearing Faults in Induction Motor. *IEEE International Conference on Power Electronic, Drives and Energy Systems*, New Delhi, 2006, pp.1-5.

8. Shashidhara. S.M., P. Sangameswara Raju. (2013). FPGA Based Embedded System Development for Rolling Bearings Fault Detection of Induction Motor. *International Journal of Reconfigurable and Embedded Systems (IJRES)*, Vol. 2, No. 3, ISSN: 2089-4864, November 2013, pp. 127~134.

9. Yang. Zhenyu (2015). Automatic Condition Monitoring of Industrial Rolling-Element Bearings Using Motor's Vibration and Current Analysis. *Shock and Vibration*, vol. 2015, Article ID 486159, 12 pages.

10. Yepeza. E. Cabal et al. (2009). FPGA-based Online Induction Motor Multiple-fault Detection with Fused FFT and Wavelet Analysis, International Conference on Reconfigurable Computing and FPGAs.

Identification of Value Based Contract Award Approach For Construction Industry Of Pakistan

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Abstract: The problems of procurement and bid are observed frequently in construction industry. It is the interest of community to improve the procurement, evaluation and awarding of bid. In construction industry of Pakistan contracts of public sector project are awarded to the lowest bidder.it is universally accepted that issues of litigation, claims cost, time overrun and quality are arise on projects awarded to the lowest bidder. The core objective of undertaking this research was to identify a value based contract award approach. An extensive literature review was carried out to identify different contract award approaches followed by unstructured interviews with construction industry experts. Six alternative contract award approaches were discussed and presented in this research.it was concluded that best value contract awarding method is more effective than low bid award method. This research presents value able information to construction industry stakeholders like client, contractor and consultants who want to enhance the bid awarding methods.

Keyword: value based, construction, contract award, public sector projects.

1. INTRODUCTION

The construction industry of Pakistan plays a vital role in growth and economy of the country. The stakeholders of construction industry usually face issues due to bid and procurement. The nature of problems varies depending upon the activities and environment of the organization. Like in public sector construction projects the contracts are awarded to the lowest price bidder. As it is preferred by Public Procurement Authority that bid of public sector projects should be procured on low bid award system. The practice of giving contract to lowest price bidder was developed so that projects are procured at the lest cost, however, the public sector projects awarded to lowest price bidder failed to achieve value for money. It is a known fact that public sector construction project of highways, building and dams etc. are usually not completed within the stipulated time and cost. (Rizwan 2008).

It is universally accepted fact low bid award system fails in achieving customer satisfaction. The projects executed by low bidder are of low quality. Many projects are not completed due to the claims and litigation issue between the client and contractor. Some of the projects are completed but client pay extra costs due projects cost overrun. The contractor performance becomes low due to usage of cheap and unskilled labor. In order to more profit the prime contractor gives the project to another subcontractor which also results in issue of quality and cost. These problems mentioned above are usually faced by construction projects of public sector in Pakistan. These core issues should be addressed in order to achieve better quality of construction projects and client satisfaction as well.(Tariq 2015).

One of the reasons for above mentioned concerns is the method of contractor selection or contract award system. The current contract award system focuses and considers only the price component offered by the contractor. The research paper aims at finding an alternative value based contract award approach which give due consideration to non-price components like schedule, performance of contractor on similar projects, contractor plan to handle the project , completion of at least 3 projects of similar in nature etc. This paper will give a baseline for developing a proposal for framework of value based contract award approach for the public sector projects of Pakistan.

2. RESEARC SCOPE

The scope of this research was to study alternative bid awarding approaches followed in different areas of the world and identify value based bid award approach for construction industry of Pakistan.

3. RESEARCH OBJECTIVE

1. Identification of suitable value based contract award approach for public sector projects of Pakistan

4. LITERATURE REVIEW

It is a well-known fact that Government of Pakistan is major client in Construction industry of country. The most commonly used procurement system is the lowest bidder system. Therefore the contracts of public sector project are always awarded to lowest price bidder who offers least price for execution of construction work (PPRA 2013). Since decades the bid award process and prequalification criteria have not seen much improvement. Through prequalification process the client receives a list of qualified contractors that are eligible to submit tendor.There are clear pitfall of low bid award system. It forces the contractors to lower the prices in order to win the contract.

4.1 Contract Award Methods in Construction

Following contract award approaches are studied in this research

1. Competitive Lowest Bidding Method (Price-basis).

2. Competitive Average Bidding Method (Price-basis).
3. Negotiated Bidding Method (Competitive).
4. Negotiated Bidding Method (Non Competitive).
5. Best value Method
6. A+B Method
7. Multi Parameter Bid Method.

