ISSN 1024-6223

The Pakistan Engineer

Vol 63, Issue 2
September, 2016

BUILD BETTER WORLD
PAKISTAN
ESTD 1948

A Publication of
The Institution of
Engineers, Pakistan

"If Pakistan is to take its proper place among the progressive nations of the world, it will have to take up good deal of leeway in the realm of scientific and technical education which is so necessary for the proper development of the country and the utilization of its resources. The establishment of institution like the Institute of Engineers will greatly stimulate technical research and help in disseminating available information. The Institute of Engineers will not only benefit the engineers themselves by improving their technical knowledge but also bring lasting benefit to public services which they are called upon to perform.

I wish the Institute every success".

(Quaid-e-Azam's message to the first inaugural meeting of the Institute of Engineers on 20th June 1948)

Published By
The Institution of Engineers, Pakistan

Engr. Muhammad Ashraf
Director General

Business Offices
Raja Muhammad Rafique
Director Admin & Publications

IEP Headquarters Building,
Engineering Centre,
Main Boulevard, Gulberg-III,
Lahore, Pakistan
Ph: 042-35754043, 35750699

Fax: 042-35759449
e-Mail: iephqr@gmail.com

Mian Abid
Graphics & Composing

Printers
Amjad Printer
Urdu Bazar, Lahore

ISSN 1024-6223 Regd. L. No: 8070

The **Pakistan Engineer**

Vol 63, Issue 2

Contents

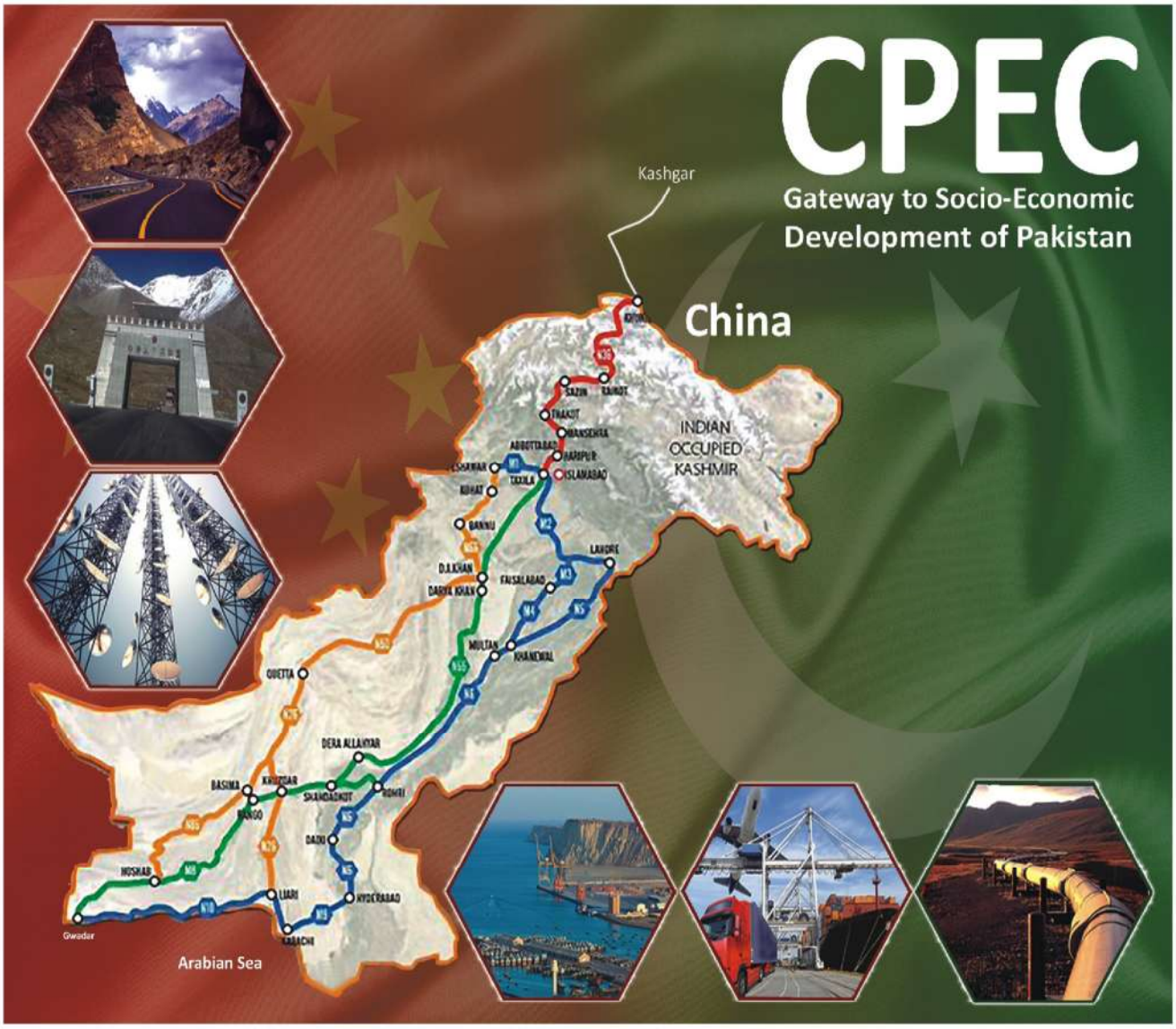
DISCOVER
CHINA PAKISTAN ECONOMIC CORRIDOR (CPEC)

Opportunities & Challenges

at International CPEC Conference & Exhibition **(ICCE-2017)**
on **18th, 19th & 20th January, 2017,** Movenpick Hotel, Karachi, Pakistan

Conceived & Planned by:

The Institution of Engineers, Pakistan



Organized In Collaboration With

BUREAU VERITAS

www.discovercpec.com

Significance of Maintenance in Power Plants and Allied Maintenance Management Systems

Engr. A. K. Leghari
leghari.ak@gmail.com

I. MAINTENANCE STRATEGIES

The importance of maintenance is universally recognized and cannot be overlooked in any field, whether it pertains to living creature or machinery items. The following proverbial expressions are truly applicable to realize the necessity of maintenance.

- A stitch in time saves nine
- Prevention is better than cure.

Maintenance is the work of keeping an operating system in good condition or putting it in working order again after it fails. Maintenance refers to the collection of activities that include inspections, overhauls, repairs, preservation of parts and replacements carried on an operating equipment to preserve its functions, avoid consequences of failure and ensure its productive capacity.

MAINTENANCE DEFINITION

British Standard Glossary of Terms (3811:1993) defined maintenance as:-

The combination of all technical and administrative actions, including supervision actions, intended to retain an item in, or restore it to a state in which it can perform a required function.

MAINTENANCE OBJECTIVES

Power Plant				
Maximizing Production	←	MAINTENANCE	→	Reduce Breakdowns
Minimizing Energy usage	←		→	Reduce downtime
Optimizing useful Life of Equipment	←		→	Improving Equipment Efficiency
Providing budgetary Control	←		→	Improving Inventory Control
Optimizing Resources utilization				Implementing Cost Reduction

IMPORTANCE OF MAINTENANCE OF PLANTS.

The maintenance of almost all components of Power plants as a whole is very much imperative especially in Boiler and Turbine domains. The treatment of water circulation and cleaning of tubes and other surface areas of such major equipment plays a vital role in achieving desired output and efficiency.

If proper maintenance is not carried out, the output is decreased considerably. One relevant example may be specifically mentioned here that in case of fouled condenser (due to poor maintenance/chemical treatment) of thermal power plant, the output is reduced by 4-5% of total capacity, thus resulting in huge financial losses.

The adverse effects of non-implementation of maintenance schedules or even poor maintenance of power plants are numerous and multifarious which may result into substantial losses due to inefficiency, breakdowns and unavailability and ultimately reduced life of the plant.

This aspect is not desirable in the scenario of healthy completion and overall repute in the industry as well.

To make Thermal Power Plants economical and reliable, the maintenance functions should be optimized by carefully selecting and planning the maintenance strategies that will address the maintenance needs of the plant at the least cost. The methods commonly applied in maintenance processes are Preventive Maintenance, Corrective Maintenance and Predictive Maintenance.

These methods have their individual strengths and weaknesses. However; careful blending of these methods is needed to achieve optimum and cost effective maintenance strategies.

a) PLANNED MAINTENANCE

In planned maintenance, the maintenance action is carried out with some fore thoughts, prior planning, record keeping and control action.

1. Preventive Maintenance(PM)
2. Corrective Maintenance (CM)
3. Predictive Maintenance(PDM)

1.PREVENTIVE MAINTENANCE

Definitions:-

British standard 3811: 1993 Glossary of Terms defined Preventive Maintenance as follows:-

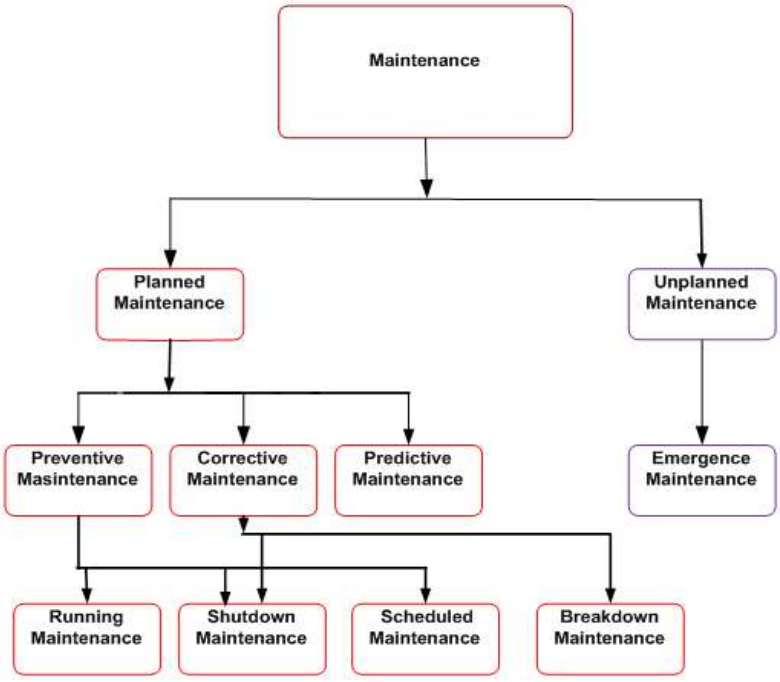
The maintenance carried out at predetermined intervals or according to prescribed criteria and intended to reduce the probability of failure or the degradation of the functioning and the effect limited.

The book 'Applied Reliability Centered Maintenance' defines PM as any scheduled preventive tasks intended to reduce the probability of failure of equipment.

The scheduling process can be done by a computer system, human memory, wall charts or other scheduling methods. In short, Preventive maintenance is a time based maintenance method in which the maintenance activities are planned and scheduled based on predetermined counter intervals in order to prevent breakdowns and failures. Preventive Maintenance consists of three types as under:-

View of Turbine hall of a typical thermal power plant

TYPES OF MAINTENANCE



Running Maintenance:-

Maintenance activities carried out when equipment is running

Shut down Maintenance:-

It can only be performed while the equipment is under shutdown

Scheduled Maintenance:-

Any variety of scheduled maintenance to be performed to an object or item of the equipment.

Five Important Reasons Pm Makes Perfect Sense

Preventative Maintenance:

These two words alone imply the outcome and benefits of this practice. Below are identified five important reasons that this type of maintenance could make sense.

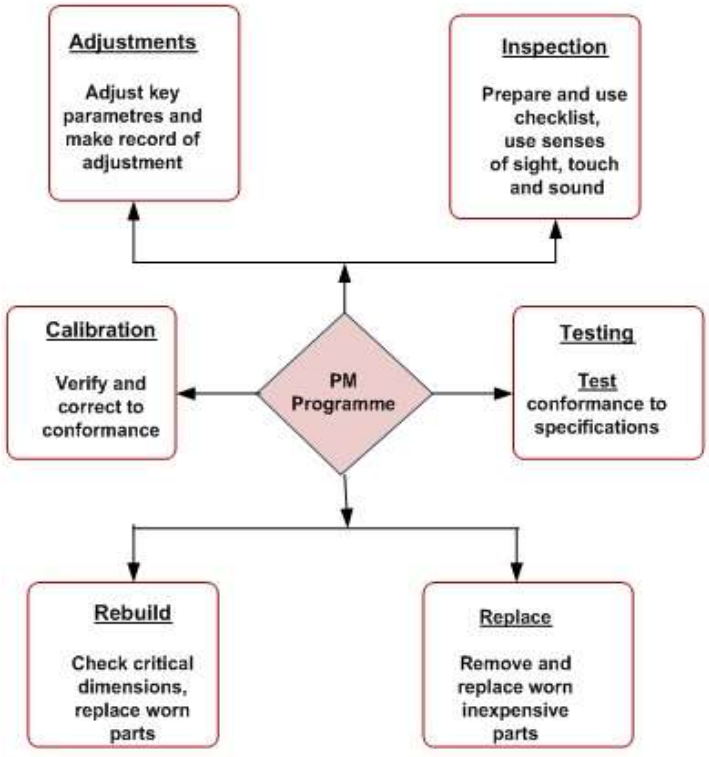
1. Plant Safety
2. Efficiency
3. Immediate Savings
4. Long-term Savings
5. Time Savings

Advantages of Preventive Maintenance

1. Improving equipment availability and reliability
2. Reduces break down and thereby downtime
3. Less odd-time repair, hence reduces overtime expenses

4. Greater safety of workers
5. Lower maintenance and repair costs.
6. Less standby equipment and spare parts
7. Better product quality and fewer rework and scraps
8. Increases chances to get production incentive bonus
9. Identification of parts and its nature and cost of repairs.
10. Reduces the chance for regulatory fines and sanctions

The maintenance tasks done under a PM program are illustrated in the figure as shown below. The routine tasks carried out in a PM include inspections, adjustments, tests, calibrations, rebuilding and replacements. Inspections start with a checklist of the equipment to be inspected, the symptoms to be looked for and the equipment location. Adjustments involve changes on certain operating parameters in order to optimize equipment performance. Tests are done to verify status conformance of equipment operations to specifications. Other features are indicated clearly in the relevant boxes of the figure as follows:-



Figure

The requirements for a good PM procedure:-

- A list of tools, spare parts & instruments required.
- A specific form to record the measurements to be carried out.
- Limits or ranges for the parameters to be measured.
- Required safety procedures such as isolation and locking out.

PM activities are scheduled, which is commonly done by Computer Maintenance Management Software (CMMS), but can also be done using a wall chart, job allocation book and maintenance habits among others.

Why P M is preferred

1. The frequency of premature failures can be reduced through proper lubrication, adjustments and cleaning.
2. If failure cannot be prevented periodic inspections can help out effectively.

2. CORRECTIVE MAINTENANCE

The main objectives of Corrective Maintenance are the maximization of the effectiveness of all critical plant systems, the elimination of break downs and elimination of unnecessary repairs and reduction of the deviations from optimum operating conditions. The difference between the Corrective Maintenance and Preventive Maintenance is that for the corrective maintenance, the failure should occur before any corrective action is taken.

The way to perform corrective maintenance activities is by conducting the four following important steps.

1. Fault detection
2. Fault isolation
3. Fault elimination
4. Verification of fault rectification

Similarly corrective maintenance has several prerequisites in order to be carried out effectively as under

- Accurate identification of incipient problems
- Effective planning which depends on the skills of planners, the availability of well-developed maintenance database about standard time to repair, a complete repair procedure and labour skills, specific tools parts and equipment.
- Proper repair procedure
- Adequate time to repair
- Verification of repairs

The Corrective Maintenance has two types defined as follows:

1. Breakdown Maintenance:-
It is an emergency based policy in which plant/equipment is operated till it fails and then it is brought back in running condition by repairs.

2. Shut down Maintenance:-
It can only be performed while the equipment is under shutdown.

3. PREDICTIVE MAINTENANCE
As the name implies, the said activity involves the prediction of the failure before it occurs, identifying the root cause of those failures symptoms

and eliminating those causes before they result in extensive damage of equipment.

It is a type of maintenance performed continuously or at intervals according to requirements to diagnose and monitor a condition or system.

It is classified into two kinds according to the methods of detecting the signs of failure:-

Condition based predictive maintenance (CBPM)
Statistical based predictive maintenance (SBPM)

CBPM depends on continuous or periodic condition monitoring equipment to detect the signs of failure.

SBPM depends on statistical data from the meticulous recording of the stoppage of the In-plant items and components in order to develop models for predicting failure.

Monitoring Key Equipment Parameters

- Vibration analysis, oil analysis, wears analysis, temperature and pressure analysis and efficiency analysis.
- Unusual sounds coming out of rotating equipment.
- Excessively hot electric cable
- Simple hand touch can point out many unusual equipment conditions.

The limitation of predictive maintenance is that it depends heavily on information and the correct interpretation of the available information.

The difference between **preventive maintenance** and **predictive maintenance** is that predictive maintenance uses monitoring the condition of machines or equipment to determine the actual mean time to failure, where as preventive maintenance depends on industrial average life statistics.

(b) UNPLANNED MAINTENANCE:-
Maintenance action which is carried out without any fore thoughts or prior planning is called unplanned maintenance.

Emergency Maintenance is one of the examples of unplanned maintenance. However, the maintenance action is executed with the help of all available maintenance resources in least possible time, without any major time lag, examples:-
Fire hazards, breakdowns of boiler and turbines etc.

II. MAINTENANCE MANAGEMENT SYSTEMS

Maintenance Management is mostly concerned with planning, organizing and directing the resources in order to control availability and performance of the plants to some specified level. To be able to manage the maintenance activities in right way, a management system is necessary. The system can be either manual or computerized. Maintenance Management encompasses all those activities required to keep physical facilities and equipment in good working conditions and making necessary repairs when breakdowns occurs, so that system can perform as desired.

Elements of Effective Maintenance Management

1. Maintenance policy
2. Control of material
3. Preventive maintenance
4. conditions monitoring
5. Work order
6. Job planning

BASIC MAINTENANCE CYCLE

The Basic Functions of the Maintenance Management System
The basic functions of a maintenance management Systems are identified as under:-

1. Plant and unit record(equipment)regarding its performance
2. Documents record
3. Technical /economic analysis of plant history, maintenance
4. Planning System of maintenance and work order routine
5. Inventory and Spare parts control system and purchasing system
6. Preventive Maintenance

Maintenance Management System Process

- Prepare an asset inventory
- Identify the frequency of the task
- Estimate the time required to complete the task
- Develop an annual work schedule
- Prepare and issue a work order.
- Determine a budget Cost

NEW STRATEGIES CONCEPTS OF MAINTENANCE

Apart from commonly applied strategies such as Break down maintenance Preventive or scheduled maintenance, Predictive or condition based maintenance, new strategies concepts such as Proactive Maintenance, Reliability Centered Maintenance and Total Productive Maintenance etc. have recently been evolved to look it from different perspective and that has helped in the developed maintenance.

Proactive Maintenance:-
In this kind of maintenance, the aim is to identify what can go wrong .i.e. by monitoring of parameters that can cause failures and breakdowns.

Reliability Centered Maintenance

The type of maintenance is chosen with reliability of the system in consideration i.e. system functions, failures relating to those functions and effects of the dominant functional system failures. This strategy in the beginning was applied to critical

applications such as aircrafts, nuclear and space applications. At present, this is being extended to critical systems in the plant.

Total Productive Maintenance

It is a Japanese concept which involves total participation of all concerned. The aim is to have overall effectiveness of the equipment with participation of all concerned (employees) using productive maintenance systems and excellent records. These results are attainable merely due to the sense of collaboration and mutual participation

Application of IT

Some companies like Hitachi have been developing products and services for advanced support for preventive maintenance of thermal power plants through the use of IT (information technology) and network technology, as to achieve desired goals. The concept in developed form can be quite helpful.

MAINTENANCE POLICIES

How much maintenance could be out source?

1. Organization may choose simply to outsource the work execution while retaining the remaining steps in –house. This is done on a limited basis.
2. An alternate approach is to outsource all activities with the An alternative exception of analysis and work identification steps. The contractor is permitted to plan and schedule his own work, but the organization retains its control over what is to be done
3. A third approach is to outsource all of the above steps, thus giving control over the development of maintenance strategies to the contractors while specifying desired achievements to be made.

Each approach has advantages and disadvantages as well. However the most appropriate approach will depend on the client's particular situation and economic conditions.

References

1. Implementation of preventive maintenance program in thermal power stations by International journal of Mechanical Engineering & Technology.
2. Complete guide to Preventive and Predictive Maintenance by Joel Levitt- 2nd edition.
3. Maintenance Management by Swanpil Chatter jee
4. Advanced technologies of preventive maintenance for thermal plants by Kiyoshi Shimomura, Dr. Eng. Hideaki Ishitoku Shigeo Sakurai, and Dr. Eng. Fumiyuki Hirose.
5. Technical Presentation on Maintenance by Kulbhushan Sharma.

(Courtesy by Dawn)

SC MOVED FOR DAMS' CONSTRUCTION ON ALL RIVERS

LAHORE: A former chairman of Water and Power Development Authority (Wapda), Shamsul Mulk, has filed a petition in the Supreme Court seeking construction of water reservoirs, including Kalabagh dam, on all rivers in the country. Filed through Advocate A K Dogar at the apex court's Lahore Registry, the petition seeks SC direction for ministry of water and power, Council of Common Interests (CH) through prime minister, provincial governments of Punjab, Sindh, Khyber Pakhtunkhwa and Balochistan, to this effect. The petitioner pleads that on account of inaction, ignorance and foolhardiness of the government functionaries, every day a huge quantity of water is allowed to flow into the sea, which could be stored in dams and used for agriculture, hydro-electric power and for drinking by animals and numerous needs of humans. He states India has already built 173 dams on rivers, including Indus, Jhelum and Chenab and 12 more have been planned by Indians to be built on River Kabul, which meets Indus at the site of Kalabagh. He says Kalabagh dam is an appropriate illustration of the in-fight and senseless political wrangling which has resulted in colossal loss of $1,000 billion and the country has been reduced to a "beggar nation". The former Wapda chief estates that the politically motivated protests against the KBD are baseless and "mere sham". He says Nowshehra will not drown if KBD is constructed and rather it will protect the city. To substantiate his point, he argues in the petition that during the recent floods water level at Nowshehra was 961 feet but if KBD were in place the level the same day would have been 880 feet and the city could have been saved from the devastation caused by the floods. Mr Mulk states the Asian Development Bank (ADB) has reported that Pakistan is among the eight nations facing worst water shortage. He pleads that the unanimous decisions of CCI in 1991 and 1998, signed by the chief ministers of all the four provinces, should be implemented by the executive authority The petitioner, who also served as caretaker chief minister of KP, asks the court to enforce fundamental rights of citizens and direct the respondents to build dams on all rivers in the country in order to save water for agriculture, hydro electric power and to guard the next generations against floods.

