ASSESSMENT OF IMPLEMENTATION LEVEL OF QUALITY MANAGEMENT STANDARDS IN THE CEMENT INDUSTRY OF PAKISTAN

Thesis of

Master of Science

By

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(2009-NUST-MSPhD-CE&M-13)

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This is to certify that the

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DEDICATED

TO

HOLY PROPHET (P.B.U.H)

MINERAT OF KNOWLEDGE

AND

MY LOVING PARENTS

WHO GAVE ME A LOT OF INSPIRATION,

COURAGE,

SUPPORTED ME MORALLY

FINANCIALLY FOR MY STUDY

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Throughout this has been a satisfying and rewarding venture.

ABSTRACT

Quality of construction project is always a matter of concern for the client. The quality of civil structure can not be independent of the quality of materials used in it. Concrete is most widely used construction material in Pakistan and cement is one of its key ingredient which is manufactured through chemical process. Pakistan is a developing country and quality is not considered that much important so the quality management field in the manufacturing industry lacks research in comparison with the volume of the industry. Cement industry is also one of the manufacturing industries and quality management of the cement industry of Pakistan is perceived to be good but a research carried out on causes of destruction of earthquake in year 2005 concluded that the major cause of destruction was low quality of construction materials and there is no research available on quality management in cement industry of Pakistan. Keeping this in view an effort was made to assess the level of quality management implementation in the cement industry of Pakistan. The assessment was carried out on two aspects of the quality management, a)- Technical system of quality management and b)- Managerial system of quality management and in addition quality management awareness among the industry. The technical system included the tools and techniques where as management system included critical factors of quality management and quality management awareness included the basic terminology implied in the quality management of cement industry of Pakistan. A questionnaire was prepared and responses were received. The analysis was done using SPSS and Microsoft excel. The research revealed that the tools and techniques on which the industry heavily relied on are Control Charts, Control Plans, Customer feed back & Bench marking where as the factors representing strong to weak hierarchy of managerial system are, top management support towards quality management, employee training, quality information availability, customer orientation, quality information usage, process and product design, employee involvement and supplier quality. The lack of awareness of basic terminology used in quality control and quality assurance phases of quality management is considered a crucial factor need to be improved. This research has identified weak and strong areas of awareness and implementation of quality management in the cement industry of Pakistan so that the industry can be benefited by improving the weak areas and capitalizing the strong areas of quality management.

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LIST OF ABBREVIATIONS

AON	Activity on Node
BM	Benchmarking
BPR	Business Process Re-engineering
BSC	Balanced Score Card
CAD	Computer Aided (process/product) Design
CAM	Computer Aided Manufacturing
CCs	Control Charts
CIM	Computer Integrated Manufacturing
CNC	Computer Numerical Control
Cp	Process Capability
Cpk	Process Capability Index
CPM	Critical Path Method
CS	Customer Survey
CSR	Corporate Social Responsibility
DFMA	Design for Manufacture and Assembly
DoE	Design of Experiments
DRIFT	Do It Right the First Time
EDE	Electronic Data Exchange
ESS	Employee Suggestion Scheme
FMEA	Failure Mode and Effect Analysis
FEA	Finite Element Analysis
GNP	Gross National Product
IT	Improvement Teams
JIT	Just In Time

KM	Knowledge Management
PDCA	Plan-Do-Check-Act Cycle
PDPC	Process Decision Program Chart
PERT	Program Evaluation and Review Technique
QFD	Quality Function Deployment
QIT	Quality Improvement Team
QM	Quality Management
QMS	Quality Management System
SD	Supplier Development
SDOs	Standard Developing Organizations
SE	Supplier Evaluation
SPC	Statistical Process Control
SQC	Statistical Quality Control
SWOT	Strengths Weaknesses Opportunities Threats
TPM	Total Productive Maintenance
TQM	Total Quality Management

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CHAPTER 1

INTRODUCTION

1.1 General

Construction industry plays an important role in the socio economic development of a country. The main goals of socio economic development are infrastructure, sanctuary and employment (Khan 2008). The construction activities are significant for achieving these goals as it includes hospitals, schools, townships, offices, houses and other buildings, highways, roads, ports, railways, airports, power systems, irrigation and agriculture systems, telecommunications etc. in the form of infrastructure.

According to Chung (2007) quality is now acknowledged to be a key issue for the construction sector whose clients increasingly demand the quality certification. Project quality management must address both the management of the project and product of the project. The quality of product of the project is mainly dependent on the quality of materials used in the project. Failure to meet quality requirements in either dimension can have serious consequences for any or all the project stakeholders (PMI 2000).

1.2 Global Distribution of Construction Output and Employment

Globally, construction industry is regarded as one of the largest fragmented industry. An estimate of annual global construction output was probably closer to US $ 4.5 trillion in 2004 (Khan 2008). Construction industry is also a major source of employment.

1.3 Construction Industry in Pakistan

The construction industry in Pakistan plays an effective role in developing economy and reducing unemployment. The construction industry provides sufficient opportunities of employment as it has linkage with other industries also. The sector through linkages affects about 40 building material industries, support investment and growth climate and helps reduce poverty by generating income opportunities for poor household. It provides jobs to about 5.5 per cent of the total employed labour force or to 2.43 million persons, (2.41 million male and 0.2 million female) during 2003- 04 (Khan 2008)

Unfortunately the construction sector is one of the most neglected sectors in Pakistan. It is at low ebb, which can be judged from the fact that per capita consumption of cement in Pakistan is one of the lowest among the developing countries i.e. 72 kgs. (Hassan 2002).