1. Competitive Lowest Bidding Method (Price-basis)

Public sector projects of construction industry are most commonly procured by this method. The aim of this method to obtain lowest possible price for a construction project. This method gives an equal opportunity to everyone who wants to be a part of bidding process and it will also save public money. In order to make the faire procedure there must be clear defined criteria that assist the officials decide whether the bidder is lowest responsive. The contract is awarded to prequalified lowest responsive bidder who submits the lowest bid and meets the specifications. (Sweet, 1989)

2. Competitive Average Bidding Method (Price-basis).

This method also considers price during evaluation of bids.it is one of variant of lowest bidding method of awarding contract. In this method the bid is awarded to one who submits the bid that is closest to average of all other bids. All other bid which are minimum or maximum are not considered responsive. Bids submitted below the average bid are viewed as underbid and bid higher than means are overbid (Photios, 1993) The point to remember is that the method also takes into account price only during evaluation of bids.

3. Negotiated Bidding Method (Competitive).

Sometimes it becomes imperative to acquire bids form selected group of contractors who hold known financial, managerial and technical capacity to complete the complex type of projects. Some projects also require services of such known contractors who possess some specialties. The client obtains tenders from such contractor. After obtaining tenders the project is awarded to the most qualified contractor by negotiation. Request for proposals is one the common example of this method (Kelley 1991).

4. Negotiated Bidding Method (Non Competitive).

In this bidding method the bid is negotiated with the preselected and prequalified single contractor due to unavailability or absence of competitors. Due to the above reason this method is also known as sole-source negotiation. It is also termed as direct procurement. Sometime contractor is selected without giving any advertisement of tender and notification .As this method saves money additional effort and time but have chances of corruption and favoritism.

5. Best value Method

In this procurement method price and other factors like qualification, quality, schedule and performance are considered during selection and evaluation process of bid so that a contractor selected gives the best long-term performance. The selection of contractor is done in three phases

a. Selection
b. Clarification

c. Management and metrics

The main reason for success of best value procurement is its transparency, fairness, open and honest (Horstman 2013). In this method the client hires a high performing contractor that controls the project and thus less management is required by the client

6. A+B Method

In this bidding method the contractor submits bid on the cost (Part 1) and also on the construction time (Part 2).The bidder with the combined lowest bid (A+B) wins the contract. This method is used by many transportation departments of USA.This method can help in saving construction time; however, this method also takes into price only.Somehow this method is also similar with the competitive low bidding method.

7. Multi Parameter Bid Method.

This method considers other parameters such a time, cost and quality in evaluation of bid. Therefore this method is termed as Multi parameter by Herbs man and Ellis. Client can consider other parameters also which seem necessary but major factors of consideration are quality, cost and time .The parameters are given a maximum no achievable points. The bid submitted by contractors is the evaluated and are ranked according to the parameters and cost as well (Herbsman,1992).

5. RESEARCH METHODOLOGY

Based on the research objective both qualitative and quantitative research methodology was employed. The study was carried out in two stages that include literature review and unstructured interviews. Before undertaking unstructured interviews with construction industry experts a detailed literature review of journals, research papers and books was done.As the public sector organization are involved in planning and exaction of constriction projects and they have profound look into construction industry. Therefore unstructured interviews were conducted from 12 construction industry experts. After the data collection conclusion were drawn on analysis of data.

6. DATA COLLECTION

The main part of study was collection of data from construction industry. The required data was collected through unstructured interviews from construction industry experts who were working on public sector construction projects in Baluchistan and Sindh. Six Unstructured interviews were conducted from Baluchistan and same number from Sindh.

7. ANALYSIS AND DISCUSSION

The experts were asked to indicate the extent to which the following bid award methods can be used as alternative contract award approaches. The data was collected according to given scale.

Strongly Agree (75 to 100 %), Agree (50 to 74%) , Slightly Agree (35 to 49%), Disagree (below 35 %). Following is summary of results shown in the below table

Table 1: Contract award Approaches

S.No	Contract Award Approach	Ratings given by Experts
1	Best value Method	Strongly Agree
2	Multi Parameter Bid Method.	Agree
3	Negotiated Bidding Method (Competitive).	Slightly Agree
4	A+B Method	Slightly Agree
5	Competitive Average Bidding Method (Price-basis).	Disagree
6	Competitive Lowest Bidding Method (Price-basis).	Disagree
7	Negotiated Bidding Method (Non Competitive)	Disagree

Above results mentioned in the table shows that experts of construction industry agree with the feasibility of best value procurement method as an alternative bidding method. Best value method is the only method which can give value for money to the client as it considers non price components during s selection of contractors. Multi Parameter method was given preference as alternate method after best value method because both the method consider other necessary factors such as quality, time ,etc rather than just considering price as sole component for selection of contractors. The other methods such as competitive average bidding method, negotiated bidding method only take into account price factor only during evaluation of tenders. Therefore construction industry experts disagree with them as alternate method.