Construction Safety Research in Pakistan: A Review and Future Research Direction

Engr. Hafiz Zahoor,
zahoor.khan@connect.polyu.hk

Engr. Abert P.C. Chan

Engr. Rafiq M. Choudhry
rchoudhry@kfu.edu.sa)

Engr. Wahyudi P. Utama, Ran Gao
wahyudi.utama@connect.polyu.hk

ABSTRACT
Comprehensive review of construction safety research is presented in this paper, aiming at summarizing the completed research work in Pakistan. It includes eleven journal papers, two dissertations and thirty two conference papers. Construction accidents are mostly caused by; fall from height, followed by electrocution. Safety non-compliance is attributed to; non-existence of a regulatory authority, delusion that investing in safety will increase the project cost nawareness, and unrealistic deadlines. Though Pakistan Engineering Council (PEC) is conducting safety awareness workshops for engineers and supervisors, no training is planned for construction workers. Few private institutes are also providing safety training but only on commercial basis. The deteriorating safety situation can be enhanced by ensuring management commitment and and communication, safety education and training, and accident reporting mechanism. It has also been recommended to establish occupational health and safety regulatory authority, redefine and enforce safety laws, and launch media campaigns to create awareness among workers. PEC is suggested to enhance the safety performance by; allocating the safety budget and responsibilities in contract documents, incorporating safety credit points in contractor licensing process, and maintaining accident statistics. Potential research areas are also identified to kindle the construction safety research in Pakistan.

KEYWORDS
Safety management system, Safety climate, Safety practices, Review, Pakistan.

1. INTRODUCTION

The construction industry is suffering from higher fatality and injury rates because of its unique nature, unpredictable site conditions, diversified human behaviour, and unsafe procedures (Ahmed et al. 2000). The developed countries are implementing various safety, health and environmental management systems to minimize these fatalities (Chan et al. 2008). Various safety schemes have also been introduced which resulted into a consistent decrease in the accident rate during the last 20 years (Choudhry et al. 2008).

Contrary to this, in the developing countries like Pakistan, stakeholders, emphasis is primarily on improving the construction quality, and reducing cost and time, whereas safety is least on their agenda. Safety regulatory authority is almost ineffective and contractors are reluctant to share the actual record of injuries and fatalities (Farooqui et al. 2007; Ali, 2006). Primary construction regulatory body i.e. Pakistan Engineering Council (PEC) has yet to lay down safety regulations to be followed in the industry (Farooqui et al. 2007). According to Farooqui et al. (2008b) most clients demand maximum speed and good quality of work at the lowest possible cost, whereas no budget is specified for safety compliance. Small construction firms do not have any safety policy so unsafe conditions exist on their work sites and labourers are exposed to hazardous conditions, however, most of the large firms, registered with PEC in category C-A (category of the contractor having no financial limit), do have a safety policy, provide safety training to their workers, and maintain safety personnel on their worksites (Raheem and Hinze, 2013b; Farooqui et al. 2008b).

According to the annual reports of Pakistan Bureau of Statistics, 7.4% (4.424 Million) of the total labour force (59.79 Millions) are associated with the construction industry (PBS, 2012-2013; 2010-2011). Consistent increase has been observed in the injuries/accidents from 14.55% in 2006 to 15.24% in 2012 in the construction industry (Table 1). Hence, it has emerged to be the 2nd most injury prone industry after the agriculture. Conversely, increase in its employment rate is relatively lower than other industries. According to Table 2, employment rate has gradually increased from 6.56% in 2006 to 7.4% in 2012. It can therefore be inferred that construction industry is employing only 7.4% of total labour force whereas its injury rate is alarmingly high (15.24% of total labour force).

According to the annual reports of Pakistan Bureau of Statistics, 7.4% (4.424 Million) of the total labour force (59.79 Millions) are associated with the construction industry (PBS, 2012-2013; 2010-2011). Consistent increase has been observed in the injuries/accidents from 14.55% in 2006 to 15.24% in 2012 in the construction industry (Table 1). Hence, it has emerged to be the 2nd most injury prone industry after the agriculture. Conversely, increase in its employment rate is relatively lower than other industries. According to Table 2, employment rate has gradually increased from 6.56% in 2006 to 7.4% in 2012. It can therefore be inferred that construction industry is employing only 7.4% of total labour force whereas its injury rate is alarmingly high (15.24% of total labour force).

Table 1: Occupational injuries/diseases Percentage distribution by Major industries in Pakistan

Occupational Injuries / Diseases – Distribution by Major Industries (%) inPakistan							
	Financial year						Ranking
Type of Industry	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2012-2013	
Agriculture, Forestry, Fishing	40.94	46.84	50.43	50.2	49.8	49.1	1
Mining / Quarrying	0.29	0.09	0.33	0.1	0.2	0.2	
Manufacturing	15.21	12.72	13.96	12.8	15.8	13.3	3
Electricity, Gas and Water	0.87	0.51	0.71	0.4	0.2	0.5	
Construction	14.55	14.93	14.54	14.3	13	15.2	2
Retail trade, Restaurants and Hotels	9.26	7.96	7.54	10.6	10.3	9.2	4
Transport / Communication	7.98	8.02	8.14	8	7.1	7.3	
Community / Social Services	10.56	8.39	4.33	3.5	3.3	5.1	
Other Industries	0.34	0.54	0.02	0.1	0.3	0.1	

Table 2: Percentage distribution of employed persons by Major industries in Pakistan

Occupational Injuries / Diseases – Distribution by Major Industries (%) inPakistan							
	Financial year						Ranking
Type of Industry	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2012-2013	
Agriculture, Forestry, Fishing	43.61	46.84	44.91	45	45.1	43.7	1
Manufacturing	13.54	12.72	13.02	13.2	13.7	14.1	3
Construction	6.56	14.93	6.62	6.7	7	7.4	5
Retail trade, Restaurants and Hotels	14.42	7.96	15.16	16.3	16.2	14.4	2
Transport / Communication	5.39	8.02	5.23	5.2	5.1	5.5	6
Community / Social Services	14.41	8.39	2.58	11.2	10.8	13.3	4
Other Industries	2.07	1.14	12.48	2.4	2.1	1.6	7

2. OBJECTIVES

This paper is aimed at reviewing the safety research carried out in the construction industry of Pakistan, with following objectives:

- Carry out a comprehensive review of construction safety research conducted in Pakistan.
- Examine the safety Regulations and their enforcement in Pakistan
- Find the gap for future research in the field of construction safety in Pakistan.

3. RESEARCH METHODOLOGY

A systematic literature review is conducted in three stages for investigating the research work carried out in the field of construction safety in Pakistan. In stage-1, a comprehensive desktop search was conducted with the search keywords; safety, safety climate, safety practices, construction and Pakistan. The databases such as Scopus, EBSCO, Science Direct, Google, Google scholar and Web of science were searched to find the related journal papers. The search result indicated that only fourteen journal papers have been published related to the construction safety in Pakistan. In the second stage, proceedings of International conferences were searched using the above mentioned search engines. Using the snow ball

technique, references given at the end of each paper were also checked so as to find the related papers. In stage-3, google scholar profiles of Pakistani researchers, who are actively involved in construction safety research, were explored. As a result, all related papers had either been downloaded (if available) or obtained from the authors via personal email requests. Hence, a total of 14 journal papers, two dissertations (one PhD and the other M. Phil), and 32 international conference papers from 12 conference proceedings had been selected for review.

4. OVERVIEW OF CONSTRUCTION SAFETY RESEARCH IN PAKISTAN

4.1 CATEGORIES OF THE RESEARCH PAPERS

Out of the fourteen shortlisted journal papers related to safety in Pakistan, 3 were related to roads, 1 for Engro-food industry and 10 were related to the construction industry (8 International and 2 Pakistani journals). Topics covered in these journal papers include safety performance, safety culture, safety climate, national culture, safety policy formulation and enforcement, use of wireless technology (Riaz et al. 2014) and Building Information Modelling. Only four of these journal papers have been published in the top peerreviewed journals. In most of the papers, basic statistical techniques had been used to analyze the data collected through questionnaire survey and interviews; however Mohamed et al. (2009) have also used factor analysis. Four scholars including Dr. Rafiq M. Choudhry, Dr. Rizwan U. Farooqui, Engineer Rehan Masood and Adeeba A. Raheem are actively involved in safety research in Pakistan. Out of the thirty two conference papers, twenty two are written by these researchers. Most of their papers are related to safety policies, safety culture, safety climate, safety practices and safety management systems.

4.2 QUESTIONNAIRES BEING ADOPTED BY THE RESEARCHERS

Questionnaire designed by McDonald and Hrymak (2001) for the Irish construction industry, Mohamed (2002) for the Australian construction industry, and Choudhry et al. (2008 and 2009) for the Hong Kong construction industry had been used by the researchers to explore the construction safety performance in Pakistan. Mohamed and Ali (2005) and Mohamed et al. (2009) have also designed a questionnaire to analyze the influence of national culture on safety behaviour. Similarly, 70 statements questionnaire under 10 groups by Ahmed (2013) and 31 statements safety climate questionnaire by Choudhry et al. (2009)were also adopted to assess the construction safety climate in Pakistan (Choudhry and Masood, 2011).

4.3 CURRENT SAFETY PRACTICES

Though technological advancement is the need of hour, it has adversely affected the construction safety especially in the developing countries, where emphasis had always been on the productivity than the safety (Farooqui et al. 2008a; Masood et al. 2014). Injury/fatality statistics of construction projects are yet to be maintained at the industry or national level (Khan, 2013b, Raheem et al. 2012), so the lagging indicators of accident statistics cannot be used to analyze the safety performance. Raheem and Hinze (2012 and 2013b) have highlighted that most of the construction companies do not update their safety manuals. Similarly, safety policies are made only for the documentation purposes (Jafri, 2012; Masood et al. 2012c). Mohamed and Ali (2005) and Qazi et al. (2006) have analyzed the effect of awareness and beliefs, physical environment and supportive environment on safety culture, and highlighted the neglected safety practices, as; poor quality scaffolding without guard rails, defective ladders not tied properly, working on roof without edge protection, temporary laid power lines and manual deep excavation without bracing. Safety training has been identified as the most neglected aspect (Haider et al. 2013; Zahoor and Choudhry, 2012). Managers and the workforce have varied opinion about safety compliance on their work sites (Masood et al. 2012b).

4.3.1 CAUSES OF ACCIDENTS

Major causes of construction accidents, in descending order, are; fall from height, electrocution, caught in between the machinery and struck by falling objects (Hassan, 2012; Nawaz et al. 2013). Higher unemployment ratio and more number of unskilled workers are also the main causes ofaccidents (Jafri et al. 2012). Few indirect cost effects have also been identified like cost of employing additional manpower, lost work hours of fellow crew members due to temporary halts and lowering of morale (Farooqui et al. 2008a).

4.3.2 REASONS FOR SAFETY NON-COMPLIANCE

Non-compliance to safety regulations is attributed to; non-existence of any regulatory authority, greed for making more profit, delusion that investing in safety will increase the project cost non-cooperation and ignorance for their rights, poor safety management techniques, political influence, pervasive corruption, meeting unrealistic deadlines, extended working hours, less wages, no maintenance and inspection schedule, no safety training, no requirement of safety certification for the workers, shortage of safety personnel, and giving least value to human lives (Farooqui, 2012; Farooqui et al. 2008a; Raheem et al. 2011; Saqib et al. 2010; Choudhry et al. 2012 and 2006).

4.3.3 RECOMMENDATIONS BY THE RESEARCHERS

The significant safety climate factors have been identified as management commitment and employees involvement (Choudhry and Masood, 2011). Mohamed et al. (2009) have concluded that under collectivist, feminist and higher uncertainty avoidance environment, safety performance can be improved. It has been emphasized to bring a cultural change and a shift in the mind set of upper echelons in the government to improve the deteriorating safety situation (Ahmed, 2013). Stakeholders need to be educated

that accident not only causes an injury but also results in time delay, morale lowering, indirect labour replacement cost, equipment repair cost, and most importantly brings bad name to the company (Hinze, 2000). The researchers have also recommended to enhance the safety performance by; redefining and enforcing safety rules and regulations, establishing health and safety regulatory authority, appointing safety inspectors, allocating sufficient budget for safety training and education, and developing an effective communication and accident reporting mechanism (Memon et al. 2013; Nawaz et al. 2013; Hassan, 2012).

Choudhry et al. (2008) have suggested that safety incentives, green card scheme and safety management system in Hong Kong are equally applicable to Pakistan and their implementation can bring positive change in the working environment. They have also suggested that Directorate of Workers Education (DWE) should take a leading role towards enhancing safety standards in all the industries. PEC is recommended to; ensure safety through contractual obligations, allocate safety budget in contract documents, incorporate 'safety credit points in the contractor license renewal process, employ safety staff, and maintain accident statistics (Raheem and Hinze, 2013a; Zahoor and Choudhry, 2012). Two (2) credit hours Occupational Health and Safety (OH&S) course has also been recommended for civil, architect and town planning students, so as to strengthen the safety awareness among the key stakeholders (Masood et al. 2012a).

5. SAFETY ENFORCEMENT AND TRAINING INSTITUTES

At the Federal government level, DWE working under the Ministry of Capital Administration & Development is primarily responsible to create awareness among workers for their rights and to educate them about their social and economic problems including OH&S training; however its performance is not satisfactory. In the province of Punjab, the department of Labour & Human Resource has established an ancillary body (CIWCE) at Lahore, which is providing professional services in the fields of OH&S. Few private institutes are also providing OH&S training but on commercial basis, including; Occupational Safety and Loss Prevention (OSALP), Occupational Training Institute (OTI), and Vivid Institute of Occupational Safety and Health (VIOSH).

PEC is also conducting safety awareness workshops and compulsory 'Continuing Professional Development' (CPD) short courses but these training sessions are only for engineers and supervisors, whereas no training is organized for construction workers (Khan et al. 2013a). PEC has incorporated following OH&S clauses in its contract documents but these are mostly not enforced due to the absence of a regulatory authority.

a. Safety, security and protection of the environment: It is clause 19.1 of part-I (General conditions of contract) of PEC standard form of bidding documents (PEC, 2007, p.90).

b. Safety precautions: It is clause 19.3 of part-II (Particular conditions of contract) of PEC standard form of bidding documents (PEC, 2007, p.152).

6. CHALLENGES FOR THE SAFETY RESEARCHERS IN PAKISTAN

6.1 SCARCITY OF CONSTRUCTION SAFETY RESEARCH

Research in the field of construction safety in Pakistan remained almost neglected, as the key stakeholders had been focusing on productivity only. Accident statistics have not been maintained at the industry level so it has proven to be the major obstacle in the data collection. Only a few researchers have worked in this area using the leading safety indicators. They have mostly used descriptive statistics for the data analysis. Moreover, sample sizes are also not quite reliable. Likewise, Structural Equation Modeling and Social Network Analysis have not been used for the data analysis and validation. Hence, very few researches had been published in the peer reviewed journals.

6.2 FUTURE RESEARCH DIRECTIONS

Detailed study may be carried out to identify the safety climate factors affecting the safety performance in the Pakistani construction industry using the exploratory factor analysis. Causal relationship among various safety climate factors using the structural equation modeling (confirmatory factor analysis) needs to be examined. A study may be conducted to examine the safety practices being practiced in the tall buildings construction as they are suffering from higher accident rates (Zahoor et al. 2015). Research may also be instigated to assess the applicability of successful construction safety management practices of the developed countries in Pakistan. Unsafe behavior of the workers, which is intrinsically linked to the workplace accidents, needs to be explored to ascertain the root causes of accidents and study the varied behavior of different tradesmen. Likewise, applicability of innovative (information and communication) technologies to effectively monitor the safety performance on construction sites needs to be explored. There is also a need to compare the cost of accidents with the investment needed for safety compliance. Contractual obligations of various construction departments may also be examined. Standardized safety rules and regulations are also required to be established for the construction industry of Pakistan.

7. CONCLUSIONS

Construction safety research in Pakistan is in its embryonic stage. Very few researches have been published in the journals; however many have been published in the conference proceedings which are mostly not accessible online. This paper is an attempt towards summarizing the completed research

work and identifying the research gap for further consideration by the researchers.

In Pakistan, construction companies are reluctant to share the accident statistics; however fatalities are mostly reported due to the fear of litigation (Choudhry et al. 2008; Mohamed, 2002). Higher unemployment ratio, unawareness and illiteracy rate force the workers to work under unfavorable site conditions. Fall from height is key cause of construction accidents (Choudhry et al. 2014). PEC Contractors' selection criterion is only based on financial strength and not the safety performance. Though PEC has incorporated safety clauses in its contract documents, they are not enforced due to the absence of a regulatory authority. PEC is also conducting CPD webinars and seminars to create awareness among its graduate members; however no attention is paid training. PEC is recommended to: launch safety awareness campaigns; establish *OH&S regulatory authority*; revise the contracting and bidding documents for provision of safety budget by the clients; incorporate safety credit points in the contractors' selection criteria; and establish an effective accident reporting and investigation mechanism. Future research directions have also been recommended for actuating the research process in the field of construction safety in Pakistan.

ACKNOWLEDGMENT

Financial support from the Department of Building and Real Estate of The Hong Kong Polytechnic University to undertake this research study is gratefully appreciated.

REFERENCES

Ahmed, S.M. (2013). "A strategic framework to improve construction safety practices in Pakistan" International conference "Safety, Construction Engineering & Project Management (ICSCEPM - 2013)" Islamabad, 9-17.

Ahmed, S.M., Kwan, J.C., Ming, F.Y.W. (2000). "Site safety management in Hong Kong". Journal of Management in Engineering, 16(6), 34-42.

Ali, T.H. (2006). "Influence of national culture on construction safety climate in Pakistan". Doctoral Dissertation, Griffith University, Gold Coast Campus, Australia.

Chan, A.P.C., Wong, F.K., Chan, D.W., Yam, M.C., Kwok, A.W., Lam, E.W., and Cheung, E. (2008). "Work at height fatalities in the repair, maintenance, alteration, and addition works". Journal of construction engineering and management, 134(7), 527-535.

Choudhry, R.M., Tariq, B., and Gabriel, H.F. (2014). "Investigation of fall protection practices in the construction industry of Pakistan". In CIB W099 International Health and Safety Conference, "Achieving Sustainable Construction Health and Safety", 2-3 June, Sweden, 211 221.

Choudhry, R.M., Ahmad, W., Azhar, S., and Hinze, J.H. (2012). "Safety management practices in the construction industry of Pakistan". 3rd International Conference on Construction in Developing Countries (ICCIDC-III). 4-6 July 2012, Bangkok, 314-319.

Choudhry, R.M., and Masood, R. (2011). "Assessment of multi-level safety climates of working groups to drive perceptual unification". Proceedings of CIB W099 International Conference on "Prevention: Means to the End of S&H Washington, D.C. USA.

Choudhry, R.M., Fang, D., and Lingard, H. (2009). "Measuring safety climate of a construction Company". Journal of Construction Engineering and Management, 135 (9), 890-899.

Choudhry, R.M., Fang, D., and Rowlinson, S. (2008). "Challenging and enforcing safety management in developing countries: A strategy". International Journal of Construction Management, 87-101.

Choudhry, R.M., Rowlinson, S., and Fang, D. (2006). "Safety management - Rules, regulations and their implementation in developing countries". CIB W099 International Conference on Global Unity for Safety & Heath in Construction". Beijing, 28-30 June 2006, 482-493.

CIWCE. The Centre for Improvement of Working Conditions & Environment, Government of Punjab. Online at http://goo.gl/X3EAA5, Accessed on April 23, 2015.

Directorate of Workers Education (DWE), Ministry of Capital Administration & Development. Online at http://goo.gl/O9un2k, Accessed on April 25, 2015.

Farooqui, R.U. (2012). "An exploratory study probing into the factors causing safety Non-Performance in the Pakistani construction industry". 45th Convention of Institute of Engineers, Pakistan.

Farooqui, R.U., Ahmed, S.M. and Lodi, S.H. (2008a). "Assessment of Pakistani construction industry - Current performance and the way forward". Journal for the Advancement of Performance Information and Value. 1(1), 51-72.

Farooqui, R.U., Arif, F., and Rafeeqi, S.F.A. (2008b). "Safety performance in construction industry of Pakistan". In 1st International Conference on Construction in Developing Countries (ICCIDC-I), Karachi, 74-87.

Farooqui, R.U., Ahmed, S.M., and Panthi, K. (2007). "Developing safety culture in Pakistani construction industry - An assessment of perceptions and practices among construction contractors". In proceedings of 4th International Conference on Construction in the 21st Century (CITC-IV), Gold Coast, 420-437.

Haider, Z., Choudhry, R.M., and Aslam, M. (2013). "Analyzing safety training needs of construction industry in Pakistan". International Conference, "Safety, Construction

Engineering & Project Management (ICSCEPM-2013)" . Islamabad, 90-95.

Hassan S.A. (2012). "Health, Safety and Environmental practices in the Construction sector of Pakistan". Masters Dissertation, Uppsala University, Sweden.

Hinze, J.W. (2000). Incurring the costs of injuries versus investing in safety. Chapter 2: Construction Safety and Health Management, (Ed.), Prentice Hall, New Jersey.

Jafri, S.F., Rao, Z.I., and Sheeraz, K. (2012). "Policy formulation of construction safety associated with labor requirements - Substantial approach for the metropolitan city, Karachi, Pakistan". IOSR Journal of Mechanical and Civil Engineering (IOSRJMCE). 1(1)1-6.

Jafri, S.F. (2012). "Safety and security policies, pre and planned construction phase". 3rd International Conference on Construction in Developing Countries (ICCIDC-III). 4-6 July 2012, Bangkok.

Khan, A.A., Ajmal, S., and Farooqui, R.U. (2013a). "Investigation of labor and management perception, commitment and attitude towards safety". International Conference. "Safety, Construction Engineering & Project Management (ICSCEPM- . Islamabad, 78-83.

Khan, M.I. (2013b). "Developing a safety culture in developing countries". International Conference, "Safety, Construction Engineering & Project Management (ICSCEPM- . Islamabad, 26-31.

Masood, R., Mujtaba, B., Khan, M.A., Mubin, S., Shafique, F., and Zahoor, H. (2014). "Investigation for safety performance indicators on construction projects". Science International, 26(3) 1403-1408.

Masood, R., Choudhry, R.M., Riaz, Z., Waseem, U., Khursheed, N., and Khan, M.Z.A. (2012a). "Strengthen the formal education of construction safety for civil engineers- Bridging the gap". CIB W099 International Conference "Modeling and Building Health and Safety". Singapore, 10-11 September 2012, 290-302.

Masood, R., Choudhry, R.M., Riaz, Z., Azhar, S., and Hinze, J.W. (2012b). "Role of managers in establishment of construction safety culture". CIB W099 International Conference "Modeling and Building Health and Safety". Singapore, 10-11 September 2012, 651-659.

Masood, R., Farooqui, R.U., Choudhry, R.M., Riaz, Z., and Munir, Y. (2012c). "Analyzing Health and Safety (H&S) policy to evaluate top management commitment level". CIB W099 International Conference "Modeling and Building Health and Safety". Singapore, 10-11 September 2012, 721-731.

McDonald, N., and Hrymak, V. (2001). "Safety behaviour in the construction industry". Report to the Health and Safety Authority (Dublin) and the Health and Safety Executive (Northern Ireland).

Memon, Z.A., Khatri, K.L., and Memon, A.B. (2013). "Identifying the critical factors affecting safety program performance for construction projects within Pakistan construction industry". Mehran University Research Journal of Engineering & Technology, Pakistan. 32(2) 269-276.

Mohamed, S., Ali, T.H., and Tam, W.Y.V. (2009). "National culture and safe work behavior of construction workers in Pakistan". Safety Science, 47, 29-35.

Mohamed, S., and Ali, T.H. (2005). "Safety behavior in the construction industry in Pakistan". CIB 021, 47th Triennial International Conference, "Rethinking and Revitalizing Construction Safety, Health, environment and uality", South Africa. 17-20 May 2005, 64-74.

Mohamed, S. (2002). "Safety climate in construction site environments". Journal of Construction Engineering and Management. 128 (5), 375-384.

Nawaz, T., Ishaq, A., and Ikram, A.A. (2013). "Trends of safety performance in construction and civil Engineering projects in Pakistan". Civil and Environmental Research, 3(5)23-40.

OSALP. Occupational Safety and Loss Prevention. Online at http://www.osalp.com.pk/safety/, Accessed on April 14, 2015.

OTI. Occupational Training Institute. Online at http://www.oti.com.pk/index.htm, Accessed on May 14, 2015.

PBS (2012-2013). Pakistan Bureau of Statistics - Labour Force Statistics. Online at http://goo.gl/BGIoZu, Accessed on April 14, 2015.

PBS (2010-2011). Pakistan Bureau of Statistics - Labour Force Statistics. Online at http://goo.gl/CmJSYb, Accessed on May 18, 2015.

PEC (2007). "Pakistan Engineering Council (PEC) Standard form of bidding documents". Online at http://goo.gl/b7yzgb, Accessed on April 25, 2015.

Qazi, A., Ye, L., and Choudhry, R.M. (2006). "Demand and awareness of construction safety in Pakistan". CIB W099 International Conference on "Global Unity for Safety & Health in Construction" Beijing, 28-30 June 2006, 470-475.

Raheem, A.A., and Hinze, J.W. (2013a). "Improving the existing regulatory infrastructure for worker safety in the construction industry of Pakistan". International Conference, Safety Construction Engineering & Project management (ICSCEPM- . Islamabad, 72-77.

Raheem, A.A., and Hinze, J.W. (2013b). "Understanding the safety culture of construction companies in Pakistan by analyzing safety policy manuals". International Conference, Safety Construction Engineering & Project Management (ICSCEPM- . Islamabad, 66-71.

Raheem, A.A., Hinze, J.W., and Azhar, S. (2012). "Injury/fatality data collection needs for developing

countries". 3rd International Conference on Construction in Developing Countries (ICCIDC-III). 4-6 July 2012, Bangkok, 308-313.

Raheem, A.A., and Hinze, J.W. (2012). "Reasons for the poor implementation of worker safety in the construction industry of Pakistan: A contractor's Prospective". CIB W099 International Conference "Modeling and Building Health and Safety". Singapore, 10-11 September 2012, 54-63.

Raheem, A.A., Hinze, J.W., Azhar, S., Choudhry R.M., and Riaz, Z. (2011). "Comparative analysis of construction safety in Asian developing countries". 6th International Conference on Construction in 21st Century (CITC-VI) "Construction Challenges in New D - 7, Kuala Lumpur. 14-21.

Riaz, Z., Arslan, M., Kiani, A.K., and Azhar, S. (2014). "CoSMoS: A BIM and wireless sensor based integrated solution for worker safety in confined spaces". Automation in Construction, 45, 96 106.

Saqib, M., Farooqui R.U, Saleem, F., and Lodi S.H. (2010). "Developing safety culture in Pakistani construction industry - Site safety implementation and safety performance improvement". 2nd International Conference on Construction In Developing Countries (ICCIDC-II), August 3-5, 2010. Cairo. 376-383.

VIOSH. Vivid Institute of Occupational Safety and Health. Online at http://www.vividpk.com/contactus.html , Accessed on May 20, 2015.

Zahoor, H., Chan, A.P.C., Utama, W.P., and Gao, R. (2015). "A research framework for investigating the relationship between safety climate and safety performance in the construction of multi-storey buildings in Pakistan". International Conference on Sustainable Design, Engineering and Construction (ICSDEC-2015). Chicago, 11-13 May.

Zahoor, H., and Choudhry, R.M. (2012). "The most neglected construction safety practices in Rawalpindi / Islamabad". CIB W099 International Conference "Modeling and Building Health and Safety". Singapore, 10-11 September 2012, 312-322. Online at http://goo.gl/bpwghH, Accessed on April 11, 2015.

(Continue Page 24)

Implementation of Waste Assessment Matrix and Line Balancing for Productivity Improvement in a High Variety / High Volume Manufacturing Plant

Engr. Basit Ali
Basitali_neduet@hotmail.com

Engr. Sarah Jaweed

Engr. Dr. Muhammad Fahad

ABSTRACT

Principle of lean manufacturing has been known since last two decades, however, its implementation in the local industries is a recent trend. A lot of analysis tools such as 5S, kaizen, Kanban, flow production and line balancing have commonly been used to improve productively by organizations across the globe as well as in the local industries. A relatively newer tool, named as waste assessment matrix (developed at Industrial Engineering dept., University of Jordan, Amman) is a technique that defines the interrelationship between different forms of waste in a job shop environment to highlight their relative significance. This study is based on the use of waste assessment matrix for identifying different type of wastes in the packing department of a high variety – high volume manufacturing plant. Other lean tools, such as 5S, kaizen, flow production and line balancing were then used to analyse and improve the wastes in the plant. The study shows that waste assessment matrix can be equally well applied in a high volume manufacturing plant as can be applied in a job shop. Results show that not only lead time, and workforce were reduced but the availability and performance of the plant were improved.

Keywords: Mass Production; WRM; Online packing; Kaizen; Lean Methodology

1 INTRODUCTION

Wastes are the profits that the company can earn and lean is a revolution that earns that profit [1]. It is not only using tool and changing few step in manufacturing processes, rather it is about complete change of business operation. The background of lean is based in the history of Japanese manufacturing techniques which have now been applied worldwide within many type of industries [2]. Every production process have some different activities. These activities could be easily classified into value added activities (VA) and non-value added activities (NVA). Activities that directly adds value to product or customer is willing to pay for are considered as value added while activities having no impact on product and its value, are termed as non value added activities [3]. Although, some of the NVAs is considered as necessary for carrying out production but, a large proportion of these NVAs is typically consideration as pure waste and could easily be removed to improve the productivity. These are usually referred to as wastes. On a broader scale, waste is divided into three types as follows:

1. Muda (Waste)-Capacity Exceeds Loads
2. Muri (Irrationality)-Loads Exceeds Capacity
3. Mura (Inconsistency)-Both cases may occur

As per taiichi ohno, wastes may comprise of motion, waiting time over production, over processing, defects, transportation and inventory [1]. These wastes add to higher cost, poor quality and less motivation. In order to remove these wastes, a tool named as lean manufacturing Methodology is used. By definition, lean manufacturing could be defined as;

"Lean manufacturing is a business model and collection of tactical methods that emphasize eliminating non-value added activities (waste) while delivering quality products on time at least cost with greater efficiency" [4].

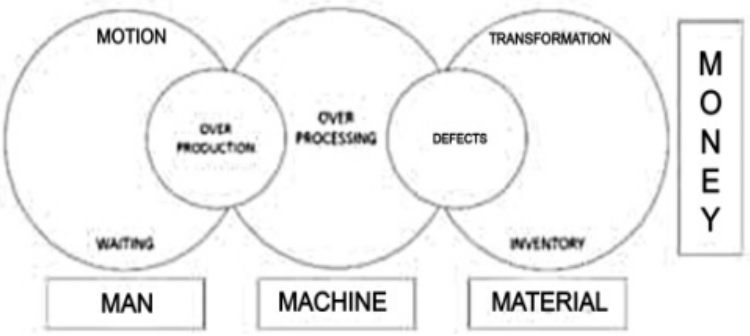


Figure 1.7 wastes of lean [3]

Lean methodology means to eliminate NVAs or convert them into Vas. It focuses not only on segments of processes but on the whole process. It includes all the employees and their motivation, hard work and efforts in the development of a lean organization. It is not a work of one man army rather every individual has to include something to it [5]. In today's high competitive market, Pakistan's industrial sector is striving hard in order to achieve the set goals and to achieve that, implementation of lean methodology has been the right way to choose.
The common questions that arise are:

1- Why follow lean?
2- What are the basic principles of lean?
3- What are the tools that could be used for executing lean?

Answer to question number one lies in the benefits of utilizing and believing in lean methodology, which are:

- Improved quality
- Less defects
- Reduce inventory
- Improve space utilization
- Easy to manage processes
- Less machine and process breakdowns
- Better efficiency
- Safe work place
- Improve morale of workers
- Improve supply chain
- Better relations from vendors to customer

Similarly, following principles are basics to lean methodology [6].

- **Specify Value –** Customer requirement.
- **Identify the Value Stream** – All the steps required to fulfil customer requirements.
- **Establish Flow** – Make sure the value flows smoothly (without any disruptions) to the customers.
- **Implement Pull System** – Use a Pull system to control inventory/information wherever required and possible.
- **Work to Perfection** - Continuously look for ways to improve the value addition process.

Finally, some of the common tools utilized for implementing lean are [1,5,7]:

- **Value Stream Mapping –** For analyzing & streamlining flow of material & information of all the processes
- **Kaizen** – Philosophy of continuous improvement of working practices
- **Just In Time** – Reducing the in process inventory and associated costs
- **Jidoka** – System stops at any un certainty
- **5S** –Methodology for work place organization
- **Kanban** – Visual signal of customer demands
- **Poka Yoke** – Mistake proofing

All the basic principles and tools listed above are targeted towards achieving the benefits of lean mentioned earlier which mainly involved identifying the waste (NVAs) and its subsequent elimination.

2 WASTE ASSESSMENT MODEL
Starting point of any journey is key to morale of people involved. For improvement if it is started with a big improvement and improvement's impact is as loud as a hammer's noise then it counts in morale and efforts improvement of human resource involved. For this kind of impact, it is very important to find out the major waste that have the highest influence on overall process and if it is improved then whole process will improve. In this regard waste assessment model is used to find out how high the effect of the waste is on system as well as on each other. This assessment model is the most important step to implementation of Lean manufacturing methodology. Ibrahim A. Rawabdeh [3] was the first person who identified the relationship between the different types of wastes by using a concept of WRM (waste relation matrix). The idea of the matrix is to establish a link between all the different types of wastes that occur while performing manufacturing processes. The waste that have strongest direct link with all other wastes is selected as the possible source of non-value adding activities and is subsequently removed/lowered via lean tools to improve the situation. The matrix was used to identify the most important type of waste in a job shop environment [3]. In this project, this approach (WRM) will be implemented in high variety/high volume production environment to find out the waste which should be eliminated from the system. The waste assessment model was designed on the basis of each type of the seven wastes (Figure 3) and their over lapping area. Then identify the strength of each direct relationship among the seven type of waste and make waste matrix that classifies the strength of relationship using a scale ranging from very weak to very strong.
In second phase, an assessment questionnaire is use to rank a waste by combining the relationship matrix and the results of the assessment questionnaire.
All type of waste are inter-dependent and discussing the relationship among wastes id complex because the relation can appear directly or indirectly.

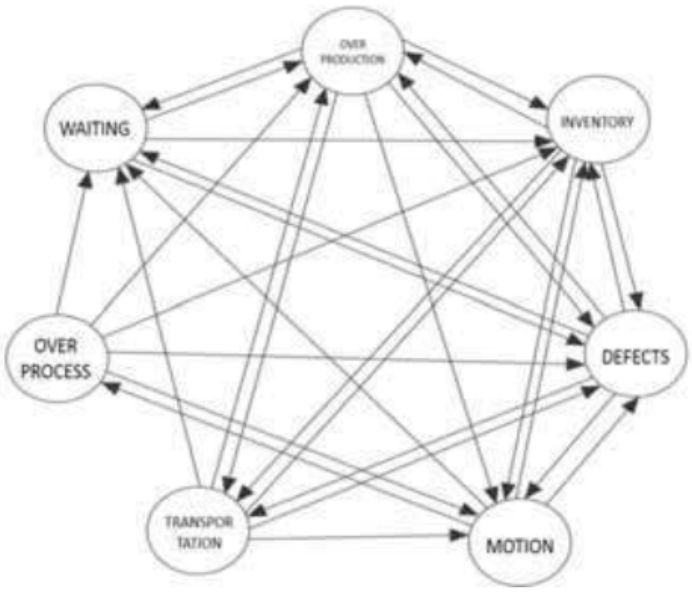


Figure 2. Relation between 7 Wastes [3]

2.1 Explanation of Waste Assessment Model

Inventory

I-O Higher inventory of raw materials can be reason to push the labour for over production in order to get the higher profit for company.

I-D Higher inventory of raw material, work in process and finish good will increase the chances to produce defected due to less of concern and unsuitable storing condition**.**

I-M Higher inventory also be the reason to increase the time in each and every process.

I-T Higher Excess inventory creates hurdle in the transportation of material.

Defects

D-O In order to overcome the defects, over production become necessary

D-I Defects mean they need to reworked, so WIP will be increases in the form of inventory

D-M defects increase the time of searching, selection and inspection of part

D-T Defects will increase the wasteful transportation activities

D-W As reworks reserve the workstation therefore new parts will be waiting to be processed

Motion

M-I Non-standardize method become reason of WIP

M-D Non-standardize process leads to increase the defects

M-P When process are non-standardize will increase the process waste due to the lack of understanding the available capacity

M-W Due to non-standardize process, time will be consumed searching, selecting the parts so in result part waiting get increase.

Transportation

T-O In order to reduce the transportation cost per unit, over production has to be effected

T-I other process can be effected due to insufficient number of material handling equipment (MHE)

T-D Sometime non-suitable MHE be the reason of damage items and defects

T-M When MHE is non-standardize then it leads to motion waste presented by double handling and searching

T-W Insufficient MHE will also lead to waiting to be transported and some of the machine will remain idle [3]

2.2 Waste assessment Model (WAM)

Waste assessment model starts by first identifying the major forms of waste that occur in the factory/plant in a general perspective. After this, each waste is linked with each other waste to establish link between the wastes. Following six questions are then used in developing the waste assessment matrix for each identification link. Assume 'a' is the source waste and 'b' is the resulting waste, then the question to be asked are:

1. Does a produce b?
2. What is the type of the relationship between a and b?
3. The effect of b due to a?
4. Eliminating the effect of a on b is achieved by?
5. The effect of b due to a, mainly influences?
6. In which degree does the effect of a and b increases manufacturing lead time?

The answers to these questions are ranked from 0 to 4 and the resulting total is listed in the form of a matrix known as waste relationship matrix (WRM). This WRM is then used to identify the waste (s) which has the most influence on all other wastes and removing this waste could not only reduce the other form of wastes but will also enable a quick improvement in productivity.

3 METHODOLOGIES

For the implementation of productivity improvement via WRM, a multinational organization which is considered as global leaders in the manufacturing of safety products was selected. The company is in operation since last thirty years and has various units not only within Pakistan, but across the globe in over forty countries. The organization has five factories in Pakistan and they produce customized as well as high volumes of regular products. This project involved implementation of WAM for productivity improvement in one of the glove manufacturing facility of the

organization. After applying WRM, the waste with highest value was selected for improvement. Value stream mapping (VSM), Line Balancing and 5S techniques were subsequently implemented to improve the system.

4 RESULTS AND DISCUSSION

The facility have strived hard for improvement in packing department through implementing the concept of batch to online (continuous) packing system. Following problems have been faced in the existing system for which this project was initiated; inventory, defects, transportation and motion. The main problem was the cycle time of the packing process (6 sec/pc) which was higher than the takt time (5.33 sec/pc). Total lead time till final finished good (FG) was about 24 hrs to 48 hrs. Not only waiting time was high but this process was also long i.e. have high transportation wastes. The more the good travels, the more the risk of damage (waste of defects). Similarly defects were also highlighted late that causes high loss.

4.1 Waste Assessment Model (WAM)

Waste assessment model was the first step taken in order to check and finalize which waste has to be given high priority in order to start the implementation process of productivity improvement by implementing its lean manufacturing tools. Range distribution of the methodology is as given in the Table 1 [3]:

Table 1. Range Distribution

Range	Type	Relation Symbol
17 to 20	Absolutely necessary	A
13 to 16	Especially important	E
9 to 12	Important	I
5 to 8	Ordinary closeness	O
1 to 4	Unimportant	U

A research was carried out for focusing on relations of all the wastes among each other. In the facility, four major defects were highlighted as discussed earlier i.e. transportation, inventory, motion and defects. Table 2 lists the final results.

After observing the relationship of wastes, next step is to write the relationships by forming a from/to (F/T) matrix as shown in Table 3.

After allotting the numbers to this matrix as defined in the range distribution (Table 1), final total percentage matrix or the waste relationship matrix was calculated as shown in the Table 4 below.

From the WRM, it is clear that transportation waste is contributing in generating 23% of the total wastes (Table 4). Similarly, next in the sequence are defects, inventory and motion. Therefore, improvement tools

Table 2. Relationship of Wastes

Question	1		2		3		4		5		6		Score	Importance
Relation	A	W	A	W	A	W	A	W	A	W	A	W		
T-I	b	2	b	1	b	2	a	2	g	4	b	2	13	E
T-M	a	4	a	2	b	2	b	1	g	4	a	4	17	A
T-D	b	2	c	0	c	0	a	2	g	4	b	2	10	I
I-T	b	2	b	1	a	4	b	1	g	4	b	2	14	E
I-M	a	4	b	1	b	2	c	0	f	2	b	2	11	I
I-D	b	2	c	0	c	0	c	0	d	2	c	0	4	U
M-T	b	2	b	1	c	0	b	1	d	2	a	4	10	I
M-I	c	0	b	1	c	0	a	2	f	2	b	2	7	O
M-D	b	2	b	1	b	2	b	1	d	2	c	0	8	O
D-T	b	2	a	2	b	2	a	2	g	4	b	2	14	E
D-I	b	2	b	1	c	0	b	1	d	2	b	2	8	O
D-M	b	2	c	0	b	2	b	1	f	2	c	0	7	O

A = answer and W = weight of each answer (see [3] for details)

Table 3. Relationship of Wastes

F/T	D	O	W	N	T	I	M	E
D	A	X	X	X	E	O	O	X
O	X	A	X	X	X	X	X	X
W	X	X	A	X	X	X	X	X
N	X	X	X	A	X	X	X	X
T	I	X	X	X	A	E	A	X
I	U	X	X	X	E	A	I	X
M	O	X	X	X	I	O	A	X
E	X	X	X	X	X	X	X	A

were selected to reduce these wastes to enhance the productivity and bring the cycle time within talk time.

Table 4. Relationship of Wastes (%)

F/T	D	O	W	N	T	I	M	E	Score	Percentage
D	10	0	0	0	8	4	4	0	26	17%
O	0	10	0	0	0	0	0	0	10	7%
W	0	0	10	0	0	0	0	0	10	7%
N	0	0	0	10	0	0	0	0	10	7%
T	6	0	0	0	10	8	10	0	34	23%
I	2	0	0	0	8	10	6	0	26	17%
M	4	0	0	0	6	4	10	0	24	16%
E	0	0	0	0	0	0	0	10	10	7%
Score	22	10	10	10	32	26	30	10	150	100%
	15%	7%	7%	7%	21%	17%	20%	7%	100%	
Based On:	A=10	F=8	I=6	O=4	U=2	X=0				

4.2 Layout Modification Line Balancing

Waste of transportation is mainly caused by the problems in layout. Current lay out of the facility is shown in Figure 3. Goods were transferred to packing through conveyor. A tray man inspects the gloves and then forwards them to inspection. Next step is pad printing, then plastic protector addition, bundle making and then final bundle packing. Lastly, the ready cartons were transferred to pallet.

Even distribution of task over the work station so that idle time of man and machine can be minimized is said to be line balancing. It is optimized operation technique which has significant industrial importance in lean system [8].

In line balancing bottlenecks and starving problems are tackled and eliminated. An ideal (balanced) line usually follows single piece flow (zero inventory), minimizes waiting and improves quality by ensuring that any defects are caught as soon as they are produced and thus no defects are moved down the line. Thus, it can be noticed that line balancing is the right choice of tool to eliminate the wastes identified by WRM.

Usually the concept of line balancing is applied in assembly line but at the selected facility, it was successfully implemented and executed. This concept of line balancing is somewhat different from traditional implementation but basic concept remains same. The current state of the different stations that were involved in packaging is shown in Figure 4.

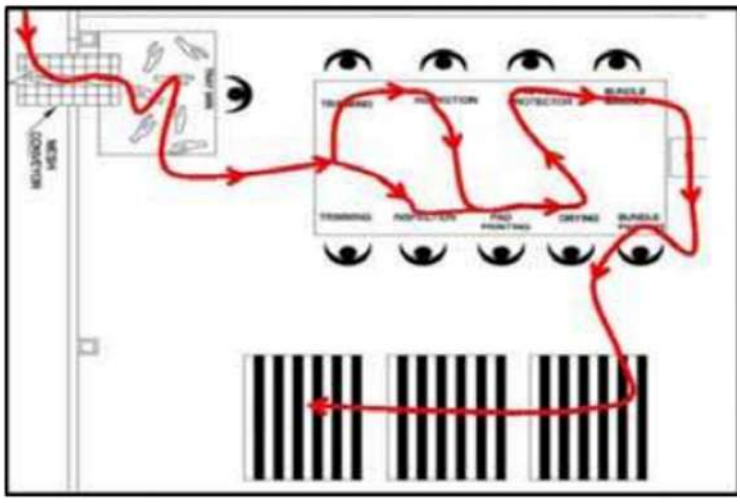


Figure 3. Current (as-is) Layout

An improved layout is shown in Figure 5 below. The feasible layout have an e-tone system (conveyor) and an on-line platform tray man, trimmer and pad printing option. While the packing area was converted to two inspectors, plastic sheet cover, pairing, bundling and then pallet. On line platform expansion helped in improving the layout. Similarly, an improved (balanced) line was obtained as a direct consequence of layout changes (Figure 6).