8. CONCLUSIONS

The objective of the research was to find a feasible alternative contract award method for construction industry of Pakistan. This was accomplished through literature review and unstructured interviews from construction industry experts. Six new method were identified which were used in different parts of the world. Among these alternative methods best value approach was selected by the experts as the most feasible method for construction industry of Pakistan. As the best value method can give value for money and the selection of contractor in this method is quite fair, open and transparent. This method considers the non-price components during evaluation of tenders relative to cost of the projects. The other methods except multi parameter bid takes into account price factor only.So best value procuremet system is a value based award method that can be used in procurement of public sector projects in order to enhance project performance and achieve the desired value for money as well.

9. RECOMMENDATIONS

This research will give value able information to construction industry stakeholders like client, contractor and consultants who want to enhance the bid awarding method in construction industry of Pakistan. As this research study identified best value method as value based bid award approach for the construction industry of Pakistan. The framework of identified approach should be made. Public procurement authority of Pakistan and Pakistan engineering council should also evaluate best value procurement and make possible its use as an alternative bid award method

10. REFERENCES

1. Farooqui, R. Saqib, M. Arif, F.Lodi, S, H. (2008), "An assessment of general trends adopted for bidding and procurement in the construction industry of Pakistan", First international conference on construction in developing countries (ICCIDC-I
2. Horstman , A. (2013), " Performance indicators in the Best Value Approach", M.Sc, , Thesis,Faculty of Engineering and technology, University of Twente
3. Herbsman, Z. and Ellis, R. (1992). "Multiparameter Bidding System-Innovation in Contract Administration", Journal of Construction Engineering and Management., 118(1).
4. Khan, T, H. Khan, A, Q. (2015), "Effects of lowest bidding bid awarding system in public sector construction projects in Pakistan". Global journal of management and business research: G Interdisciplinary, Vol no.15
5. Kelley, M.N. (1991). "Estimating and Bidding fromContractor's Point of View", Journal of Construction Engineering and Management., 117(3
6. Photois G. I. (1993). "Average-Bid Method-Competitive Bidding Strategy", Journal of Construction Engineering and Management,119(1).
7. Public Procurement Regulatory Authority Pakistan. (2013), "The National Procurement Strategy".
8. Sweet, J. (1989). Legal Aspects of Architecture,Engineering, and the Construction Process, West Publishing Company, St. Paul, MN

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TEMPERATURE DEPENDENT VISCOSITY AND DENSITY CORRELATION FUNCTIONS FOR JATROPHA CURCAS OIL THROUGH STATISTICAL MODELING

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Abstract: Density and viscosity of vegetable oils are important parameters that determine engine performance during its run on pure jatropha curcas oil. Due to its higher viscosity, the straight use of jatropha curcas oil in a compression ignition engine leads to engine wear and tear. It is important to reduce its viscosity before it effectively combusts inside the engine. The reduction in density and viscosity is of prime importance and majorly done by pre-heating the oil before sending it into the pistons. The optimum temperature ranges to which jatropha oil must be heated in order to bring down its viscosity to an acceptable level depends on its cultivation environment. For this study, jatropha samples taken from local areas of Pakistan were tested for their temperature dependence of density and viscosity. Data obtained through experiments was further analyzed and relationships between density and viscosity of the oil with temperature were determined through regression analysis.

1. INTRODUCTION

The world's conventional energy sources are coming to an end. Scientists and engineers are directing their energies towards extraction of energy from renewable sources. Many vegetable oils are capable of serving as potential sources of energy and have characteristics quite similar to that of diesel. Jatropha Curcas yields oil that has opportune properties making it a good candidate for clean and renewable energy production (Openshaw Kieth, 2000).

According to many researches the quality of Jatropha Curcas oil depends mainly on its cultivation environment, previous land use, processing conditions and the usage of pesticides or fertilizers. The plant can be grown even in barren lands but the quality varies with the mentioned variables. For the first 3 years a hector of Jatropha will yield 2.5-3.5tonnes of seeds but the annual yield increases to 5000-12000tonnes from the sixth year. Achten (WMJ, 2008).