Major wastes that were removed included transport and inventory while motion was also reduced. Transportation and inventory values of current and improved states are compared in Table 5.

5S

The concept of 5S is constituted on the basis of Kaizen. 5S is used by 5 different Japanese words which are Seiri (Sort), Seiton (Set in order), Seiso (Shine), Seiketsu (Standardize) and Shitsuke (Sustain). These five S focus on effective work place and work procedure and their proper implementation allow for the application of continuous improvement by all the employees within the organization [7].

Sort

Sorting requires the separation of necessary and unnecessary items. Red tagging the unnecessary items is the common step to be taken during sort.

The items which are unnecessary for the workplace are marked with red tag and relocated in a review area.

After the sorting has been finished, the items tagged red are assessed and then finalized whether to keep on plant or remove from plant and move to drum yard.

Results obtained by red tagging are shown in Table 6.

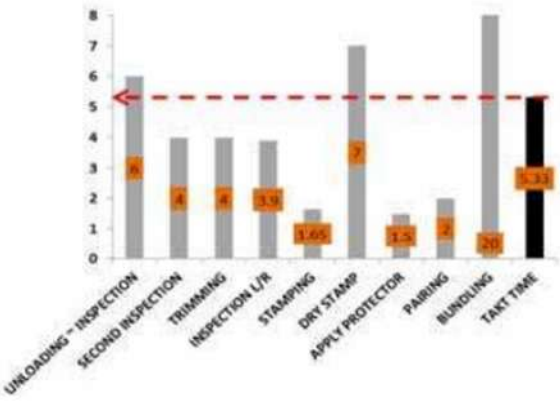


Figure 4. Current (as-is) Load Chart

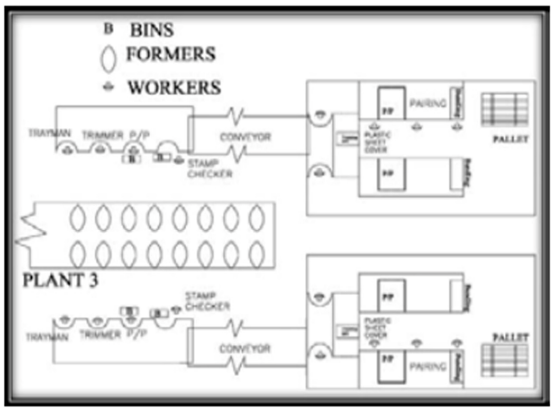


Figure 5. Improved (to-be) Layout

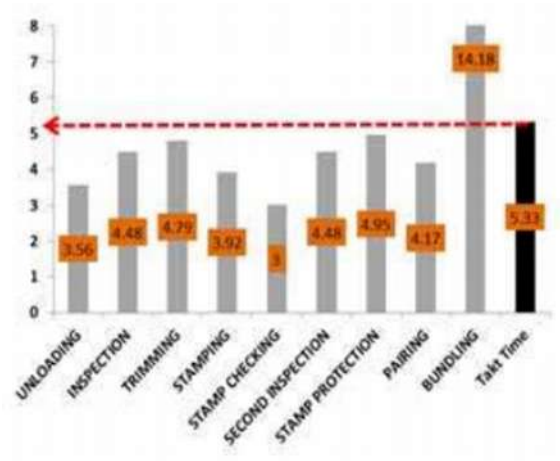


Figure 6. Improved (to-be) Load Chart

Table 5. Transportation& Inventory Comparison

	AS-IS	TO-BE
Glove travelling distance (unloading~carton making)	70 feet	57 feet
Glove travelling time (unloading~carton making)	8 min	2.41 min
Inventory b/w operations	262 DP	12.25 DP
No. Of workers	7	7
No. Of workers (future state)	7	5

Set in order
All the available equipment of plant was arranged as per the necessities and its use. An example is shown in Figure 7.

Shine
Cleaning and painting of whole plant was done. Marking of floor was performed and better aesthetics were created. Figure 8 shows an example of shine activity being carried out.

Standardize
Area for putting the right thing in right place was performed and all the equipment were given standard position. Floor marking is evident from Figure 9.

Sustain
For sustaining the 55 activities, performance chart was added on visual board and weekly discussion is also set to occur as shown in Figure 10.

5 RESULTS Outcomes of the waste assessment was utilized in the implementation of lean manufacturing concept i.e. line balancing leading to layout change, one piece flow and 55. These tools lead to valuable decrease in identified wastes of transportation, inventory, motion and defects and thus result in the improvement of produced quantity and decreased lead time. Summary of improvements achieved are listed in Table 8.

6 CONCLUSIONS
Gut feelings and experience are sometimes not enough in order to bring the change, remove wastes and create improved environment. As per an industry practice, it has been noted that some of the waste cannot be observed or acknowledge as per their intensity by line manager. This research paper proved that waste assessment can be applied in high volume and high variety industry.

Also, waste assessment matrix could be used a tool that identifies the exact targets for productivity improvement purposes.

Wastes identified by WRM were subsequently improved by using the tools such as layout change, line balancing and 5S implementation. The results showed real improvements and proved that the wastes as identified by WRM were mainly the causes of disruptions and thus the value was not flowing to the customers. However, by removing these wastes, not only productivity was improved, but the production system was reoriented to ensure the flow of value to the customers in a timely manner which is what required in a lean system. However, this must be kept in mind that these changes could only be sustained only if the continuous improvement route is followed rather than once in a while

Figure 7. Set in Order

Figure 8. Shine

Figure 9. Standardize

Figure 10. Sustain

Table 8. Summary of Improvement

S.No.	METRIC	AS IS	TARGET	ACHIEVED	QTY. CHANGED	% CHANGED
1	**Value Added (sec) (Unloading to Carton)**	36.00	26.47	34.47	1.53	4%
2	**Total Lead Time (hrs) (Unloading to Carton)**	5.00	0.95	1.00	4.00	80%
3	**Layout**					
a	Glove travelling distance (RFT) (Unloading to Carton)	70.00	55.00	57.00	13.00	19%
b	Glove travelling distance (min) (Unloading to Carton)	8.00	2.00	2.41	5.59	70%
c	Inventory b/w operations (DP)	262.00	10.00	12.25	249.75	95%
d	No. of Workers	7.00	5.00	7.00	-	0%
4	**Production (DP)**	450.00	635.00	600.00	150.00	33%
5	**Inventory WIP (DP)**	682.00	150.00	350.00	332.00	49%
6	**5S Level of Excellence**	1.00	5.00	3.50	2.50	150%

approach. This model have not only emphasized on a single waste but it has also given the path of continuous improvement i.e. after removal of two or three big waste, it is the time to move to next waste and its removal. There are still some stones un-turned in this methodology of waste assessment model and major one is its implementation in service sector and comparison of results. However, the results in this study suggest in equal relevance in a high variety/high volume production system.

ACKNOWLEDGEMENTS

Authors would like to pay the gratitude to each and every individual involved in the implementation of this project.

REFERENCES

[1] Taiichi Ohno, "The Bible of Toyota Production System", pp. 85/188, Mar 1978

[2] T. Melton, The benefits of lean manufacturing "What Lean Thinking has to Offer the Process Industries", Institution of Chemical Engineers, 2005

[3] I A. Rawabdeh, "A model for the assessment of waste in job shop environments", International Journal of Operation & Production Management, Vol. 25, 2005

4] Lean manufacturing and the environment, http://www.epa.gov/lean/environment/ (accessed on 12.04.2015)

[5] E R K Mehta, D Mehta, N. K. Mehta, An Exploratory Study on Implementation of Lean Manufacturing Practices (With Special Reference to Automobile Sector Industry), 2012

6] Manufacturing, http://www.hcltech.com/ manufacturing/lean-manufacturing (accessed on 12.04.2015)

[7] T. Karkosazka, J. Honorowicz, "Kaizen philosophy a manner of continuous improvement of processes and products", Journal of achievements in materials and manufacturing engineering, Vol. 35, 2009

[8] N Kumar, D Mahto, "Assembly line balancing: A review of developments and trend in approach to industrial application", Global Journal of researches in engineering and industrial engineering, Vol. 13, pp. 1, 2013.

Evaluation of Maintenance Management Practices in Automotive Industries of Pakistan

Engr. Javeria Younus

Engr. Dr. Muhammad Fahad
mfahad@neduet.edu.pk

Engr. Dr. Maqsood A.Khanl

ABSTRACT
Increased global competition for manufacturing sector have led many companies towards pursuing ways to gain competitive edge in domains such as service, cost, quality and timely delivery. Role of effective maintenance towards the overall productivity of an organization has received increased attention in the past few years and the role of maintenance has shifted from necessary evil to profit contributor. The study presents an overview of perspectives and trends of maintenance function in automotive industries of Pakistan. Automotive sector was selected due to its high importance in the economic growth and because it is considered to be a leading industrial domain of Pakistan that steers the growth in large scale manufacturing sector. Performance of different industries were evaluated and compared with each other as well as with that of world class practices. It would bring to light areas which the industries lead and lack and would not only help them to improve their maintenance practices but also bring them up to the global standards.

Keywords: Maintenance management; automotive sector

INTRODUCTION
Maintenance can be defined as "the combination of all technical, administrative and managerial actions during the life cycle of an item intended to retain it in, or restore it to a state in which it can perform the required function" [1] or a combination of functions which are considered necessary to provide a given service. Whereas maintenance management can be defined as management activities that determine the maintenance objectives, priorities, strategies and responsibilities and implement them by using maintenance planning, maintenance control, supervision and several improving methods [2]. Maintenance management is considered to be an important function of any manufacturing firm. If managed effectively it can bring improvement in the performance of any organization. It has been found that maintenance represents from 15 to 40% of the total product cost and improving maintenance is considered to be easier and more likely to occur [3].Therefore in order to make rapid improvement in manufacturing sector maintenance management can play an important role especially for the developing country like Pakistan and has high scope in research. The study presents an overview of trends and perspectives of maintenance function in automotive industries of Pakistan. Automotive sector was selected due to its high importance in the economic growth and due to the reason that it is considered to be a leading industrial domain of Pakistan that steers the growth in large scale manufacturing sector [4]. Performance of different industries were evaluated and compared with each other as well as with that of world class practices to help the industries identify the areas which need improvement and subsequently take measures to improve their performance to the world class standards.

8 METHODOLOGY
The aim of study was to evaluate the performance of the selected industries among themselves and with that of the world class benchmark (WCB) standards. For the purpose, four areas of maintenance management were considered for the study and a questionnaire by Wireman [5] was used to evaluate the performance of the industries. Table 1 shows the maintenance management areas and their WCB values. The questionnaire

was being filled by different concerned personnel belonging of the same firm so as to ensure authenticity of data. Then bar charts were used to analyze the collected data and evaluate performance of the selected industries. The performance of industries individually, and on average were also compared with that of WCB in each section.

Table 1. Maintenance Management activities and world class benchmark values[5]

Sections	WCB
Preventive Maintenance	24.1
Maintenance Work Orders	26.3
Maintenance Inventory & Purchasing	28.4
Asset Care Continuous Improvement	26.9

8.1 DESCRIPTION OF SELECTED INDUSTRIES

8.1.1 Industry 1:
A multinational company (MNC), original equipment manufacturer (OEM), founded twenty six years ago, capacity of 54,000/year and a turnover of Rs. 57,000 millions/year.

8.1.2 Industry 2:
An MNC, OEM, founded twenty two years ago, installed capacity of 150,000/year and a turnover of Rs. 51,000 millions/year.

8.1.3 Industry 3:
An MNC, OEM, founded twenty eight years ago, installed capacity of 750,000/year and a turnover of Rs. 44,000 millions/year.

8.1.4 Industry 4:
A local company, OEM, founded thirteen years ago, installed capacity of 55,000/year and generates a turnover of Rs. 1000 millions/year.

8.1.5 Industty 5:
A local vendor company, founded thirty six years ago, capacity of more than 1,000,000/year and turnover data was unavailable.

9 ANALYSIS

9.1 PREVENTIVE MAINTENANCE (PM)
In order to attain world-class performance, most companies are replacing corrective strategies for maintenance with proactive strategies such as preventive and predictive maintenance techniques. Preventive maintenance is often referred to as use/time-based maintenance activities that are executed according to a plan (i.e. planned activities). It is comprised of maintenance activities that are undertaken after a specified period of time or amount of machine use [1,2]. Different researchers have emphasised on the role which preventive maintenance can play in improving maintenance function and have placed it at the foundation of their proposed maintenance frameworks [5,6]. World class manufacturing experts believe that a rigid and disciplined preventive programs helps to produce high quality products. Also, the use of effective preventive maintenance activities can lead a company to achieve a ratio of 4:1 between proactive maintenance and reactive maintenance respectively. This means approximately 80% activities are planned and only 20% activities are corrective which could help to make other maintenance practices and processes to become more effective in terms of planning, execution and control [5].

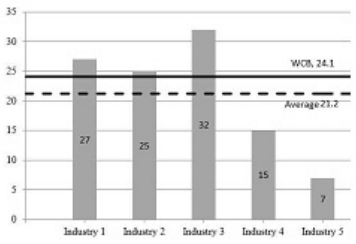


Figure 1. Preventive Maintenance

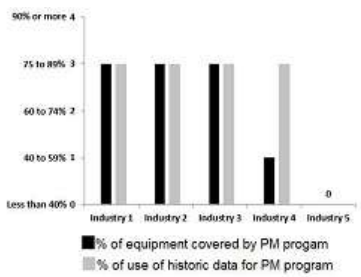


Figure 2. Percentage of critical equipment coverage and use of historic data by preventive maintenance program

Results presented in Figure 1 show that the average performance of the evaluated industries stands below than that of WCB standards. On further evaluation it can be seen that industries which are MNCs, have scored high in the evaluated section whereas the performance of both local industries is well below the evaluated average as well as WCB. Use of historic data along with the inclusion of critical equipment in PM program are the ingredients that make a PM program [5]. Historical data, if accurate and used properly, could give useful information about the equipment such as mean time between failures, date of last repairs, causes of failure etc. which, in turn, helps to design an effective preventive maintenance plan. Without effective historic records, PM would only become a guess work. From Figure 2, it is clear that industries utilizing historic data perform better than those which do not make use of historic data for their PM program. Industry 4, as indicated by results (Figures 1 and 2), shows exception from the above argument as it showed the same usage of historic data as industries 1, 2 and 3 but its performance in PM was below the average as well as WCB (Figure 1). This could be attributed to the percentage of equipment covered by PM program. Although, it may not be cost effective to include all the equipment in the facility in a preventive maintenance program, however, it seems obvious from the results in Figure 2 that the organizations (i.e. industry 1, 2 and 3) which include a higher percentage of their equipment to be covered by preventive maintenance program perform better. On the other hand, industry 4 and 5 did not cover a high percentage of their equipment under PM program which resulted in their low performance in the context of PM program implementation.

9.2 MAINTENANCE WORK ORDERS (WO)
An essential part of the maintenance control is the work order system which is based on utilizing a document (i.e. WO) which provides necessary information for planning, monitoring and reporting maintenance work. Work order system is a tool to measure and control the maintenance

function and is considered to be an important indicator of maintenance performance [9]. Studies show that it is impossible to measure and control maintenance activities if an organization does not have a well implemented work order system [5].

Results in Figure 3 show that, similar to the results of PM domain, the performance of local industries (4 and 5) in the domain of work order system is well below the average performance and the WCB. Work orders if properly managed contain historical data which can not only be used for forecasting equipment failure but also for optimizing maintenance strategy, resource allocation and hence making maintenance function cost effective and more efficient. Figure 4 shows that for Industry 4 and Industry 5, very low percentage of work orders are available for historical data analysis.

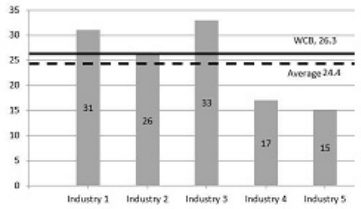


Figure 3. Maintenance Work Order System

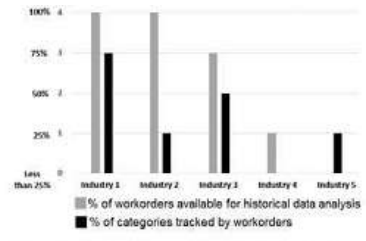


Figure 4. Work orders available for historical data analysis and categories tracked by workorders

One of the reasons could be that the concerned personnel are usually reluctant of filling up the work orders and if filled the data is either not accurate or complete and hence cannot be used for future use which is also evident from 4. Majority of the firms track only 25% or even less of the categories for the future use through work orders. It is important that work order system should not only cover the jobs performed but also the data entered should be relevant, accurate and complete.

9.3 MAINTENANCE INVENTORY AND PURCHASING

The timely availability of materials, spare parts and services is a key element of an effective and strong maintenance program. However having too many parts in stock will increase inventory and would result in tie up of capital. The purpose of maintenance inventory and purchasing is to maintain the spare parts and inventory required at an optimize level. Too low or too high both levels can affect the performance.

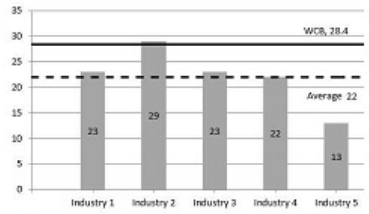


Figure 5. Maintenance Inventory and Purchasing.

Results evaluated in Figure 5 show that the performance of all selected industries, apart from industry 2, is not up to the mark (WCB) in the context of maintenance inventory and purchasing.

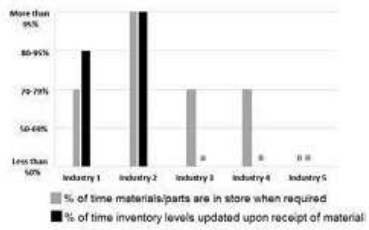


Figure 6. Percent of time materials in store when required.

In order to be successful within the highly competitive market it is essential to have spare parts where and when required as it ensures reliable equipment and customer satisfaction [10]. Good inventory control enables the maintenance department to be responsive to the operations group, while increasing the its own personal productivity [5]. Results in Figure 6 show that only Industry 2 has an inventory system that is efficient enough to provide spare parts when required. On the other hand, Industry 5 is not able to get the required spare part for even 50% of the times which is not a good sign and reflects poor practices of the company. Updating inventory levels on regular basis would convey actual number of inventory items and spare parts present resulting in correct reorder quantities without having unnecessarily high or low inventories. From Figure 6, it also evident that only Industry 2 is able to update its inventory levels (spare parts) on frequent basis. This suggests that regular updating of inventory would result in keeping the right spare parts inventory and thus the operation of maintenance department would be enhanced, which is the case for industry 2.

9.4 ASSET CARE CONTINUOUS IMPROVEMENT

In all aspects of business, continuous improvement is considered to be an essential element for meeting the challenge of today's turbulent environments [11]. Continual improvement, when considered in reference to asset care is an ongoing evolution that includes constantly looking for the little things that can make an organization more competitive[12]. Many authors have included different continuous improvement techniques as a part of their proposed frameworks for asset care and maintenance management [2-5] since it can tremendously increase asset productivity [16].

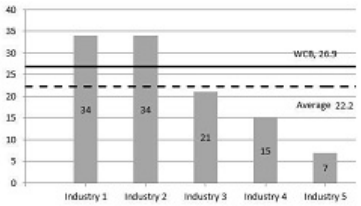


Figure 7. Performance of automotive industries of Pakistan in asset care and continuous improvement.

Results depicted in 7 show that the performance of Industry 1 and 2 have been exceptional whereas the other three industries have performance below WCB in this domain.

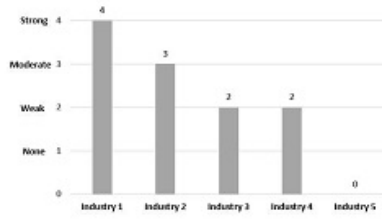


Figure 8. Management support for continuous improvement

Management support can play an important role to enhance continuous improvement efforts for maintenance function [14]. Senior management must not only communicate its support throughout the organization but the message must be repeated over time to encourage continuous improvement. Similarly, performance audits should be conducted to ensure that optimization is achieved and show management concern [16]. Results in Figure 8 show that both the industries 1 and 2 have moderate to high support of management in relation to continuous improvement efforts. Whereas the same for industries 3, 4 and 5 is weak to none. Thus, it is clear that in order to have a world class performance, management support is an important element. Researchers believe that utilization of emerging techniques and technologies such as Total Productive Maintenance (TPM) and Reliability Centered Maintenance (RCM) can have higher impact on the maintenance practices and its outcomes [14]. Reliability engineering is comparatively a new philosophy in maintenance domain for industries of a developing country like Pakistan. When evaluated in reference to continuous improvement effort it was found that none of the evaluated organizations have positive attitude towards it (i.e. no industry showed any response to using reliability engineering for improvement of maintenance activities). This could definitely be an important reason behind the average performance of industries being below to WCB in this domain.

10 CONCLUSION

Maintenance is considered to be a critical support activity for any manufacturing industry. For a developing country like Pakistan the role maintenance can play for the development and improvement of industries cannot be denied. The study conducted shows that the average performance of the Industries, in the evaluated sections is below the WCB. Moreover on further evaluation this can be noted that multinational industries and the industries which are in business for longer time have scored and showed comparatively better performance. Therefore the newly emerging and the local industries can target those industries as their benchmark to improve their performances. Results also reflect that the industries have not scored well in the section of continuous improvement and do not show positive attitude towards the newly emerging techniques. Industries should continuously evaluate and improve their present practices and also welcome new techniques since it would help them to improve their current performance and bring their standards to international level.

REFERENCES

[1] British Standards Institution, Glossary of terms used in terotechnology. London: BSI, 1993.

[2] A. C. Marquez and J. N. D. Gupta, "Contemporary maintenance management: process,framework and supporting pillars," Int. J. Manag. Sci., vol. 34, pp. 313-326, 2006.

[3] T. Wireman, "How to calculate return on investment for maintenance improvement projects," 2007. [Online]. Available: www.vestapartners.com.

[4] Minister for Industries, "Auto Industry Development Programme." [Online]. Available: http://www.pama.org.pk/images/stories/pdf/AIDP/ AIDP.pdf.

[5] T. Wireman, Benchmarking best practices in maintenance management, 2nd ed., vol. 34. New York: Industrial Press Inc, 2004.

[6] C. W. Gits, "Design of maintenance concepts," Int. J. Prod. Econ., vol. 24, no. 3, pp. 217-226.

[7] F. Herbaty, Handbook of maintenance management: cost-effective practices, 2nd ed. Park Ridge, N.J., U.S.A: Noyes Publications, 1990.

[8] R. Smith, "Benchmarks maintenance organization effectiveness," reliabilityweb, Apr-2003. [Online]. Available: http://www.reliabilityweb.com/excerpts/excerpts/Maintenance_Benchmarks

[9] Handbook of maintenance management and engineering. Dordrecht ; New York: Springer, 2009.

[10] A. BORJESSON and A. SVENSSON, "Critical equipment classification and cost reduction within professional maintenance," Master of Science Thesis in Production Engineering, CHALMERS UNIVERSITY OF TECHNOLOGY, Sweden, 2011.

[11] J. Bessant and S. Caffyn, "High-involvement innovation through continuous improvement," Int. J. Technol. Manag., vol. 14, no. 1, p. 7, 1997.

[12] M. C. Eti, S. 0. T. Ogaji, and S. D. Probert, "Reducing the cost of preventive maintenance (PM) through adopting a proactive reliability-focused culture," Appl. Energy, vol. 83, no. 11, pp. 1235-1248, Nov. 2006.

[13] J. D. Campbell, Uptime: strategies for excellence in maintenance management, 2nd ed., New ed. New York: Productivity Press, 2006.

[14] A. Crespo Marquez, The maintenance management framework: models and methods for complex systems maintenance. London: Springer, 2007.

[15] P. Jonsson, "The status of maintenance management in Swedish manufacturing firms," J. Qual. Maint. Eng., vol. 3, no. 4, pp. 233-258, 1997.

[16] J. D. Campbell, Jardine, and J. McGlynn, Asset management excellence optimizing equipment life-cycle decisions. Boca Raton, FL: CRC Press, 2011.

Coal Gasification as a Source of Sustainable Energy –Geometric Analysis Using Aspen Plus® Model

Engr. S. A. Taqvi
s_taqvi@hotmail.com

Engr. F. Uddin,

Engr. Dr. I. Memon

Engr. S. Nadeem

ABSTRACT
The Energy Crisis at hand has been the focus of most of the research done recently across various disciplines. To come up with a sustainable yet inexpensive solution is a challenge for their work. Pakistan is a country blessed with many natural resources having vast potential to solve the issue both in short and long term basis, one of which is Coal. However, among other constraints, its environmental effects have been a topic of debate in engineering circles. This paper presents Coal gasification as a viable solution and proposes a model of indirect gasifier for this purpose. Results obtained from simulations on Aspen PLUS® show that cold gas efficiency and carbon conversion vary significantly as the diameter as well as height of the bayonets is altered, rising to about 50% and 90% respectively. Values of H2/C0 ratio obtained are approaching the conventionally desirable value of 3, but these parameters have relatively less impact on this ratio. The model also confirmed the reduced amount of SOx and NOx, without significantly affecting coal gas efficiency.

Keywords: Energy Crisis; Sustainability; Coal gasification; Aspen PLUS® Model

1 INTRODUCTION
Previous century was fuelled by the petroleum and natural gas. The pollutants unleashed by Petroleum are degrading the environment. In addition to their primary toxic nature, the sulfur and nitrogen compounds can also react further to produce other lethal chemicals. Furthermore, their depletion is at hand and it is high time to develop alternate fuels to go on with our lives as we do now.[1] Coal is a reliable resource of energy due to its abundance in many countries of the world. However, it contains larger amounts of nitrogen and ash than those in other fuels, and its utilization has been questioned due to the environmental hazards it poses.

The ash present in the coal causes metallurgical constraints for its processing. Burning coal produces massive amount of CO2, which is the main cause of global warming. There is a global requirement to develop technology so that the coal may be utilized in a highly proficient, environment friendly way. [2]

Gasification is a process in which combustible materials are partially oxidized. The product of gasification is a combustible synthesis gas, or Syngas. Because gasification involves the partial oxidization of the feed, gasification processes operate in an oxygen-lean environment. Gasification processes typically operate above their stoichiometric oxygen-to-fuel ratio to ensure near complete conversion to syngas. The amount of oxygen used in gasification, however, is always far less than that used in combustion and typically is less than half.

From a processing point of view the main operating difference is that gasification consumes heat evolved during combustion. Under the reducing environment of gasification the sulfur in the coal is released as hydrogen sulfide rather than sulfur dioxide and the coal's nitrogen is converted mostly to ammonia rather than nitrogen oxides. These reduced forms of sulfur and nitrogen are easily isolated, captured, and utilized, and thus gasification is a clean coal technology with better environmental performance than coal combustion.

2 SIMULATION MODEL

The development of the process for the reactions being carried out in gasifier is being carried out by using Aspen Plus® as the process simulator. The model comprises of three main processes i.e. coal drying, coal pyrolysis and char gasification carried out in the gasifier. The heat for these processes will be taken from the hot gaseous mixture passing through the section till the point that all the materials in the top section are in thermal equilibrium.

2.1 COMPONENTS:

The following components were selected from Aspen Plus® databank: 02, CO2, H2, H2O, CH4, N2, H2S, C6H6, C, S and (Coal, Dry Coal, Char and Ash) were taken as Non-Conventional. The different components used in this study are described with their composition and property models are used for the approximation of their physical properties. For these components two models must be assigned: one for density (DCOALIGT) and the other for enthalpy (HCOALGEN), which requires knowledge of proximate analysis and ultimate analysis of the solids. These characteristics for coal are presented in paper, which is provided by Pakistan Council for Scientific and Industrial Research, PCSIR, Karachi Pakistan. These numbers represents, the PROXANAL and ULTANAL of air-dried sample of Thar Lignite Coal shown in Table 1.

Table 1. Thar Coal Analysis

Proximate Analysis		Ultimate Analysis		Sulphur Analysis	
Element	Value (wt. %)	Element	Element	Value (wt. %)	Element
Moisture (wet basis)	8.5	C	54.57	Pyritic	1.46
		H	3.21		
Fixed carbon (dry basis)	25.83	N	1.07	Sulphate	1.47
		Cl	0		
Volatile Matter (dry basis)	53	S	4.39	Organic	1.46
		O	15.59		
Ash (dry basis)	21.17	Ash	21.17		

2.2 PROCESS DESCRIPTION:

In this process, the coal is heated and a rapid process takes place with can be completed and certain temperature, the bounded moisture is removed from the coal by using steam that was injected from the bottom and coal from the top of the gasifier. The heated mixture contribute the breakdown of dried coal into char and other gases engendered form the conversion of volatile material into other products and tar. Heat required for the process can is supplied by the bayonets which are in vertical arrangement. The produced gases i.e. CO, CO2, H2, and CH4 sent to the product stream with some other unreacted steam also escorts them. The ash discards off from the bottom. The product stream is alienated in to two parts, part of which is combusted in the furnace to derive gasifier bayonets and other as a sales product. Figure-1 shows the process of indirect gasification .

1.3 HEAT INTEGRATION:

Hot syngas stream available from the gasifier at high temperature is introduced in the cross-flow heat exchanger, where saturated steam is produced. The cold syngas stream is then fragmented in two parts. One is drawn as the product stream for further processing while the other goes for the combustion in the furnace combined with preheated air and then sent for combustion in the furnace where hot flue gases are generated. The saturated steam already produced is then used to generate superheated steam using the heat from the high temperature flue gases from the furnace. This steam is then sent to the gasifier to take part in the gasification reaction. Then the flue gases enter the bayonets to provide the heat required for gasification reaction. The flue gases from the gasifier bayonets are then used to preheat the air stream required for the combustion in furnace. The flow rate of the air stream is kept in excess to the stoichiometric air requirement for the combustion of syngas. Flue gases from the air preheat are then used to generate the corresponding saturated steam for the process and are exhausted to the atmosphere. The saturated steam produced here is mixed with the saturated steam produced from syngas cooling and sent for superheated steam generation. Hot ash from the gasifier is used for the preheating of water.

2.3 CHEMICAL KINETICS:

In the process of char gasification, the following reactions are considered.[3][4]

$$\text{Coal} \rightarrow CO + H_2 + CO_2 + H_2O + H_2S + N_2 + CH_4 + C_6H_6 + \text{Char} \quad (1)$$

$$C + \frac{x+2y}{2x+2y}O_2 \rightarrow \frac{x}{x+y}CO + \frac{y}{x+y}CO_2 \quad (2)$$

$$C + H_2O \rightarrow CO + H_2 \quad (3)$$

$$C + CO_2 \rightarrow 2CO \quad (4)$$

$$C + 2H_2 \rightarrow CH_4 \quad (5)$$

$$CO + H_2O \rightarrow CO_2 + H_2 \quad (6)$$

$$H_2 + 0.5O_2 \rightarrow H_2O \quad (7)$$

Where, [6]

$$\frac{x}{y} = \frac{[CO]}{[CO_2]} = 2500e^{\frac{-6249}{T}} \quad (8)$$

3 RESULTS:

Results were generated by using different geometric variations in order to analyse their effect on the quality of the syngas produced. Feed conditions for both coal and steam were taken as same, with steam to coal ratio of 2.0. The effects of the following variables were analysed:

- Diameter of the gasifier;
- Height of Bayonets (making the non-adiabatic gasification section);

The performance indexes which were defined and estimated according to

simulation results were following:

Cold Gas Efficiency

Cold Gas Efficiency of the process is calculated as:

$$\text{Cold Gas Efficiency} = \frac{\textit{Total Heating Value of Dry Syngas, kCal/hr}}{\textit{LHV of Total wet Coal, kCal/hr}}$$

Carbon Conversion

Conversion of coal in the reactor is based upon the conversion of carbon content in the char introduced to the gasification process:

$$X_c = \frac{m_{c_{in}} - m_{c_{out}}}{m_{c_{in}}}$$

H_2/CO molar ratio:

$$\frac{H_2}{CO} = \frac{\dot{n}_{H_2}}{\dot{n}_{CO}}$$

Simulation results for the Thar Lignite Gasification are presented in Figures 2, 3 and 4. These results are based on the analysis of dry syngas after condensate removal from the raw syngas product stream and were plotted by using MATLAB ® 2013.

In Fig. 2, cold gas efficiency is reported as a function of diameter and

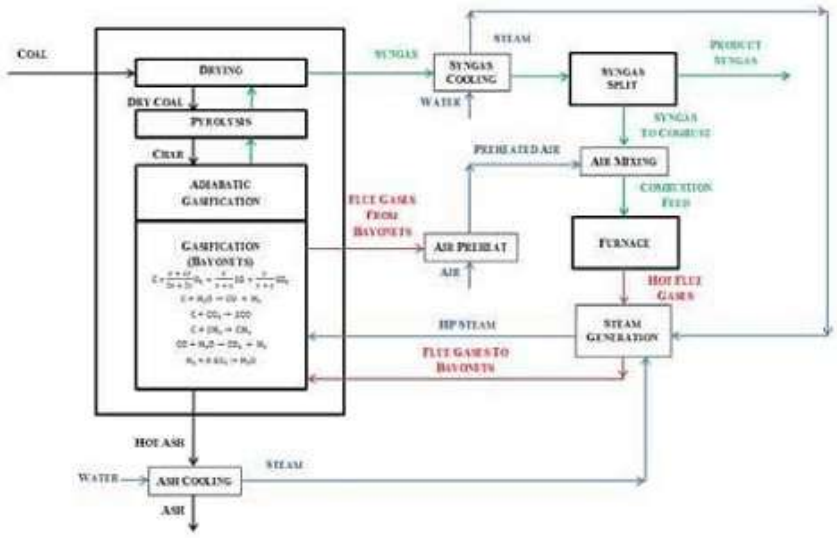


Figure 1: Process Scheme of indirect gasification using partial product syngas combustion with heat integration

bayonets' height. A trend similar to the elliptical valley was obtained. It is shown that cold gas efficiency varies significantly as the diameter as well as height of the bayonets are altered, rising in the middle to about 50%. The parameters, when altered, cause a change in superficial velocities within the gasifier and heat transfer between the flue gases and the gasifier environment. Hence the cold gas efficiency is drastically changed.

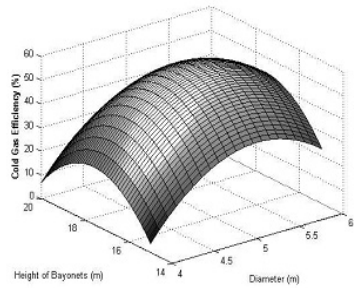


Figure 2: Cold Gas Efficiency v/s Height of Bayonets (m) and Diameter (m)

H2/CO molar ratio is reported as a function of diameter and bayonets' height in Fig. 3. It can be seen that the values of H2/CO ratio obtained are approaching the conventionally desirable value of 3. The sensitivity of the parameter is much increased at the higher values of diameter. H2/CO molar ratio is showing increasing trend as with increase in diameter. However, it should be noted that the values of H2/CO are all close to 2.7 and it can be concluded that these parameters have less impact on this ratio.

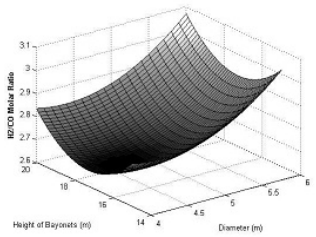


Figure 3: H_2/CO Molar Ratio v/s Height of Bayonets (m) and Diameter (m)

Carbon conversion in percentage is plotted as a function of diameter and bayonets' height in Fig. 4. The trend obtained was similar to that of cold gas efficiency. It was observed that the carbon conversion do not drop lower than 70% and can be as high as 90%. The Conversion of carbon in gasifier is showing optimum results by increase in the diameter of gasifier.

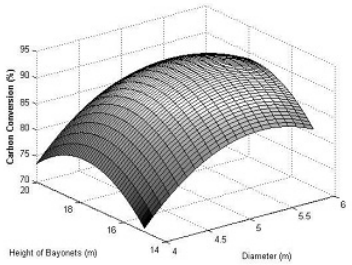


Figure 4: Carbon Conversion (%) v/s Height of Bayonets (m) and Diameter (m)

4 CONCLUSIONS:

The development of the gasifier environment is carried out by using Aspen Plus® process simulator. Coal, Dry Coal, Char and Ash are described using their proximate and ultimate analyses. In the gasifier, coal is de-moisturized, pyrolyzed and gasified to produce syngas. Part of the syngas stream is combusted in the furnace where hot flue gases are generated to provide the heat required for gasification reaction. Results were generated by using different geometric variations in diameter of the gasifier and height of bayonets. Cold gas efficiency, carbon conversion and H2/CO molar ratio were considered as the performance indexes. Results show that cold gas efficiency varies significantly as the diameter as well as height of the bayonets is altered, rising to about 50%. Values of H2/CO ratio obtained are approaching the conventionally desirable value of 3, but are all close to 2.7 and it can be concluded that these parameters have relatively less impact on this ratio. Carbon conversion is affected considerably as the diameter and height of the bayonets is changed, attaining a maximum of about 90%. Production of SOxs and NOxs are also avoided due to the reductive environment of gasifier. Hence the scheme proposed is viable and can provide solution to the energy crisis as well as environmental pollution.

ACKNOWLEDGEMENTS

The authors are extremely thankful to Mr. Junaid Akhlas, (Enrolled Ph.D. student, Department of Chemical

Sciences, University of Padova, Italy) who extended his helping hand in the ups and downs of this work. His experience and expertise in the software were cooperative in the generation of the results.

REFERENCES

[1] Maria Sudiro, Carlos Zanella, Alberto Bertucco, Luigi Bressan, Marco Fontana. Dual-Bed Gasification of Petcoke: Model Development and Validation. Energy Fuels, 24 (2010), 1213-1221.

[2] Maria Sudiro, Alberto Bertucco. Production of synthetic gasoline and diesel fuel by alternative processes using natural gas and coal: Process simulation and optimization. Energy, 34 (2009), 2206-2214.

[3] C.Y. Wen, H. Chen, M. Onozaki (1982). User's Manual for Computer Simulation and Design of the Moving Bed Coal Gasifier. Report submitted to Morgantown Energy Technology Center and U.S. Department of Energy, Contract No. DOE/MC/16474-1390.

[4] I.H. Rinard, B.W. Benjamin (1985). Great plains ASPEN model development: gasifier model. Literature Review and Model Specification. Presented to U.S. Department of Energy, Morgantown, WV, Final Topical Report DOE/MC/19163-1782..

[5] C.Y. Wen, T.Z. Chaung (1979). Entrainment coal gasification modelling. Ind. Eng. Chem. Process Des. Dev., 18, 684-695.

Foto News

Technical Visit to the Walled City, Lahore 2nd May, 2016

Latest Development in the Structural Material Consisting of Reinforced Baked Clay

Engr. Dr. Abdul Aziz Ansari,
dransari@quest.edu.pk

Engr. Sajjad Ali Mangi
sajjad.nec@gmail.com

Salim Khoso
engr.salimkhoso@gmail.com

Engr. Dr. Kanya Lal Khatri
rajaln@yahoo.com

Engr. Ghulam Shabir Solangi
solangi_shabir@yahoo.com

ABSTRACT
A novel approach has been presented along with the research that has been carried out to prove its validity so that implementation regarding the use of indigenous materials like clay could be accomplished. It is strange to note that although clay has remained in use as major material of construction where it is available in plenty since the time immemorial, no scientific approach has been adopted to replace reinforced cement concrete with this cheap material of construction. With this particular intention in mind, a systematic programme of experimental study visualizing the future construction in the rural areas at relatively cheap and affordable prices for the poor masses, a large number of beam panels were cast, baked, post reinforced, cured and tested. The results of that experimental study have been presented in this paper. This study was carried out in terms of modulus of rupture, shear/ flexural behavior, mode of failure, crack pattern and ultimate load of baked clay beams.

KEYWORDS
Baked Clay, Construction, Compacted, Post-reinforced, plate support,

1. INTRODUCTION

Clay is a very common, abundant and inexpensive material. It is easy to extract and does not require significant transformation. Clay is also a capricious material with very variable physical properties. Clay creates many problems when it shrinks during drying and firing. Certain clays shrink more than others. The finished products of clay crack during cooling [Argile, 2007]. Advocating clay as the first choice for rendering straw bale walls as well as any other conventional wall system is predominantly linked to its great benefits to our health and the environment. Earth has a vast technical and architectural potential in the construction industry and the fact that it has been used in the simplest and most sophisticated structures all over the world supports its importance in this industry today [Strawtec]. Clay is cohesive material and this property improves if clay is micro-fined and properly kneaded after mixing the water. Wet clay having a sufficient quantity of water acts like a lubricant but with only a little quantity of water, it acts like a plastic body. It has no elastic limit and could be worked to any shape with little pressure without rupturing. Clay possesses the property of a binding agent [Kulkarni G. J. 1980]. International Resource Institute (IRI) has recently been involved in Natural Composite Architecture using a composite of bentonite clay/cellulose fiber /straw bale wall and roof system [Lance. D]. Polymer clay has been in use as man-made modeling material just like ceramic. It is being supplied by various suppliers under the brand name as FIMO. FIMO is easy to use extremely versatile plastic based modeling clay [Garie S]. A systematic review of a large number of journals pertaining to the field of Civil Engineering including those of ACI, ASCE and British Institute of Civil Engineering was carried out but as expected, there is no research conducted up to this time mentioned for studying the behavior of the pre-fabricated, postrein forced baked clay structural panels which would be used as replacement for pre-cast concrete panels for erection of buildings at relatively lower cost without sacrificing durability, reliability and elegance. Although hundreds of technical publications regarding the properties and uses of clay for various purposes were found in the Journals, they

mostly discussed the geotechnical, geological, chemical and agricultural aspects of clay. Complete series of booklet published by the United Nation's Economic & Social Commission for Asia & Pacific Region Bangkok, giving details of research conducted on indigenous materials of construction and low cost housing does not include any research on the structural panels as tested during present study [United Nation]. Baked clay brick fragments were used in cement concrete as coarse aggregate [Memon et-al, 1992] and the same aggregate was later treated with cement slurry to reduce its porosity and increase the strength [Memon et-al, 1995]. For several years hundreds of researchers worked on various aspects of concrete as major material of construction for buildings, bridges and other structures. However, economy could be achieved if local materials of construction are used instead of transporting heavy and expensive materials like hill sand, coarse aggregate of rock origin, cement and steel bars over long distance particularly in fertile plains of various countries. The most commonly and universally available materials of construction such as the clay, silt and pit sand have not been resorted to for the construction with pre-perceived notion that these are inferior and therefore could not be used for quality work. In fact clay has remained in use right from the early civilizations like that of Moen-jo-daro, Mesopotamia [Magnus M, 1977] and Nile delta in the shape of sun dried and burnt bricks for masonry. During preliminary experimental study by the authors [Memon M et-al, 1999] which consisted of molding, compacting, baking and testing hundreds of clay cylindrical and cubical specimens having various intensities of compression for compaction and clay to pit-sand ratio as the parameters, it was clearly manifested that strength of this particular type of material could equally be as good as that of cement concrete, if properly compacted. The cement concrete used in common buildings for R.C construction is normally designed for compressive strength of 20 N/mm2 (3000psi). But from our study it was quite visible that with properly controlled conditions and 70:30, clay: pit-sand ratio the strength could comfortably be increased much more beyond this limit by increasing the compacting force and decreasing the water content which obviously reduces the voids. All these aspects self-evidently imply to the direction where instead of bricks, structural panels could be manufactured, baked and used for swift quality construction of buildings at relatively lower cost than concrete.

2. CLAY AS REPLACEMENT OF RCC

Clay has remained in use for erecting the most beautiful and durable structures even better than RCC even thousands of years ago. They were considered as the Wonders of the world. The Ziggurats of Mesopotamia and the Hanging Garden of Babylon are the evidence. One third of humanity of the world even today has made use of clay as the major material of construction. However, no systematic research has been carried out to make use of this material as a parallel to concrete. For the first time the authors under took this task. For ten years we wallowed in the wildness of clay and developed an idea to use precast panels pre-perforated, baked, post-reinforced and grouted which could be factory made on mass scale and used for multistory buildings as a replacement of RCC [Ansari, 2007, Memon et-al, 1999, 2006, 2007, 2014, 2007, 2007], which has been named as R.B.C. The authors on their part have reached a stage where compressive strength resembling to that of concrete has been achieved. The material constants like Poissan's ratio and modulus of elasticity are well within the range of RCC. The flexural and shear behavior is also satisfactory. More research is required which is being carried out presently [Lakho, 2007] and remains un-published so far. Future buildings as per the vision of this project shall be of baked clay, particularly in the fertile plains where this material is abundantly available.