For a country like Pakistan which relies mainly on oil imports, the trend of using Jatropha Curcas as a biodiesel will lead the country's economy to the roads of better future. The country is having 31% of the total land as barren. Through proper planning these lands can be used to cultivate Jatropha Curcas. This will not only provide the country with self-sufficiency in terms of power generation but will also help generating employment opportunities for the local farmers.

The pure plant oil (PPO) from Jatropha has a high viscosity as compared to diesel. Thus the prolonged use on existing compression ignition engines can cause multiple problems due to this higher viscosity (Abadi A.G and Omer S.M, 2015). These problems include incomplete combustion, increased fuel spray penetration and reduced fuel atomization, thus leading to thickening of lubricating oil, permanent damage to injection equipment, and high engine deposits (Nuhu.I et al., 1998).The high viscosity would also create problems in combustion, pumping and atomization in the injector systems of the engine (Jindal.S, 2015). Therefore, the reduction in viscosity of is of prime importance so that it can serve as a promising alternative fuel in Compression Ignition (CI) engines.

To encounter the problem of high viscosity, various methods are in practice. These include pyrolysis, trans-esterification, blending and preheating (Kole Chittaranjan et al., 2012). The processes of trans-esterification and pyrolysis, reduce viscosity by changing the composition and chemical structure respectively, but are complex and costly processes (Openshaw Kieth, 2000). Blending jatropha curcas oil with less viscous fuels is another approach towards the solution to the viscosity problem, but this too is costly, especially when the blend ratios are kept low (Kumari. Annapurana, 2009). Reducing viscosity by heating jatropha curcas oil before injecting it into the engine is a more feasible approach (Ramkumar.S and Kirubakaran.V, 2016).

Many studies reported benefits of using Jatropha Curcas oil in Compression Ignition engines, reducing its viscosity through preheating. The molecules of vegetable oils lose attraction upon increase in their kinetic energies which in other words can be stated as “Viscosity of vegetable oils is proportional to Temperature and hence the Density”. The pure plant oil from jatropha experiences a significant drop in its viscosity at higher temperatures, as studied by K.Pramanik. (Pramanik, 2003).

The viscosity and density of fuel play a major role in determining the performance and combustion characteristics of it. Many researchers have made successful attempts to measure viscosity of jatropha oil at various temperatures using analytical as well as the experimental procedures. Since the properties of oil extracted from jatropha curcas depend majorly on the plant’s cultivation environment and age, samples obtained from different geographical locations may differ in their properties. This creates the need for the development of the functions relating viscosity and density with temperature of the oil; equations that can be used to determine one parameter, given the other. This paper examines the same for samples obtained from jatropha curcas extracted from local areas of Pakistan. Multiple samples of the oil were tested for density-temperature and viscosity-temperature relationship and empirical relations were derived for both via curve fitting.

1.1 Fuel Properties

The jatropha oil used for this study was provided by Pakistan State Oil-PSO. The oil was untreated and referred to as pure plant oil from jatropha curcas. The samples were analyzed at alternate energy labs using ASTM standard methods. Table 1 below shows the properties noted for pure plant jatropha oil.

Table 1: Properties of Pure Plant Oil from Jatropha

TEST	METHOD	RESULT
Color	Visual	L2.5
Flash point ^oC (PMCC)	ASTM D-93	216
Density @ 15 ^oC Kg/L	ASTM D-1298	0.9176
Kinematic viscosity @ 40 ^oC cSt	ASTM D-445	33.45
Pour point ^oC	ASTM D-97	+3
Cloud point ^oC	ASTM D-2500	+6
Sulphur % wt	ASTM D-4294	Nil
Total acid No. mg KOH/gm	ASTM D-974	56.24
Free fatty acids % wt	-	18.96

In terms of calorific value, Jatropha has energy production capacity nearly equal to that of diesel. Also, Jatropha has much lower sulfur content and a higher cetane number which makes it more environment friendly fuel. Thermal conductivity is also an important parameter whose value helps in the design of efficient equipment for heat transfer. Its value from the literature was found to be 4.250 W/m ^oC.

1.2 Temperature Dependence of Density and Viscosity

As aforementioned, the density and viscosity are important parameters that have a direct influence on engine performance. Their relationship with temperature is inverse and hence improved performances are recorded at elevated temperatures. In this section, mathematical relations set to these quantities are explained.

1.2.1 Density

Density is the mass of a substance contained in a unit volume of space. More the mass is, more will be the density. The particles at higher temperature tend to move apart from each other, hence occupying more space which consequently leads to reduction in density. These less dense particles show greater mobility during their passage in the injection equipment which consequently leads to better engine performance and greater life. The density and temperature have a linear relationship, given by equation 1.