3. PRESENT STUDY

Stiff steel moulds were fabricated for casting the specimens for beam panels. The design of these moulds was accomplished on the basis of stress analysis performed by using computer based numerical approach. The major force for which these moulds were to be designed was the lateral outward force induced by vertical compression applied for compaction. A Plate Bending, rectangular, eight-node Finite Element, originally formulated by Hinton and Owen was employed to perform elastic analysis particularly in terms of maximum deflection at free edges (upper edges of long walls of the moulds) and bending moments at fixed edges of the long sides of the mould, the thickness of which was assumed in the first instance. The base slab is firmly supported all over by the ground. The thickness of this plate was also assumed and then its adequacy was checked against induced stresses. The long walls were analyzed as fixed at both the ends at the bottom while the top edge was a free edge. Since the compressive load was applied vertically downward for compaction and the clay was nearly in the plastic state, it was presumed that all the force was transferred to the long sides of the mould as lateral force which was normal to the inner surfaces of the long sides of plates. The distribution of this force was assumed to be uniform. Special arrangement for applying the pre-compression manually, (so that density could be improved, compaction to the desired degree could be achieved), was designed and fabricated. During casting of models it was observed that due to lateral deformation bulging took place beyond acceptable limits. Therefore a system of restraining the lateral deformation was designed and made use of after trying various options. This arrangement is presented in Fig 1.

Figure 1: Strengthening of the mould by welding the stiffeners and other strengthening system to avoid the bulging.

which is the best and most efficient

amongst those tried by authors. Mixing of materials depended upon best proportions of clay and pit sand with earlier research presented in [Memon et-al, 2006], Total water content as percentage in terms of dry material was maintained at about 20 percent on the basis of the results pertaining to workability and strength to be achieved. The clay was obtained from various sources at a depth of 4 ft from the ground level. It was dried at a temperature of 105°C for 24 hours. The clay was then pulverized for micro-fining. Then as in previous research conducted by the authors [Memon et-al, 2006] 30% of pit-sand, was mixed. Mixing of the materials and the water was done with the electrically operated Pan mixer.

Mixing was done for approximately 10 minutes for each batch. After delivery of the material in the mould, compressive force for first test series of 3.5 N/mm2 was applied and measured with the help of electric load cells and digital display amplifier system. Compression was applied by tightening the wing nuts as shown in Fig. 2. Several impediments and hurdles were experienced. For example enormous shrinkage occurred during drying which caused cracking of the beams rendering them useless. The drying under the shade without exposure to sunshine with a thin plastic wrapper solved the problem. Special scheme was resorted to by providing a heavy wooden plank fitted with a very smooth surfaced metallic sheet properly oiled to support the beam specimen at the bottom during its drying period; so that shrinkage and consequent deformation did not cause any cracking. However, a system of slight compression with the help of springs was devised and used as shown in Fig 3.

It must be mentioned here that the beams cast, dried, baked and tested during this experimental investigation were 6 inches (150 mm) wide, 12 inches (300 mm) deep and 6.5 ft (1950 mm) long initially but were reduced in length by 4 inches (100 mm), breadth decreased by 0.3 inches (7.2 mm) while the depth showed a shrinkage of 0.6 inches (14.3 mm). After drying for sufficient time under the shade the beams were exposed to sunshine to exclude as much moisture as possible which was trapped deep inside them. The beams were then placed in the Kiln where the temperature was measured with the help of thermo-couples. Initially a lower temperature of 250°C was maintained for six hours. The temperature was then raised gradually to 950°C and was maintained at this level for 22 hours. Then the temperature was lowered slowly and the fire was stopped and the kiln was allowed to cool down over next two days. The temperature and time periods were selected after trying a large number of temperature and duration combinations to achieve the best possible results because the thickness of beams is obviously much more than bricks and therefore the complete baking of the beams could be possible only on the basis of experimental investigation. The beams were pre-perforated near the bottom with two holes of one inch diameter for placement of tensile reinforcement. However, a few beams were reinforced both at top and bottom hence there were two holes near top and two near the bottom in these beams. A few beams contained vertical holes at 6 inches centre to centre for shear reinforcement as shown in Figure4.

The steel bars of 3/8", ½" and 5/8 inch diameter were used as longitudinal reinforcement. A puller as shown in Fig. 5 was manufactured to pull out the steel shafts from the beams after their casting. The bond between steel bars and the surrounding baked clay was achieved through forced grouting of cement slurry with fine aggregate in the ratio 1:1. The equipment manufactured for this purpose is shown in Fig 6. After grouting curing was done for 14 days. Curing tub is shown in Fig 7. This created sufficient bond to avoid the problem of slipping of bars up to the ultimate load. Initially the bond between steel bars and baked clay openings was investigated separately to ensure that the failure did not occur on this account. Special trolley was designed and fabricated for safe lifting of the beam from place to place.

Platform Lift was designed, manufactured and installed beside the kiln for safe lifting up of clay beam models which are so fragile that even a slight jerk could reduce them to pieces, as shown in Fig. 8.

Mobile Lift as shown in Fig. 9 was designed and manufactured for carrying the beams to the testing laboratory for placement of these models on the machine for testing. Torsee Testing Machine that was used to test the beams. Load cells were used together with digital display system to measure intensity of the load independently. Demec Gauge was used to measure the strain at various locations with reference to the neutral axis. Thirteen pairs of demec pads were stuck on the beam to measure the strain with the help of demec gauge. To test the fundamental structural properties of the beam material itself specimens were cut from the intact portions of beams after testing.

4. DISCUSSION OF TEST RESULTS REGARDING FLEXURE & SHEAR BEHAVIOUR OF BEAMS

The flexural strength of the beams in terms of tension and compression was calculated by using the equations of BS CP 8110 and ACI-318 after removing all partial safety factors. The shear strength of the beams was also estimated in accordance with the above codes. All these values along with ultimate experimental loads are presented in Table 1, for the phase-I of the Main Test Series. It was expected that the failure would be dominated by shear strength of the beams. The failure of the beams did occur due to shear. The failure occurred due to diagonal cracks as shown in Fig. 10, which is indicating shear force behaviour. From the test results shown in Table 1, it is quite apparent that the failure occurred somewhere near the estimated load calculated on the basis of shear strength. This is clear indication that baked clay panels are sufficiently good when compared with the concrete. Initially the rectangular beams were roller supported subjected to point load at the centre. The load at failure is in the range

which is averagely 1.33 times more than the shear strength calculated on the basis of BS CP-8110 and 1.04 times more than shear strength calculated on the basis of ACI-318. However, for I-section this relationship between ultimate experimental load and the estimated load was only 1.03 and only 0.79 respectively. It appears that BS CP-8110 is more conservative than ACI-318 when it comes to estimate shear strength of beams. From this it can be deduced that I-section baked clay beams which were basically tested in order to investigate the possibility of the use of a lighter section, cannot be considered as suitable. Great improvement in terms of experimental load at failure was observed when uniformly distributed load (UDL) was applied in place of point load on the central portion of beam 1.15 meter wide as shown in Fig 10. UDL was applied only at the central portion because in the regions near the supports, the load would have been directly transferred to the supports thus giving false impression about the strength of the beams. The average ratio between estimated critical shear strength and the actual load at failure is found to be 3.19 and 2.13 respectively, which is quite good. The benefit in terms of uniformly distributed load is 100%. However, in terms of bending moment at the centre, this increase is found to be 31% where a component must have been due to (i) the resistance offered by the loading system, (ii) the reduction of concentration of stresses due to bending as compared to point load and (iii) due to gradual increase of shear force from centre towards the supports. The type of support when rollers were replaced by plates, affected the ultimate experimental load by approximately 12%. However, the increase of maximum bending moment at the centre was only 2%. It can be observed from Table 1, that although the failure was dominated by shear, the strain in baked clay at the level of flexural steel is an indication that the yielding point had already in the beams which were tested by applying UDL. Although maximum shear is at the supports and if the shear alone is responsible for the failure such an increase of ultimate load could not have been achieved. It may be mentioned here that the UDL was applied by the system so that the friction could be minimized in order to let the baked clay material undergo compression without being deterred by the load application system. However, since this was a relatively stiff steel beam transferring load through a number of circular bar pieces welded with it, this might have affected the behaviour of the beams and their ultimate load to some extent. Perhaps a system consisting of smaller separate hydraulic jacks or a multi-point electrically operated hydraulics load applying machine would have worked better. However, due to practical difficulties and un-availability of required gadgets this system could not be developed /tried. After testing the beams the bottom cover of a few beams was removed to ensure that bond failure between steel and surrounding concrete did not occur. Initially the load was measured in DVM units with the help of load cell and digital display system. Through calibration this load was converted into Newtons. One DVM unit was equal to 460 N. Since DVM units were same for all the five beams within each group, so the values became same for all the beams of the same group. Thus it can be deduced that if buildings are to be constructed in the rural areas where hill sand, coarse aggregate and cement are not available locally this material can also serve the local population well within affordable prices. This material could prove suitable for multistory buildings of reasonable height. Therefore we shall stick to the original idea of producing structural panels on large scale with minimum quantity of reinforcement, no cement, no aggregate of hill origin but clay and pit-sand, dune-sand and river bed sand; all available locally and cheaply. A very respectable average of ultimate load for rectangular beams supported on steel plate with UDL has been achieved which is 3.55 and 2.3 (BS CP-8110 & ACI respectively) times more than the estimated strength in terms of shear. Beams which were tested were only 1.95 meters long. However, in real structures beams could be very long and more commonly loads are distributed because slab transfers the load to the beam along its entire span, the structure produced with panels of preper forated post-reinforced baked clay shall exhibit even better performance.

5. CONCLUSIONS

1. As compared to normal cement concrete the compressive strength of baked clay panel with a proportion of 70:30 percent of clay:pit sand, holds promise to achieve strength as good as concrete with only moderate compression force of 3.5 N/mm2 for compaction. A value of crushing strength as high as 31.39 N/mm2 is reached.

2. Great improvement in terms of experimental load at failure was observed when uniformly Distributed Load was applied in place of Point Load on the central portion of the beam.

3. The average ratio between estimated critical shear strength and the actual load at failure to be 3.19 and 2.13 respectively, which is quite good.

4. When roller supports were replaced by plate supports, affected the ultimate experimental load by approximately 12%. However, the increase of maximum bending moment at the centre was only 2%.

5. Split of bottom cover, slipping of bar or destruction of bond between steel and surrounding material did not take place.

6. It can be deduced that if buildings are to be constructed in the rural areas where hill sand, coarse aggregate and cement are not available locally, this material can also serve the local population well within affordable prices.

7. It is quite apparent that the failure of beam is dominated by shear rather than flexure, thereforeshear strength must be improved to ensure ductile failure due to yielding of steel in tensile zone.

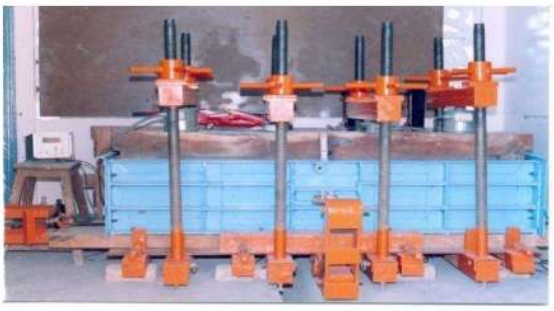


Figure 2: Compression was applied by tightening the wings and nuts

Figure 3: The system used to avoid the cracking in the clay beam due to shrinkage

Figure 4: Photographs showing the holes provided for tension & compression bars and at the top for shear reinforcement.

Figure 5: Puller System

Figure 6: Grouting System

Figure 7: Curing Tub

Figure 8: The Photographs showing Platform Lift fabricated for lifting the beam to be placed in the kiln

Figure 9: Mobile lift manufactured for Baked Clay Beams

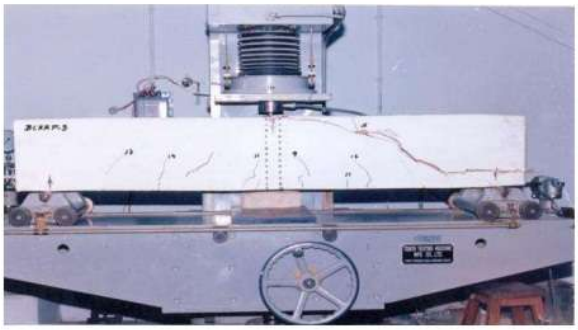
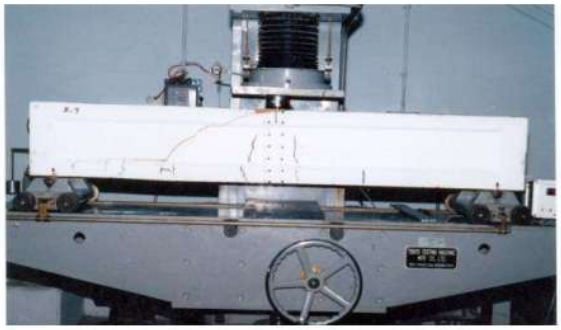



Figure 10: Photographs showing the crack pattern of the Baked clay Beam after testing

Table 1: Details of Estimated and Experimental Ultimate Loads For Different Baked Clay Reinforced Beams Tested by The Authors.

S#	Description	Flexural Strength in terms of Steel "N"		Flexural Strength in terms of Baked Clay "N"		Shear Strength Calculated "N"		Experi-mental load @ failure "N'	Exp. Shear strength / Calculated shear strength				Remarks
		CP8110	ACI	CP8110	ACI	CP110	ACI		CP8110	Av:	ACI	Av:	
1.	BCRRP – 1	95523	107804	134347	103968	21261	27740	56595	1.33		1.02		
2.	BCRRP – 2	94282	106247	127480	103014	21261	26964	56595	1.33		1.04		
3.	BCRRP – 3	95521	107175	133489	103777	21261	27740	56595	1.33	1.33	1.02	1.04	Roller supported rectangular beams subjected to point load at center
4.	BCRRP – 4	95523	106652	128338	103396	21261	27302	56595	1.33		1.04		
5.	BCRRP – 5	91801	104466	117607	101488	21261	25682	56595	1.33		1.10		
6.	BCIRP – 1	93042	100315	125290	101465	20832	26626	42795	1.03		0.80		
7.	BCIRP – 2	95523	102239	132019	102027	20832	27425	42795	1.03		0.78		
8.	BCIRP – 3	93042	100817	124449	101091	20832	26560	42795	1.03	1.03	0.80	0.79	Roller supported I-Section beams subjected to point load at center
9.	BCIRP – 4	94282	100779	125206	101278	20832	26527	42795	1.03		0.80		
10.	BCIRP – 5	93841	100944	125290	10465	20832	26626	42795	1.03		0.80		
11.	BCRRUD – 1	100321	107960	196032	159290	17886	27032	114095	3.18		2.11		
12.	BCRRUD – 2	99141	108032	196495	158703	17886	27133	114095	3.18		2.10		
13.	BCRRUD – 3	101501	107791	192937	158117	17886	26829	114095	3.18	3.19	2.12	2.13	Roller supported rectangular beams subjected to uniformly distributed load.
14.	BCRRUD – 4	97960	108019	196107	159290	17886	27133	115015	3.21		2.10		
15.	BCRRUD – 5	99141	107084	184152	156357	17886	25952	114095	3.18		2.19		
16.	BCIRUD – 1	100884	105096	201433	156893	17526	27322	79595	2.27		1.45		
17.	BCIRUD – 2	99967	104277	192373	155453	17526	26494	79595	2.27		1.50		
18.	BCIRUD – 3	99769	104224	189134	159136	17526	26428	79595	2.27	2.27	1.51	1.48	Roller supporter I-Section beams subjected to uniformly distributed load.
19.	BCIRUD – 4	100489	104236	196907	156029	17526	26924	79595	2.27		1.47		
20.	BCRPUD – 1	100911	108393	202633	159584	17886	27639	127435	3.56		2.30		
21.	BCRPUD – 2	100619	108278	200650	159290	17886	27470	127435	3.56		2.32		
22.	BCRPUD – 3	100497	108028	196673	158703	17886	27133	127435	3.56	3.55	2.34	2.33	Rectangular beams supported on plate on both ends subjected to uniformly distributed load.
23.	BCRPUD – 4	100136	107848	192732	158117	17886	26863	126975	3.56		2.36		

6. ACKNOWLEDGEMENT

The research work, details of which are presented in this paper was carried out in the Structures Laborator Laboratory of Civil Engineering Department, Quaid-e-Awam University of Engineering Science &Technology [QUEST], Nawabshah, (Sindh), Pakistan. The authors are grateful to the University authorities for providing facilities and funds to make this research possible.

4. REFERENCES

Ansari. A. A. (2008), "Experimental Study of the Behavior of Pre-Perforated Post-Reinforced baked Clay Panels of beams", A Ph.D thesis , Quaid-e-Awam University of Engineering Science & Technology, Nawabshah, (Sindh).

Garie S., Creative clay for creative people. Electronic document: http://www.garieinternational.com.sg/clay/clay.htm

Kulkarni G. J. (1980), "A text book of engineering materials Eleventh edition, Kirit Ambala Patl, Ahemednagar, pp. 55.

Lance. D., National composite architecture: Building without use of lumber, concrete, steel, or petroleum products. The Last Straw Journal, No.17 Electronic document: http://www.networkearth.org/naturalbuilding/composite.html

Lakho. N. A. (2007)., "Experimental Study of Long term Behavior of Pre-perforated Post-Reinforced Baked Clay Beams", PHD Project , Quaid-e-Awam University of Engineering Science & Technology, Nawabshah.

Magnus M (1977), "The archaeology of the Bible lands, pp 195-208.

Memon. M, memon M. A & Durrani N. A (1992)," Behavior of conference with with indigenous aggregate. Mehran University Research Journal of Engineering and Technology, Vol.11, No.4, p.25-30.

Memmon M., Durrani N. A., & Memon N. A. (1995), "Treatment of Indigenous aggregate. Mehran University Research Journal of Engineering and Technology, Vol.4, No.2, p.13-19 .

Memon. M, Ansari. A.A and Shaikh. A.M. (1999), "Preliminary Study of Structural Properties of baked clay", Mehran University Research Journal of engineering & Technology, Vol. 18, No.3, pp. 161-166.

Memon. M. & Ansari A. A. (2006), "Fundamental Structural Properties of Compacted Baked Clay Specimen", Quaid-e-Awam University of Engineering Science & Technology, Vol. 7, No.2, pp. 39-44,

Memon. M. & Ansari. A. A. (2007), "Clay: The Environment friendly Material of Construction", Proceedings of First National Conference on Assessment and Proper Utilization of Indigenous Energy Resources and Their Impact on Environment, Organized by Energy and Environment Engineering Department, Quaid-e-Awam University of Engineering Science & technology, Nawabshah, Held on 26-28 February 2007.

Memon. M., A.H. & Ansari. A.A. (2007) "Mechanical Systems Developed for Reinforced Baked Clay Structural Panels", Paper presented in the Conference on Failure of Engineering Materials & Structures FEMS (2007), held on 22-23 Oct: 2007, University of Engineering & Technology, Texila, Pakistan.

Memon. M. & Ansari A. A. (2007), "Pre--Perforated Post Reinforced Baked Clay Structural Panels as Potential Proceedings American Concrete Institute (ACI)Pakistan Chapter, CBM-CI, International workshop, organized by NED University of Engineering & Technology, Karachi, held on 10-11 Dec: 2007 at pearl Continental Hotel, Karachi.

Memon. M. & Ansari A. A. (2004), "Behavior Baked Clay Structural Beam Panels", Proceedings of Ninth International Summer Symposium, Japan Society of Civil Engineers, Yokohama National University, Yotsuya 1-chome, Shinjuku-ku, Tokyo, 160-0004, Japan.

Pottery La Pipe d' Argile. (2007) "Clay Electronics document" http://www.lapipedargile.com/argile/largile-ger.html

Strawtec, "Clay: the highest quality from design to construction", Electronic document: Clay: the highest quality from design to construction,

United Nation Booklet Series, on Low Cost Housing Indigenous Materials , United Nations Economics Social Commission for Asia and Pacefic Region, Bangkok 10200, Thailand

Faith

Unity

Discipline

We must sink individualism and petty jealousies and make our minds to serve the People with honesty and faithfulness. We must have faith, unity and discipline.

Quaid-e-Azam Addressing Pakistan Railways Officers (27th December,1947)

Developing an Expert System for Controlling Cost and Time Overrun (ESCCTO) in Construction Projects

Engr. Muhammad Akram
akhund42@gmail.com,

Engr. Nafees Ahmed Memon
nafees.memon@faculty.muet.edu.pk

Engr. Tauha Hussain Ali
tauha.hussain@faculty.muet.edu.pk

Engr. Fida Siddiqui
fida.siddiqui@facuty.muet.edu.pk

ABSTRACT
Nowadays Artificial Intelligence especially Expert System is used in the fields of Science, Engineering, Business, Manufacturing, Management, Construction Management and many others.

This paper delineates development of an Expert System Frame-Work for controlling time & cost overruns in construction project. The purpose of this paper is to assess the significant level of causative factors of cost and time overrun on project success throughout the lifecycle of construction process. Expert system will be completely attached with the whole project schedule to the approximate outcome of the causative factors, which are not properly controlled. This will be goaled by applying the techniques of artificial intelligence, such as rule based system and case based system. The purpose of system will also be capable for suggesting the mitigation measures for controlling the causative factors. In the last various reports can be made up for controlling the causative factors of cost and time overrun by applying the appropriate mitigation measures.

KEYWORDS
Artificial Intelligence, Expert System, Time Overrun, Cost Overrun, Significant Factors.

1. INTRODUCTION

A project can be successful by measuring of different ways of performance such as time, cost, quality etc. Atkinson (1999), expressed that cost, time in addition with quality assists on Iron Triangle to meet a project successful. Time in addition to cost performance will be the most important warning regarding project accomplishment. It shows not only the productivity of an organization but also firm's profitability throughout any construction project. It can be witnessed and always used to achieve the estimated performance of the project.

However, poor cost and time performance makes a construction project un- capable to complete with its estimated time and budget. This persistent issue is increasing to critical condition and it can be observed worldwide. A research work regarding the cost overrun issues was conducted by Flyvbjerg et al. (2003), throughout the world in which they found that 9 out of 10 projects suffer with an average of more than 28% cost escalation. The issue of poor performance of cost and time overrun is frequent issue in both developed and developing countries like USA, UK, Portugal, Malaysia, Pakistan and others. The succeeding section presents literature review of some previous studies relates d to cost and time overrun.