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$\rho = a + b*T$ (1)

Where ρ is density of oil, a and b are the intercept and slope respectively and T is the temperature.

1.2.2 Viscosity

Viscosity is the force of friction that exists between different layers of a fluid. Its reduction is very much prone to higher temperatures. The relationship between kinematic viscosity and temperature is defined by equation 2, called the modified Andrade equation.

$\log(\eta) = A + B/T + C/T^2$ (2)

where η is the kinematic viscosity, T is the temperature while A, B and C are the constants of linear regression.

When dealing with moving fluids however, dynamic viscosity is taken into account. It can be found by simply multiplying kinematic viscosity by the density of the fluid, both at same temperatures.

$\mu = \eta * \rho$

1.3 Statistical Modeling

Statistical modeling is a common way of approximating reality and generating trend lines from a given set of points to make predictions. The trend lines are added to these data points to obtain a best fit. The R squared values usually determine the quality of the fit. These values range between 0 and 1, indicating the closeness of data to the regression line when closer to 1. When the values tend away from 1, more error is expected in the regression model. Once a model equation is formed, it can be used to predict one variable at any given value of the other. This research suggests density-temperature and viscosity-temperature correlation models for jatropha curcas oil obtained from local area of Pakistan, through linear regression.

2. METHODOLOGY

Density-temperature and viscosity-temperature statistical models for this research were formed for jatropha curcas oil at multiple temperature points. Results for both the tests were then plotted against temperature. The data points obtained were analyzed through statistical modeling and R squared values were recorded. Finally, best models were suggested.

2.1 Density

Samples of jatropha pure plant oil were taken for analysis. ASTM D-1298 method was used to find out density at temperatures ranging from 298 to 373 K. The method employed hydrometer, a digital thermometer and a glass cylinder to determining the density at multiple temperatures. The data obtained was plotted to read the pattern of density variations in jatropha curcas oil as it is gains heat. Multiple trend lines were added and R squared values for each of these was noted. Equation was formed for the trend line for which the error was negligible or R squared was closest to 1.

2.2 Viscosity

Standard ASTM D-445 method determined the kinematic viscosity at the same temperature points. Ostwald type viscometer and a digital thermometer were used for the test. To ensure no heat is lost when viscosity is being recorded and the temperatures remains constant, the viscometer was suspended inside an insulated cylinder with a temperature regulator. The data obtained formed statistical models for kinematic and dynamic viscosities.

3. RESULTS

3.1 Density-Temperature Correlation

The noted values of viscosity plotted against temperature are shown in figure 1. Multiple trend lines were added to fit the curve with density and temperature as variables. The R squared values for each of the trend lines is given in table 2. Out of all, the R squared value for polynomial function was observed to be closest to 1 giving the best empirical relation.

Table 3: R squared values of density-temperature fit

Trend	R^2
Exponential	0.987
Linear	0.988
Logrithmic	0.983
Polynomial	0.99
Power	0.982