2. LITERATURE REVIEW

In 1994, a study in usa was conducted. It showed that only 16% of the projects were according to the criteria of cost, time and quality. A case study on four projects on cost performance was conducted by chang (2002), it identified that 12.3% to 51.3% projects were facing cost overrun problem, which is an average of 24.8% of a contract. In contrast, barrick, (1995) studied throughout the uk, that almost a third of the owners' complaints that their own projects usually overrun funds. Even more, Department of Environment, Transport and the Regions (DETR, 2000) stated that 55% of projects experienced a huge amount of cost

overrun. An audit report between 1985 and 2002 was published by National Court of Audit Portugal (NACL, 2000) as summarize by (Moura, Teixeira, & Pires, 2007). It included cost effectiveness of 26 motorway and 98 expo projects. The report of these projects showed that 35% of motorway and 41% of expo projects had cost overrun. Construction industry is facing the common issues of cost and time overruns problems. In 2008 Malaysian Auditor General highlighted report which reviewed by other researchers (Khamidi, Khan, & Idrus, 2011). It reported that RM 1.43 billion cost overrun in the completion of double track electrified project between Rawang and Ipoh . A total of 359 projects were analyzed by Endut et al. (2009), in which they found 46.80% projects completed within the estimated budget and remaining projects faced cost overrun. Moreover, a research conducted by Abdullah et al. (2009) in the Majlis Amanah Rakyat (MARA) large construction projects, revealed that more than 90% of MARA large construction projects experiencing delay since 1984 with major effects of time and cost overrun. Like other countries, cost and time overrun are common problem in construction projects of Pakistan. A Research study conducted by Nida Azhar et. el. (2008) mentioned that cost overrun is the major problem in Pakistan. Every construction project exceeds 100% of its time and budget. Recently a research study was conducted on time overrun in construction projects by Saiful Haq et al. (2014), which revealed that 99% of construction projects delay due to the time ove run. This indicates that the construction projects are mostly facing the problem of poor time and cost performance and it must be addressed.

3. FACTORS AFFECTING COST AND TIME OVERRUN IN CONSTRUCTION PROJECTS

Several factors and reasons can cause delays in construction projects or cost overrun issues. Construction performance in terms of time and cost is prone to risk due to several governing factors. Hence, comprehensive literature review on causative risk factors regarding time and cost overrun is carried out to understand these issues. Various researchers have highlighted number of factors which basically become the cause for time and cost overrun. It's quite important to control these factors to limit the cost and time overrun.

In 2006, Assaf and Al-Hejji studied the reasons for delays in huge construction projects in Saudi Arabia and revealed the utmost important causes of delay, that includes the change orders by owner during construction, delay in progress payments, ineffective planning and scheduling by contractor, poor site management and supervision by contractor, shortage of labors, difficulties in financing by contractor, changes in government regulations, traffic control and restrictions at site, effect of social and cultural factors and accidents during construction.

A questionnaire survey was conducted by Frimpong et al. (2003). It consisted of 26 factors to study major contributors of cost overrun in groundwater drilling projects in Ghana.
Out of 26 factors considered, top 10 factors are monthly payment difficulties, poor contract management, material procurement, inflation, contractors' financial difficulties, escalation of material prices, cash flow during construction, planning and scheduling deficiencies, bad weather and deficiencies in cost estimates prepared.

Time overrun issues in construction building projects in Ghana from views of clients, consultants and contractors were focused by Fugar and Agyakwah - Baah (2010), Time overrun factors which influenced much, were delay in honoring certificates, underestimation of the cost of project, underestimation of complexity of project, difficulty in accessing bank credit, poor supervision, underestimation of time for completion of projects by contractors, shortage of materials, poor professional management, fluctuation of prices/rising cost of materials and poor site management.

The causes of construction delay in traditional contracts in Jordan were studied by Odeh and Battaineh (2002).

The major causes which were found by the authors includes owner interference,
inadequate contractor experience, financing and payments of completed work, labor productivity, site management, slow decision making, construction methods, improper planning and subcontractors. Later, through Sweis et al. (2008), it came to be known that all of the respondents (i.e. clients, contractors, consultants). Too many change orders from owner and poor planning and scheduling are the main critical causes of consultant's part. The shortage of manpower and too many orders from owner were major causes of time overrun in view of contractors.

While incompetent technical staff working on the project, poor planning and scheduling done are the most critical factors in view of owners. Le-Hoai et al. (2008) studied the causes of time and cost overrun in large construction project of Vietnam using questionnaire survey. It included 21 causative factors and top 5 common and intense causes of cost overrun were poor site management and supervision, poor project management assistance, financial difficulties of owner, financial difficulties of contractor; design changes.

In UK, Jackson(2002) studied the reasons of budget overrun through questionnaire survey and found that major reasons of overrun were design changes, design development factors, information availability, method of estimation, performance of design team and project management.

Another investigation was carried out by Olawale & Sun (2010) for finding

time and cost overrun factors through an administered questionnaire and found that cost control inhibiting factors were (in ranking order) design changes, risk and uncertainty associated with projects, inaccurate evaluation of projects' time/duration, non-performance of subcontractors and nominated suppliers, complexity of works, conflict between project parties, discrepancies in contract documentation, contract and specification interpretation disagreement, inflation of prices, financing and payment for completed works, lack of proper training and experience of project manager, low skilled manpower, unpredictable weather conditions, dependency on imported materials, lack of appropriate software, unstable interest rate, fluctuation of currency/exchange rate, weak regulation and control, project fraud and corruption, and unstable government policies.

Schedule delay was identified as the major reason of cost overrun; as found in summary of Malaysians Auditor General 2008 report by Khamidi et al. (2011). Ali & Kamaruzzaman, (2010) conducted a study to identify main causes of cost overrun in large building projects in Klang Valley and found that major factors contributing to cost overrun included inaccurate or poor estimation of original cost, inflation of project costs, improper planning, fluctuation in price of raw materials, poor project management, lack of experience, obsolete or unsuitable construction equipments and methods, unforeseen site conditions, mistake in design, insufficient fund, poor contract management, high cost of machineries, and construction cost underestimation . In 2007, Alaghbari et al, the problems of time overrun and were studied and found that the top ten important factors included financial difficulties by owner, financial problems by contractor, supervision too late, slowness in making decisions and slow give instructions by consultant, lack of material by external factor, poor site management, materials shortage, construction mistakes and delay delivery of materials by contractor, slowness making decision by owner, lack of experience and incomplete documents by consultant. Another study by Sambasivan and Soon (2007) revealed the most important causes of time
overrun and those were contractor's improper planning mistakes during construction stage, inadequate contractor experience, inadequate client's finance and payments for completed work and lack of communication between parties.

In 2008, Nida Azhar et al, conducted a research concerning the Pakistan's construction industry to identify the major causes of cost overrun and determined major factors of contributing the cost overrun including the fluctuation in prices of raw materials, unstable cost of manufactured, management/ poor cost control, delays between design and procurement phases, incorrect/ inappropriate methods of cost estimation, additional work, improper planning, and unsupportive government policies, materials, high cost of machineries, lowest bidding procurement procedures, poor project (site).

Later Naeem Ejaz et al. (2013) studied that these are the main causes of time and cost overrun in Pakistan construction projects. The authors identified escalation of material prices, inadequate control procedure, shortage of technical persons, delays in work approval and shortage of materials, plant/equipment are most critical factor of time and cost overrun . These factors of time and cost overrun throughout the world in construction projects are the part of the whole literature review. On the basis of this comprehensive literature review 27 common factors of time and cost overrun are identified, which are shown in table 1.

Table 1: Mapping Factors Affecting Cost and Time Overrun

No.	Factors Affecting Time and Cost Overrun	Origin
1.	Change orders by owner during construction	Fugar and Agyakwah - Baah (2010), Sweis et al. (2008), Le-Hoai et al. (2008).
2.	Delay in progress payments	Assaf and Al-Hejji (2006), Frimpong et al. (2003), Odeh and Battaineh (2002).
3.	Ineffective planning and scheduling by contractor	Assaf and Al-Hejji (2006), Sweis et al. (2008).
4.	Poor site management and supervision	Frimpong et al. (2003), Assaf and AlHejji (2006), Fugar and Agyakwah - Baah (2010), Le-Hoai et al. (2008).
5.	Shortage of labors	Assaf and Al-Hejji (2006), Odeh and Battaineh (2002), Naeem Ejaz et al. (2013).
6.	Difficulties in financing by contractor	Assaf and Al-Hejji (2006), Frimpong et al. (2003), Fugar and Agyakwah - Baah (2010), Odeh and Battaineh (2002), LeHoai et al. (2008).

7	Changes in government regulations	Assaf and Al-Hejji (2006), Olawale & Sun (2010).
8	Material procurement	Frimpong et al. (2003), Assaf and AlHejji (2006).
9	Escalation of material prices	Frimpong et al. (2003), Fugar and Agyakwah - Baah (2010), Olawale & Sun (2010), Khamidi, Khan, & Idrus, (2011).
10	Unpredictable weather	Frimpong et al. (2003), Olawale & Sun (2010),
11	Shortage of material	Assaf and Al-Hejji (2006), Fugar and Agyakwah - Baah (2010), Olawale & Sun (2010).
12	Inadequate contract experience	Odeh and Battaineh (2002), Sweis et al. (2008), Sambasivan and Soon (2007).
13	Improper planning and subcontractor	Odeh and Battaineh (2002), Olawale & Sun (2010), Khamidi, Khan, & Idrus, (2011), Sambasivan and Soon (2007), Nida Azhar et. el. (2008).
14	Incompetent technical staff	Sweis et al. (2008), Olawale & Sun (2010), Alaghbari et al. (2007).
15	Design Changes	Le-Hoai et al. (2008), Jackson (2002), Olawale & Sun (2010), Khamidi, Khan, & Idrus, (2011).
16	Conflicts between project parties	Olawale & Sun (2010), Khamidi, Khan, & Idrus, (2011).
17	Lack of appropriate software	Olawale & Sun (2010), Alaghbari et al. (2007).
18	Lack of experience	Khamidi, Khan, & Idrus, (2011), Alaghbari et al. (2007).
19	Mistakes in design during construction	Khamidi, Khan, & Idrus, (2011), Alaghbari et al. (2007), Sambasivan and Soon (2007).
20	Lack of communication between parties	Sambasivan and Soon (2007), Olawale & Sun (2010).
21	Delays between design and procurement phases	Olawale & Sun (2010), Nida Azhar et. el. (2008).
22	Inappropriate cost estimation methods	Olawale & Sun (2010), Nida Azhar et. el. (2008).
23	Unsupportive government policies	Olawale & Sun (2010), Nida Azhar et. el. (2008), Sambasivan and Soon (2007).
24	High cost of machineries	Nida Azhar et. el. (2008), Sambasivan and Soon (2007).
25	Inadequate control procedure	Nida Azhar et. el. (2008), Naeem Ejaz et al. (2013).
26	Delays in approval of documentation	Olawale & Sun (2010), Alaghbari et al. (2007).

4. EXPERT SYSTEM FOR CONTROLLING COST AND TIME OVERRUN (ESCCTO)

The purpose of "ESCCTO" is to provide a user interface friendly system for determining the various causative factors of time and cost overrun performance; it will also be able to suggest the possible mitigation measures for controlling the time and cost overrun factors. Following tasks are involved in developing the ESCCTO.

1. Determining the causative factor of time and cost overrun in each phase of construction project life cycle.
2. Determining the significant level of causative factor through (SPSS) Statistical Package for Social Science.
3. Incorporating expert system in proposing mitigation measures for controlling causative factors of time and cost overrun.

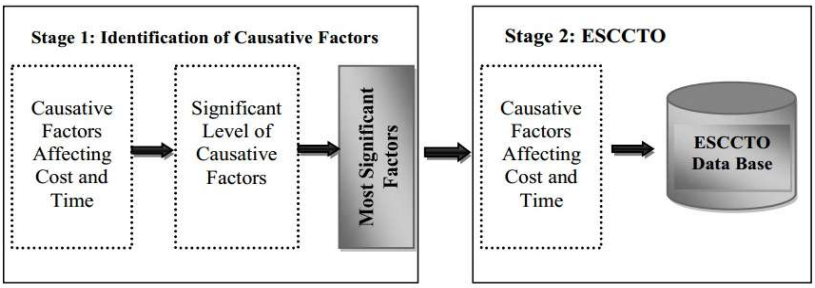
This research will use quantitative and qualitative approach in determining the causative factors of time and cost overrun in each phase of construction project life cycle. The data will be analyzed by using SPSS. The key fulfillment of this research is incorporating the expert system with experience based mitigation measure for controlling the identified/ expected causative factor of time and cost overrun.

4.1 CONCEPTUAL FRAME-WORK OF ESCCTO

For determining the various causative factors of time and cost overrun, ESCCTO will provide a user interface friendly system and this system will also support the users in suggesting the mitigation measures of the causative factors. The figure 1: is shows the conceptual FrameWork of ESCCTO system.

Figure 1: Conceptual Frame-Work of ESCCTO

The conceptual frame-work of ESCCTO is divided in two stages as explained bellow;



Stage 1: Give the clear image of the determining the causative factors of time and cost overrun. This will be completed through quantitative approach technique using questionnaire surve y and interviews with the experts involved in construction projects. From that stage users will be capable to find out the significant factors of cost and time overrun for exploring the mitigation measures.

Stage 2: A data base of mitigation measures will be developed on the basis of the causative factors. The expert system will help in selecting the most appropriate measure from the data base to control the causative factors of cost and time overrun.

4. CONCLUSION

This research study is presenting a conceptual frame work of software development for controlling the problem of time and cost overrun is faced by construction industry since decades. As mentioned most of the construction projects throughout the world are concerned with time and cost overrun. These overruns are the outcome of various causative factors which are the main barriers to project completion. ESCCTO frame work will be able in determining the various causative factors in affecting the project time and cost. On the basis of determined factors the proposed system will be capable to suggest the mitigation measure for controlling the causative factors of time and cost overrun and consequently improve the project performance.

6. REFERENCE

Abdullah, *MR, AA Abdul Azis, and I Abdul Rahman. "Causes of Delay and Its Effects in Large Mara Construction Project." International journal of Integrated Engineering (Issue on Mechanical, Materials and Manufacturing Engineering) (2009).*

Alaghbari, Wa'el, Mohd Razali A Kadir, and Azizah Salim. "The Significant Factors Causing Delay of Building Construction Projects in Malaysia." Engineering, Construction and Architectural Management 14, no. 2 (2007): 192-206.

Ali, AS, and SN Kamaruzzaman. "Cost Performance for Building Construction Projects in Klang Valley." Journal of Building performance 1, no. 1 (2010).

Assaf, Sadi A, and Sadiq Al-Hejji. "Causes of Delay in Large Construction Projects." International Journal of Project Management 24, no. 4 (2006): 349-57.

Atkinson, Roger. "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, no. 6 (1999): 337-42.

Azhar, Nida, Rizwan U Farooqui, and Syed M Ahmed. "Cost Overrun Factors in Construction Industry of Pakistan." Paper presented at the First International Conference on Construction In Developing Countries (ICCIDC I), Advancing and Integrating Construction Education, Research & Practice, 2008, 499-508.

Barrick, A. . "Poll Reveals One in Three Jobs Late. Building, 28 July, 10." (1995).

Chang, A. S.-T. , and "Reasons for Cost and Schedule Increase for Engineering Design Projects." Journal of Management in Engineering 18, no. (1) (2002): 29 36.

Ejaz, Naeem, Imran Ali, and Muhammad Fiaz Tahir. "Assessment of Delays and Cost Overruns During Construction Projects in Pakistan." (2013).

Endut, Intan Rohani, Akintola Akintoye, and John Kelly. "Cost and Time Overruns of Projects in Malaysia." retrieved on August 21 (2009): 243-52.

Flyvbjerg, Bent, Mette K Skamris Holm, and Søren L Buhl. "How Common and How Large Are Cost Overruns in Transport Infrastructure Projects?". Transport Reviews 23, no. 1 (2003): 71-88.

Frame, JD. "Establishing Project Risk Assessment Teams." Kähkönen K. and Artto KA (eds.) Managing Risks in Projects, St. Edmunsbury Press Ltd., Suffolk, UK (1997): 22-27.

Frimpong, Yaw, Jacob Oluwoye, and Lynn Crawford. "Causes of Delay and Cost Overruns in Construction of Groundwater Projects in a Developing Countries; Ghana as a Case Study." International Journal of Project Management 21, no. 5 (2003): 321-26.

Fugar, Frank DK, and Adwoa B Agyakwah-Baah. "Delays in Building Construction Projects in Ghana." Australasian Journal of Construction Economics and Building 10, no. 1/2 (2010): 103-16.

Hamzah, N, MA Khoiry, I Arshad, NM Tawil, and AI Che Ani. "Cause of Construction Delay Theoretical Framework." Procedia Engineering 20 (2011): 490-95.

Haq, Saiful, Yahya Rashid, and Muhammad Shakeel Aslam. "Effects of Delay in Construction Projects of Punjab-Pakistan: An Empirical Study." (2014).

Hussin, Jamilus Md, Ismail Abdul Rahman, and Aftab Hameed Memon. "The Way Forward in Sustainable Construction: Issues and Challenges." International Journal of Advances in Applied Sciences 2, no. 1 (2013) : 15-24.

Jackson, Simon. "Project Cost Overruns and Risk Management." Paper presented at the Proceedings of Association of Researchers in Construction Management 18th Annual ARCOM Conference, Newcastle, Northumber University, UK, 2002.

Khamidi, Mohd Faris, Waris Ali Khan, and Arazi Idrus. "The Cost Monitoring of Construction Projects through Earned Value Analysis." Paper presented at the International conference on economics and finance research, Singapore, 2011.

Le-Hoai, Long, Young Dai Lee, and Jun Yong Lee. "Delay and Cost Overruns in Vietnam Large Construction Projects: A Comparison with Other Selected Countries." KSCE journal of civil engineering 12, no. 6(2008): 367-77.

Moura, Helder M Pinto, José M Cardoso Teixeira, and Brígida Pires. "Dealing with Cost and Time in the Portuguese Construction Industry." (2007).

Odeh, Abdalla M, and Hussien T Battaineh. "Causes of Construction Delay: Traditional Contracts." International Journal of Project Management 20, no. 1 (2002): 67-73.

Olawale, Yakubu Adisa, and Ming Sun. "Cost and Time Control of Construction Projects: Inhibiting Factors and Mitigating Measures in Practice." Construction Management and Economics 28, no. 5 (2010): 509-26.

Sambasivan, Murali, and Yau Wen Soon. "Causes and Effects of Delays in Malaysian Construction Industry." International Journal of Project Management 25, no. 5 (2007): 517-26.

Sweis, Ghaleb, R Sweis, A Abu Hammad, and A Shboul. "Delays in Construction Projects: The Case of Jordan." International Journal of Project Management 26, no. 6 (2008): 665-74.

(Courtesy by Dawn)

900 Railway Coaches To Be Upgraded

News Digest

LAHORE: A total of 900 railway passenger coaches will be overhauled and upgraded, decided a meeting presided over by Minister Khwaja Saad Rafique here on Monday. For the last five years, some 420 coaches of German origin had been stationed at various railway yards for periodic overhaul, while another 480 also required overhaul, the meeting was informed. The minister constituted a committee, headed by Additional General Manager (Mechanical) Liaqat Chughtai, to submit by July 31 a report about the condition of the coaches. Directing that standard of coaches' maintenance be improved, Mr Rafique also sought a comprehensive plan for upgrading the washing lines so that sanitary conditions in trains could be further improved. Availability of sanitary staff in every train should also be ensured, he said. Meanwhile, another meeting presided over by the minister finalized agenda for a six-member delegation of Pakistan Railways (PR) visiting China from July 24. The delegation would primarily discuss with their Chinese counterparts upgrading of Karachi-Peshawar and Taxila Havelian dry port main rail track. Matters pertaining to implementation of Phase I and II of five-year China-Pakistan Economic Corridor (CPEC) project, especially improving the capacity of the existing track and framework would also be discussed in details during the visit. Comprising Railways Board Chairperson Parveen Agha, minister's adviser Anjum Pervaiz, Chief Executive Officer Javed Anwar, CPEC railways project head Ashfaq Khattak, Additional General Manager (Infrastructure) Humayun Rashid and Director General (Planning) Mazhar All Shah, the delegation will return on July 29.

Developing a Standard Safety Manual for the Construction Industry in Afghanistan

Mehran Amiri
(Assistant Professor, Department of Civil Engineering, Payame Noor University (PNU), Tehran, Iran)

Mohammad Gul Hamidi
(MSc Student, Construction Engineering and Management, Islamic Azad University,Kabul Unit,
Kabul, Afghanistan)

ABSTRACT
This study aimed to provide a general view and description of safety structure of the construction industry in Afghanistan including private projects, government projects, NGO projects, PRT projects, U.S. army projects and other donors who are working in this sector in Afghanistan. Several interviews were conducted with thne officials of governmental ministries in Kabul and their related departments in Herat province to find out how they manage safety in construction sites such as sewer systems, water supply and power projects inside the country. Beside the interviews, several contracts and reports were reviewed in order to find out the current safety procedures in the construction industry of the country. The policy makers have not developed a unique standard safety manual to be applied all over the country, yet. Furthermore, accurate data of annual occupational accidents are not available and policy makers have not taken any step to make a structure for recording accidents' characteristics up to now. Moreover, unfamiliarity with safety hazards and safety promotion techniques has led to increasing frequency and severity of accidents in construction jobsites. It is highly recommended that decision makers and top management develop a standard safety and health manual for the construction industry to be applied all over Afghanistan.

KEYWORDS
Safety structure, Occupational safety, Construction industry, Safety promotion, Afghanistan

1. INTRODUCTION
"Construction is known as one of the most dangerous industries all over the word" Amiri et al., 2014). The approach for controlling accidents in the construction industry needs considering several factors. Among them, an important factor is generating standard safety guidelines /manuals and proper application of these guidelines at construction sites. Lack of national safety manuals / guidelines in Afghanistan has resulted in various safety hazards.
Safety structure in Afghanistan can be studied in two time intervals as below:

- Before 2002: The construction industry was under the preemption of government of Afghanistan. In this period, few construction companies were established by the support of government to implement infrastructural projects inside the country. For instance, the following companies can be mentioned: Banai construction organization, Afghani construction organization, Helmand construction organization, Tasadi Khanah Sazi corporation in Kabul and some others. Generally, PPE were given to workers, but a complete/standard safety manual was not developed to be used at construction sites.