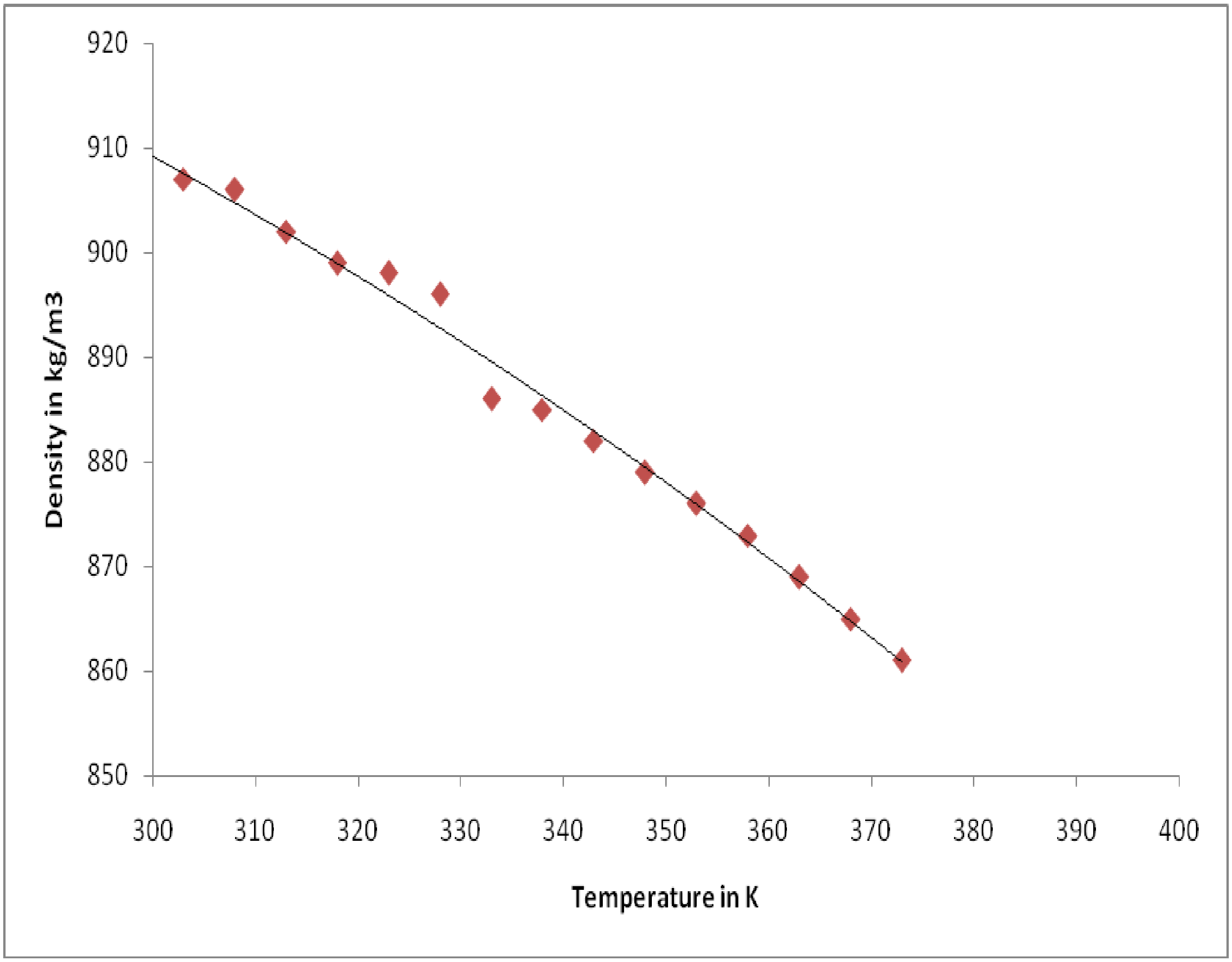

Fig 1: Density Trend at Varying Temperatures

3.2 Kinematic Viscosity-Temperature Correlation

The values of kinematic viscosity that were recorded are plotted in figure 2. R squared values obtained through regression analysis of the values of viscosity is given by table 3. The minimum error was again recorded for the polynomial function.

Table 3: R squared values of kinematic viscosity-temperature fit

Trend	R^2
Exponential	0.975
Linear	0.948
Logarithmic	0.96
Polynomial	0.991
Power	0.969

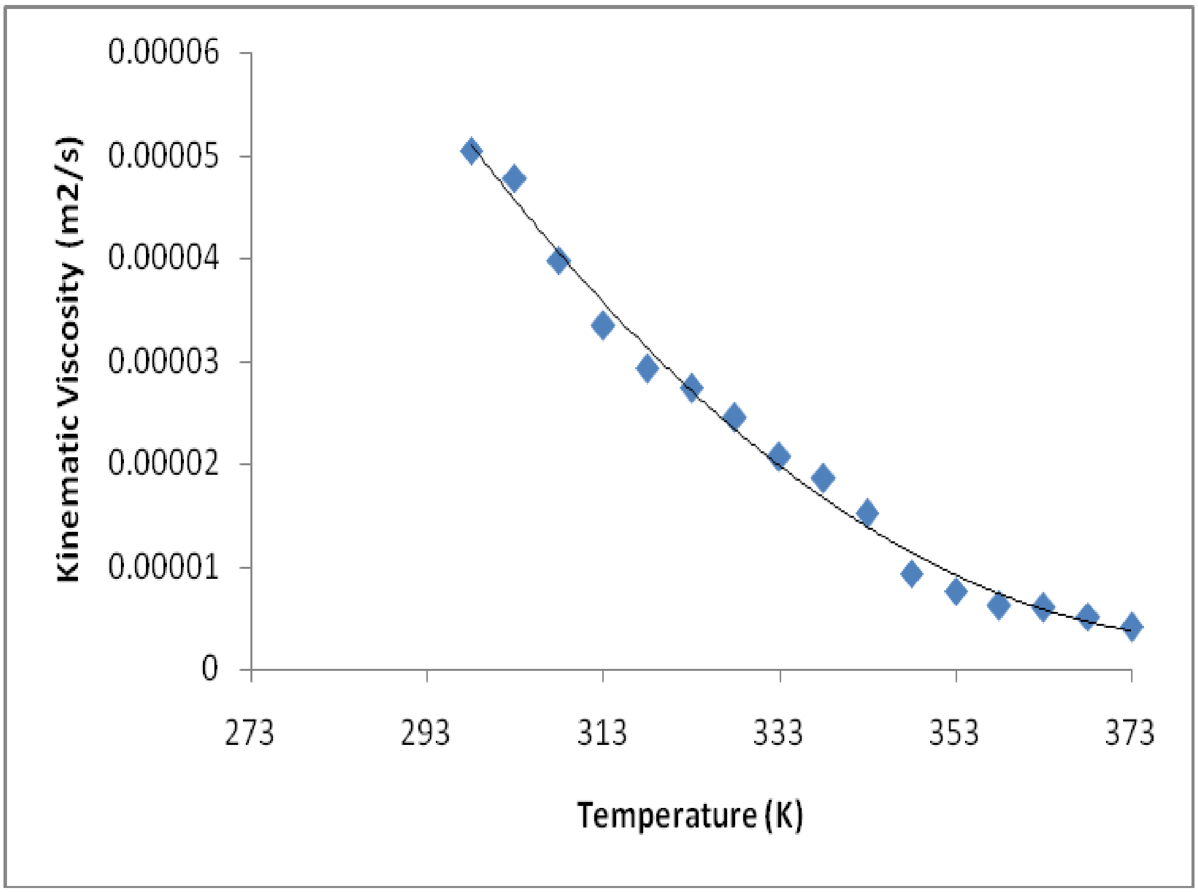

Fig 2: Kinematic Viscosity Trend at Varying Temperatures

3.3 Dynamic Viscosity-Temperature Correlation

R squared values recorded from different trends relating dynamic viscosities with temperatures are listed in table 4. The plot is shown in figure 3. The results reveal that polynomial fit is the best fit for dynamic viscosity-temperature fit.

Table 4: R squared values of dynamic viscosity-temperature fit

Trend	R^2
Exponential	0.985
Linear	0.986
Logarithmic	0.982
Polynomial	0.988
Power	0.981