- After 2002: After the collapse of Taliban regime in Afghanistan in 2001 by the military assistance of USA , rehabilitation and reconstruction of infrastructures projects restarted at 2002 by the national and international community's financial aids. Military forces from several countries of NATO entered to Afghanistan and the Provincial Reconstruction Team (PRT) was established at each province to control security of the country. Besides taking care of the security issues, participating in the reconstruction of infrastructures was

another objective of the PRTs as well. Furthermore, some other donors such as World Bank, Asian development bank, USAID and others tried to provide financial aid for the rehabilitation and reconstruction projects in the country. In addition, USA army allocated a big amount of found for reconstruction of army bases for national police and national army of Afghanistan. These projects were implemented according to safety culture/standard of each donor).

This study is based on the working experience with different donors and agencies including UN organization, government of Afghanistan, international and national construction companies in Afghanistan since 2002. In addition to personal experience, several interviews are conducted with different provincial departments in Herat and ministries at Kabul to find the exact safety and health structure in the construction industry of Afghanistan. However, the authors could not find any national safety document/guideline to be used nationwide. The aim of this study is to encourage the policymakers of Afghanistan to start developing a comprehensive guideline in order to mitigate safety hazards at construction industry of Afghanistan. Methodology, results, discussion, conclusion and references are coming in the next sections.

2. METHODOLOGY

The research methodology is based on the following points:

- The author conducted several interviews with officials in Herat and Kabul provinces and with different departments who are engaged in the construction industry (in order to check the availability of a national safety manual) and gathered information about safety structure in the country.

- Collecting information, reports, data, contracts, design drawings and photos related to safety structure of the country from individuals and related organizations.

- Searching o n l i n e publications and published reports on safety procedure in different types of construction projects in Afghanistan.

- Review of relevant literature, including several reports and Ministry of Agriculture Irrigation and contracts, in particular, produced by Ministry of Energy and Water (MEW), Livestock (MAIL), Ministry of Rural Rehabilitation & Development (MRRD), Ministry of Urban Development (MUD), Food and Agriculture Organization (FAO), Asian Development Bank (ADB), World Bank and Corps of Engineers projects in-country.

- Subsequent analysis of the above mentioned data to introduce the construction safety structure of Afghanistan.

One of the challenges in considering safety measures in the construction industry in Afghanistan is lack of national safety manuals, accident data, low reliability and accuracy of the accident databases inside the country. “unfortunately, a great deal of Information, resources and institutional capacity of accurate monitoring and reporting on natural resources statistics were lost during the years of (Rout and Lee, 2008)

This study has focused on numerous information sources as presented in table (1) and (2):

Table 1: List of Departments and Authorized Persons Who Are Interviewed in Heart.

ID	Organization	Position
1	Construction department of Herat municipality, Herat, Afghanistan	Director of construction
2	Lower Hari Rud-Morghab river basin department, Herat, Afghanistan	Director
3	Urban development affairs department of Herat, Afghanistan	Deputy director
4	Public work department of Herat, Afghanistan	Director
5	Rural rehabilitation and development department of Herat, Afghanistan	Director
6	Water supply and waste water department of Heart, Afghanistan	Director
7	Bania construction company, Herat, Afghanistan	Director

Table 2: List of Organizations Contacted in Kabul

ID	Organization	Position
1	Ministry of energy and water, Kabul, Afghanistan	Director of planning water department
2	Unite nation- food and agriculture organization, ministry of energy and water	Quality control manager
3	Ministry of urban development affairs	Construction director
4	Ministry of rural rehabilitation development- Nation Solidarity Project (NSP)	Senior irrigation design engineer
5	Ministry of urban development affairs	Former minister (2008)

3. RESULTS AND DISCUSSION

After collecting information from several in-charge organizations, it was found that safety structure in the construction industry of Afghanistan is based on the projects financial source. In this regard, at the present time, projects are divided into five main categories based on their financial source in Afghanistan as follows:

3.1 GOVERNMENTAL PROJECTS:

These projects, which are implementing by government, are divided into two categories based on the source of financial fund as below:

- Projects which are financed by government's normal budget: Most of these projects are implemented by local and international contractors without proper safety considerations. However, contractors must provide safe working-site and PPE for workers based on standard human resource management policy of Afghanistan which stiputates: "the contractor must provide proper safety equipment and PPE for the workers at construction site." (Standard Human Resource Management Policy, 2008).

The Chapter 10 of standard human resource management policy of Afghanistan is dedicated to safety and health issues in construction. This chapter includes 13 separate items which provide instructions to clients and contractors. According to this chapter, they must provide enough considerations for safety of jobsite personnel in construction sites. However, detailed techniques of safety requirements are not defined clearly.

- Projects which are financed by loans or grants of donors: Safety considerations can't be observed in these projects as well, albeit contract documents obligate the contractor to provide proper safety environment and PPE for workers. However, there is not a complete safety manual/guideline attached to contracts in order to define all required safety techniques for minimizing safety hazards at all stage of construction. Furthermore, the contractors that are awarded these contracts are not screwed by the implementer agencies for using the standard safety techniques and protect workers from safety hazards. In addition, most of engineers who are working in government organizations are not aware of the criticality of safety hazards and their effects.

3.2 PRT'S CONSTRUCTION PROJECT

In 2002, the Provincial Reconstruction Teams (PRT) of NATO was established in Afghanistan and military forces of each NATO member entered a province to provide security and participate in reconstruction of infrastructures of that province. In this regard, they financed several projects such as schools, roads, bridges and other infrastructures. However, from construction safety point of view, they did not care safety in almost all their projects.

3.3 NGO'S CONSTRUCTION PROJECTS

Most of the construction projects which are implemented by NGOs, do not benefit from a standard safety plan. These construction sites are not safe for workers and PPE are not provided to them as well.

3.4 PROJECTS IMPLEMENTED BY THE GRANT FUND OF THE NEIGHBORING COUNTRIES

The contractors of these projects were from the country that provided the fund of the projects and safety rules and regulations were based on safety standard of that country. For example the Salma dam is under construction in western region of Afghanistan and Indian government provides the fund of this project. So, the contractor of this project is an Indian construction company who manages safety at the project site based on his own safety rules and regulations.

3.5 US ARMY FUNDED MILITARY PROJECTS

Safety was the first priority in construction jobsites of projects that were implemented by corps of engineers and AFCEE in Afghanistan. All the safety rules and regulations were implemented in the US army projects according to safety and health requirement manual EM385-1-1, which has been developed by the US army corps of engineers. It was stipulated that "This munual prescribes the safety and health requirements for all Corps of Engine Safety and Health Requirements Manual, 2008).

The applicability of this manual is defined as: "This manual applies to headquarters, US Army Corps of Engineers (HQUSACE) elements, major subordinate commands, district, centers, laboratories and field operation activities (FOA), as well as USACE contracts and those administered on behalf of the USACE. Applicability extends to occupational exposure for missions under the command of the Chief of Engineers, whether accomplished by military, civilian, or contract Safety and Health Requirements Manual, 2008)

The US Army projects that are executed in Afghanistan affected on afghan construction companies, engineers, foremen, skill labors, operators and labors and made them aware of latest construction systems and safety programs at construction jobsites. Actually, these projects were a job training course for the afghan human resources working in the construction industry of Afghanistan.

All in all, the findings of this study can be summarized as follows:

- Still the policymakers in Afghanistan have not developed a comprehensive national safety manual to be applied on Afghan construction jobsites.
- The role of insurance systems is not still defined in the construction industry of Afghanistan.

- Occupational accidents are not recorded in the Afghan hospitals; therefore, collecting proper data of the accidents are a challenge for researchers inside the country.

- Most of engineers working in governmental organizations do not have enough knowledge about safety and health rules and regulation.

- Lack of safety training for construction workers has resulted in a profound lack of interest in workers to follow safety rules and regulations in jobsites.

The US army has implemented billion dollars of construction projects in the past ten years with high standard of safety and health. Many engineers, foremen, supervisors, lab technicians, skill labors, operators and labors are trained at these jobsites and got proper information about safety hazards and manners to protect from these hazards. Opportunity of working with US army corps of engineers system has built the capacity of Afghan construction industry to continue the safety system that has been established by the U.S. army corps of engineers inside the country.

5. CONCLUSION

This study shows that the development of a standard safety manuals and its application is one of the most important priorities for the construction industry of Afghanistan. Further, this study can help to motivate the vision of the policy makers to start the development of standard safety manual for the country in order to have better control on prevention of the safety hazards at construction sites.

Moreover, it is recommended that officials collect more information about corps of engineers in order to prepare a standard safety manual based on the EM385 and apply it all over the county.

6. REFERENCES

Amiri, M., Ardeshir, A., Fazel Zarandi, M.H. (2014). "Risk-based analysis of construction accidents in Iran during 2007-2011- me Iranian Journal of Public Health, Vol. 43, No. 4, pp. 507-522.

Rout, B., Lee, C. (2008). How the Water Flows: A Typology of Irrigation Systems in Afghanistan, Afghanistan Research and Evaluation Unit, Kabul, Afghanistan.

Safety and Health Requirements Manual, EM385-1-1 (2008). Department of Army, U.S. Corps of Engineers, Washington D.C., USA.

Standard Human Resource Management Policy (Dari Version) (2008), Independent Administrative Reform of Civil Services, Kabul, Afghanista

Academia Industry Linkages

Engr. Muhammad Ijaz Rabbani
ijaz.rabbani@hotmail.com
ijaz.rabbani@gmail.com

INTRODUCTION

Engineering, based upon building of difficult things for bringing comfort in the lives of people, is a very tough study of science. Wearing the same t-shirts, recycled jeans, different socks, having swollen red eyes, being forcefully insomniac but still managing to get to lectures on time, engineering students always have a way to make things work. Associated to the pain of thousands of intricate mathematical formulae, numerous droning spend making assignments, reports, and projects, engineers who take away the countless sleep-deprived nights are rarely hailed as heroes for bringing about positive changes in the lives of Pakistanis.

Presently the leading problem in the world is unemployment, which is increasing rapidly due to scarcity of sources and in such complex scenarios of unemployment phase, frequent problems including crimes take place. Pakistan the Asian country has more difficulties in these days and unemployment is one of those. According to the parents, family members and friends, an engineer means that he can fix everything around and due to these external pressures and the employment situation in the market of Pakistan, engineers often settle for non-engineering odd jobs. This is a genuine issue for a large group of freshly-employed engineers. Engineers in Pakistan are not only underappreciated, but are heavily underpaid too. In such situation, then how we can expect them to make things work for Pakistan when they can't even properly work effects out for themselves. The social aspect of this massive under-employment and unemployment is not in the interest of peace and development of Pakistan.

PREVAILING SATE OF AFFAIRS.

The economy of Pakistan, though improving is not in a good shape. Recently, it has been rated as one of the most expensive countries of Asia. Our inflation rate is still very high. It has been handicapped by our imports. The price of Pakistani products is incompatible to cope with the foreign products. Pakistan has countless natural resources but unfortunately those are being wasted since the independence of Pakistan. The people of Pakistan are considered highly talented and hardworking in the world, while there is no value of talent in Pakistan. A large No. of students graduating out of Pakistan's engineering colleges run the risk of being unemployed, wandering about for job opportunities due to bad employment system and the others are constrained to take jobs well below their technical qualifications in the market, where there are only few jobs for the overflowing technical talent pool. Affected by a flood of institutions, offering degree in various disciplines of engineering education and a shrinking market for their skills, Pakistan's engineers are struggling to survive in an extremely challenging market. The future of engineers in Pakistan is very disappointing. Those without any influence remain unemployed, which makes the drain of qualified technology possessed persons out of Pakistan and desire of development in technical field remains unfold due to this neglect of technical tools. Presently Pakistan is generally not a friendly place for graduate Engineers, specially the fresh engineers and many of the fresh graduates have immense difficulty in securing a good job. This is because the industry in Pakistan is not flourishing and also that it does not either look keen and interested to engage graduate engineers or the engineering industrialist are not yet aware of its importance, as they do not actually identify that engineering is a broad term which covers many areas of scientific, finance and marketing study and most of these studies are highly connected and of course sharp problem solving skills are made readily available to them. It is however not out of place to mention

that most of the industries hire graduates from reputed engineering universities, which of course is also debatable in a way that mushrooms of engineering institutions have succeeded in getting recognition of Pakistan Engineering Council (PEC), but failed to produce promising quality of engineers and as such could not gain confidence of industrialist. The Supreme Court of Pakistan also shown similar concern about medical colleges, as reported in "daily Jang" dated August 24, 2016.

The quality of engineer passing out of many colleges is not up to mark and most of them are unaware about what they did in 4 years and it looks like as degrees are awarded without imparting quality education and research work. The problem is also linked with the lack of research and development in our industry. The commercialized approach of businessmen and the non-industrially approach at academia is the main stumbling block in development of this research sector.

According to data from PEC, the regulator for engineering education in Pakistan, there were 113 engineering colleges offering 340 engineering courses in different disciplines across the country. According to multiple estimates, Pakistan trains around 15000 engineers per annum, meaning thereby that about 1250 new vacancies are required to adjust the new graduate's engineers every month, which is a great challenge and No. of unemployed engineers, is increasing with the announcement of every successive final year's result of each engineering institution.

The tendency of employers is changing increasingly and they don't care what you know but they focus on what you can do with that knowledge and in such situation the candidates having practical technical knowledge better than a graduate engineer are preferred.

Customers are asking for more and as such recruiters are changing their strategy. The crisis is very real today and an engineering degree is a poor proxy for your education and employment skills. To meet these challenges, the linkage of Academia and Industry leads towards better solution.

NEED FOR ACADEMIA-INDUSTRY LINKAGES

Knowledge gains value if it meets the present-day requirements and simultaneously it is shared expansively. Research work of industry-specific needs is essential, which requires identification of industry's research needs and also the reliable data. Therefore integrated Academia-Industry Linkages are the dire need of today.

One of the critical requirements for the success in this regard is highly superior manpower. Though the solution lies in the linkage of academia and industry, while both the two entities normally work in different spheres and their collaboration can bridge the gap of mindset, where according to academia knowledge output of scientific research is a public ownership but contrarily most of industrial organizations consider their scientific and technical knowledge as their proprietary.

Sustainable linkage has remained a big challenge in Pakistan as industries have a genuine complaint that the curriculum of engineering universities/institutions is mostly of tutorial approach which does not match with the industrial needs. Such linkages can prove a historic event, if academic standards are improved to international level, students are encouraged and managed to translate science and technological knowledge to develop commercialization achievements so as to transform the relevant data into required results through research, with the deployment of qualified and devoted faculty.

Such curriculum designed to meet industry's requirements backed with the feedback system of corporate sector can bring revolutionary uplift in productive changes of market dynamics to the demand of young engineers, firm's productivity and economic growth, besides formation of automatic accountability system amongst the engineering universities / institutions.

REAL TIME SCENARIO IN BUILDING OF ACADEMIA INDUSTRY LINKAGES

The linkages could not take priority in Pakistan for numerous reasons. Some the factors for barrier in building of Academia-Industry Linkages can be illustrated as under:

i. Non-allocation of substantial funds by the Government of Pakistan for R&D in science and technology.

ii. Mismatch between the knowledge delivered by academic institutions and the real demand of applied knowledge in industry.

iii. Communication gap between academia and industry.

iv. Difference in nature and objectives of the two entities.

v. Cultural difference of two individual bodies, operating under different organizational environments with different customs, standards and values.

vi. Lack of motivation, confidence and entrepreneurial spirit among the faculty of newly established institutions / universities to shift the role of academia from traditional engineering and science education providers to the additional role of contributing the knowledge towards commercialization and active contribution to the development of private enterprises.

vii. Non sharing of research achievements with others to

keep it proprietary for profit strategies.

viii. Geographic location of university, having limited access to the high-tech industries due to inadequate infrastructure of communication modes and transport etc.

ix. Inadequate lab facilities at universities to conduct Research and Development activities.

x. Lack of time due to workload capacity commitments, lack of proper methodology/SOP and encouraging/helpful structure for such linkages.

FORMATION

To match the international standards of present-day requirements and to fight for the survival of economy, research oriented education system in collaboration with industry is necessary so as to transform teaching universities / institutions to research universities/institutions in the first stage and subsequently transform these research universities/institutions to entrepreneurial in the second stage.

To achieve the targets, sustainable collaboration between academia and industry is need of the day, which cannot prevail a success without the presence of a regulatory body.

Higher Education Commission (HEC) and Pakistan Engineering Council (PEC) should be the strategic partner sunder sponsored supervision of the Government of Pakistan.

Regional Academia-Industry Linkage committees should be formed with essential membership of Chamber of Commerce and Industry. These committees should work as interaction cells within the universities, which will be instrumental in developing relations between academia and industry.

The dedicated units comprising of devoted and experienced persons, capable of providing support services to involve academia in solving industry problems should be established. A strong set of policies and SOP should be formulated for smooth and successful working of the cell. HEC and PEC may jointly develop a consortium under which research needs of various types of industry may be elaborated and course outlines are designed and monitored accordingly.

OBJECTIVES

Following objectives can be achieved through building of Academia-Industry linkages.

(i) A very useful platform can be provided for mutual discussions, exchange of knowledge, experience sharing, seminars, workshops, meetings and exhibitions with different industrial divisions.

(ii) Development of friendly relations between academia and industry for lodging industrial internship programs at undergraduate and postgraduate stages.

(iii) To set line of direction to translate tutorial knowledge to research oriented output on the basis of feedback data of industry and also transform the research results into entrepreneur.

(iv) To develop understanding for providing job opportunities to the fresh engineers of undergraduate and postgraduate programs, trained on a specific research activity of industrial needs.

(v) Technology transfer within or across firms through movement of employees from one section to another within the same industry, from one industry to the other or one country to another and of course coordinated transfer of knowledge between academia and industry.

GUIDELINES TO ACHIEVETHE TARGETS

The following are the suggested plans for fastening the industries and academia.

1. A policy should be drafted by the Government of Pakistan to encourage R&D efforts by allocating R&D grant for universities and tax concessions to the industry, collaborating with universities and using local technology.

2. Interaction Cells formed in the universities be made effective.

3. Industrial internship should be included in the curriculum. The industries, Consulting Engineering Firms and Constructors/Operator Firms should coordinate with the academia for extending one year internship program to fresh graduates and three months program for final year/final semester students to take training in the specific field of their expertise.

4. Interactions between academia and industry should also focus on contract research, joint research, consultancy and the projects to contribute innovation.

5. Laboratory facilities be improved.

6. All the engineering universities should establish incubation centers on priority basis. These centers will serve the purpose of establishing a platform where both the sectors can meet on regular basis. The industry, recommended by Chamber of Commerce and Industry will have access to these incubation centers.

7. In order to bridge the gap between industry and academia, universities should publicize job market data to attract the students and HEC/PEC should play their role to restrict universities to keep needs of

employers in consideration before designing and offering the courses accordingly.

8. Regular industrial visits by students and the staff should be encouraged.

9. Universities should involve skilled and experienced staff in teaching programs.

10. Seminars and workshops should be conducted by the universities, Institution of Engineers Pakistan, Institution of Electrical and Electronics Engineers, Pakistan Engineering Congress, Institution of Chemical Engineers of Pakistan, other engineering institutions and industry on the latest research on regular basis. In addition training, contract research, consultancy, development and innovation and many other interactions, besides accountability of universities / engineering colleges can be demonstrated through such linkages.

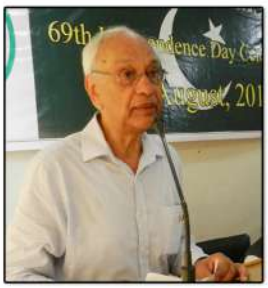
11. It should be made obligatory for the academics to undertake a certain amount of work with industry and after some experimentation introduce reforms in the university policies with respect to governance of technology commercialization and introduce entrepreneurial knowledge in university syllabus. The PHD scholars of academia can serve the purpose of annual business evaluation of industry and production cost can be considerably decreased if the latest technologies are coped by the local experts. Things would get cheaper if it is streamlined with the latest advancements that increase efficiency with minimum cost.

12. Career grooming workshops of students/young engineers should be carried out with the strong interaction between the specialists to distinguish the work nature of different jobs.

13. Many of the industries in Pakistan work by taking projects from international companies and then even hire highly specialized staff to cater those projects or in other cases, look for other companies abroad to out-source those projects. If these projects are out-sourced to the fresh graduates or even students through incubation centers, then they can carry out that project in much less expenses. This would benefit both the industry and academia. Industry would save its money whereas students and fresh graduates will get experience as well a small amount of money to make them independent. ■

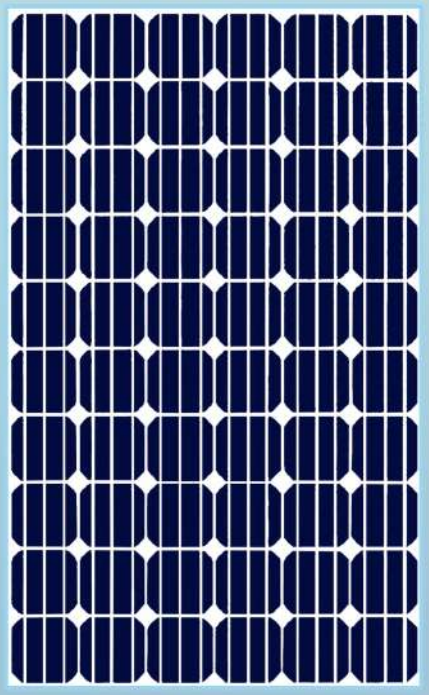
Foto News

Engr. Mian Shaminm Ahmad Senior Fellow of IEP is performing Flag Hoisting Ceremony at the IEP Headquarter Building on the occasion of 69th Independence Day of Pakistan 2016.



CREATIVE GROUP

ISO 9001 - 2008 CERTIFIED



Frp/ Grp & Epoxy Composite Pipes

Fuse Cutout & Accessories

CREATIVE ELECTRONICS PVT. LIMTED

SKYPOWER (PVT) LTD.

CREATIVE ENGINEERING PVT. LIMTED

Head Office:-160/s Q.I.E
Kot Lakhpat,
Lahore - Pakistan
Ph: 042-35118710
042-35111727
www.Creativegrp.net

LAHORE ORANGE LINE METRO TRAIN PROJECT PACKAGE-1
FROM DERA GUJJRAN TO CHAUBURJI

SPEED STRENGTH STANDARD

HABIB
CONSTRUCTION
SERVICES

METRO BUS LAHORE
(MAO COLLEGE TO BHATTI CHOWK)

KALMA UNDERPASS, LAHORE

AZADI INTERCHANGE, LAHORE

SIGNAL FREE CORRIDOR JAIL ROAD AND
MAIN BOULEVARD GULBERG, LAHORE

15-A, Block G-1, Canal Bank Road, Near Doctors Hospital, Johar Town, Lahore, Pakistan
UAN: 92-42-111 123 427 Email: hcs@hcs.com.pk Web: www.hcs.com.pk