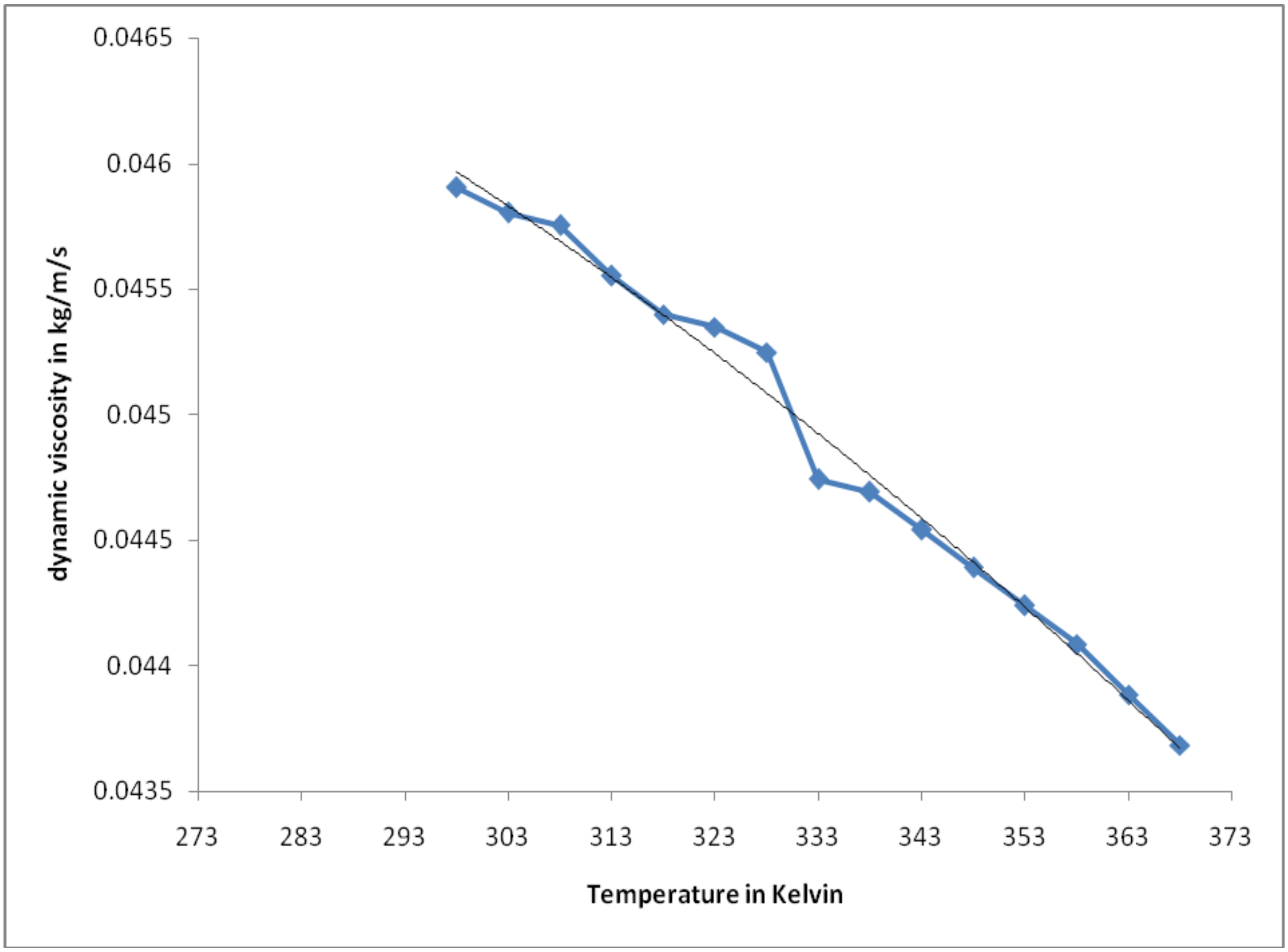

Fig 3: Dynamic Viscosity Trend at Varying Temperatures

4. CONCLUSION

Comparison of R-squared values suggest that polynomial function gives a best fit for temperature dependence of density as well as the viscosity of jatropha curcas oil. The model thus obtained from these polynomial trend lines may serve the purpose of predicting density and viscosity at any given temperature. The important parameters for these models are listed in table 5.

Table 3.4: Coefficients of Derived Statistical Models

Function	A	B	C	R^2
Density	918.3	0.475	-0.001	0.990
Kinematic viscosity	0.001	- 5E-06	7E-09	0.991
Dynamic Viscosity	0.046	2E-05	-9E-08	0.988

5. REFERENCES

Abadi AG, Omer SM. (2015). Research article physical and chemical properties of jatropha biodiesel. International journal of recent scientific research, 6: 5172-5174.

Achal V, Kumari D, Pan X (2011). Bioremediation of Chromium Contaminated Soil by a Brown-rot Fungus, Gloeophyllum sepiarium. Research Journal of Microbiology, 6: 166-171.

Achten WMJ, Verchot L, Franken YJ, Mathijs E, Singh VP, Aerts R, Muys B 2008. Jatropha bio-diesel production and use. (a literature review) Biomass and Bioenergy 32(12), 1063-1084.[2] doi:10.1016/j.biombioe.2008.03.003The Jatropha

Agarwal A, Agarwal A.K. (2007). Performance and emissions characteristics of Jatropha oil (preheated and blends) in a direct injection compression ignition engine. Applied Thermal Engineering, 27: 2314–2323.

Cengel Yunus A. (2006). Heat and Mass Transfer A practical Approach. McGraw-Hill Science/Engineering/Math. 3: 636.

Kole C, Joshi C, Shonnard D. (2012). Handbook of bioenergy crop plants. Boca Raton, Florida: CRC Press.
Jindal.S. (2015). Low Cost Modification Kit for Retrofitting on Small Diesel Engines to Run on Straight Vegetable Oils. Journal of Clean Energy Technologies, 3: 110-114.

Nuhu, I.; Sani, F.M, Rufai, I.A. (2014). Investigation of Corrosion Effects of Jatropha Biodiesel on the Injector of an Engine Fuel System. International Journal of Engineering Trends and Technology (IJETT). 8: 9-13.

Openshaw K. (2000). A review of Jatropha curcas: an oil plant of unfulfilled promise. Biomass and Bioenergy. 19: 1-15.

Pramanik.K. (2003). Properties and use of jatropha curcas oil and diesel fuel blends in compression ignition engine. Renewable Energy. 28: 239-248.

Ramkumar.S, Kirubakaran.V. (2016). Review on Admission of Preheated Vegetable Oil in C.I. Engine. Indian Journal of Science and Technology. 9(2): 11p.

Sundarapandian.S. (2007). Performance and Emission Analysis of Bio Diesel Operated CI Engine. Journal of engineering, computing and architecture. 1: 1-22

Taborek J. (1979) Evolution of heat exchanger design techniques. Heat Transfer Engineering. 1: 15- 29.