1.4 Construction Industry and Quality Management

Global competition is becoming a greater concern as more countries are allowing the free market model and opening up their borders for investments and trading (Lee 2002). To stay competitive, a company’s fundamental business strategy must focus on strategic advantages through enhancing its business excellence and performance. The business excellence and performance can only be approached through an effective quality management. As pointed out by Temtime (2003), quality management has become an indispensable and a globally pervasive strategic force in today’s turbulent and dynamic business world, and the increasing intensity of global competition has made quality management a prerequisite for business survival. It is generally agreed that companies that pursue sound quality management practices will become more competitive due to business excellence and enhanced performance (Lee 2002).

The quality management with no exception is equally important for the construction industry. There are two aspects of quality of the construction projects, the quality of construction (workmanship, conformity of standards, etc.) and the quality of materials used in the construction. A cheaper building can be built of inferior materials and is likely to be less attractive and less durable. The quality of construction project can not be guaranteed without the quality of materials used.

1.5 Cement Industry of Pakistan

Cement industry of Pakistan is considered to be one of the well established industries in Pakistan. It doesn’t only produce the cement as required by Pakistan but it also export the cement to other countries like, India, Afghanistan Sri Lanka, United Arab Emirates (BOI 2007). The export of the cement is not possible without good quality. The cement industry is growing as indicated by the Board of Investment Government of Pakistan the annual production of cement increased from 9876,000 tons in 2001 to 17112,000 tons in 2005. Research is available on the cement industry with an intention to provide information to investors but no research was found related to quality management and use of quality standards in the cement industry.

1.6 Assessment of Quality Management

Evans and Lindsay (1999) divided quality management into two categories i.e. technical system and managerial system. Technical system of quality management includes the tools and techniques used to implement quality management. There are many tools and techniques which have emerged with the development of quality management. The use of specific tool is an indication of the company's quality management phases as well the priority of the company objectives. As Statistical Process Control (SPC) is a statistical approach for assisting the operators, supervisors and managers to manage quality and to eliminate special causes of variability in a process (Oakland 2003), the initial role of SPC is to prevent product or process deterioration rather than identify product or process deterioration, but Xie and Goh (1999) suggest for its new role to actively identifying opportunities for process improvement. So the use of SPC is an indication that the company is managing the process in a logical way.

The second category on which the quality management can be assessed is managerial system. The managerial system of quality management includes critical factors. There are 27 critical factors of quality management used in the development of the research questionnaires for quality management. Kanapathy (2008) from Sunway University College of Malaysia published a research paper to identify 8 most famous critical factors out of these 27 factors. The research paper concluded, top management commitment, quality information availability, quality information usage, employee training, employee involvement, product/process design, supplier quality, customer orientation.

The purpose of the present research study is to investigate the cement industry in view of implementation of quality management (implementation of QM tools & techniques, implementation of QM critical factors) and to identify strong and weak areas of quality management implementation for the benefit of professionals, academician and future researchers.

1.7 Problem Statement

Quality is a desirable characteristic of all stake holders in construction and more over the key of enhancing GNP and strengthening our economy lies in improving the quality of our goods and services. The construction industry in Pakistan has been struggling with quality issues for many years (Khan et al. 2008). The quality of construction projects is dependent on the quality of materials used.

The materials being manufactured in Pakistan might be of good quality but there is very less research carried out in this field. Some of the research carried out in related fields of construction activities shows that the some of materials being manufactured are of very low quality, In the earthquake of Oct. 2005 more than 60% of block masonry buildings in urban area of earthquake were demolished and the main reason of damage was of low quality of concrete blocks (Naeem and Ali 2005). Cement manufacturing in Pakistan is perceived to be international standard but there is no research available to bench mark the industry.

The certification of ISO 9000 does not guaranty that the quality is continuously assured (Reimann and Hertz 1994). So the certification alone is not an indicator of good quality product till the time other methods are also applied to check the quality management application of the industry.

Quality management can be divided into different phases which came into existence with the evolution of the quality management. Paliska et al. (2007) has divided these phases into Quality Control (reactive approach), Quality Assurance (Proactive approach) and Quality Management System, Total Quality Management and Quality Award. Each phase has its characteristics by which it can be identified. If a particular industry is benchmarked with regard to quality management phase it's level of implementation can be helpful to predict the quality of product.

As quality management (QM) cannot be practiced effectively and objectively without using a set of tools and techniques (Ahmed and Hassan 2002), so the precision will be more if the research identifies the phase of quality management implementation with quality management tools and technique in practice. There are 8 famous critical factors out of 27 factors used in different research papers for the implementation of quality management or quality culture of the companies. So for the best, industry benchmarked with respect to quality phase, tools and techniques and quality culture will give in detail insight about the quality management implementation.

In conclusion there is no research available on cement industry of Pakistan about the quality management standards in use which are indicators of the quality of product.

1.8 Objectives of the Research Study

Quality management is important for the survival of the industry. In Pakistan, "Pakistan Standards and Quality Control Authority (PS&QCA)" came into operation on 1st December 2000 (www.psqca.com.pk). One of its functions was to promote the standards and conformity assessments. This shows that Pakistan knows the importance of quality and has taken the steps to address the issue. The quality aspect in Pakistan is improving but it can't be ascertained from the information available on the Pakistan Standards and Quality Control Authority website.

This research study will be mainly addressing the below given objectives:

1. To assess the awareness of quality management in cement industry to identify the weak areas of awareness so the industry can improve those areas for better implementation of quality management.
2. To establish the level of implementation of quality management in the cement industry that can be used as bench mark for other construction material industries.
3. To identify the weak and strong areas of quality management in the cement industry so the industry can capitalize on strong factors and pay attention to weak areas to improve their quality management.

1.9 Scope and Limitation of Research

Quality management is a vast subject and most of the research is available on new concepts of the quality management like, Total Quality Management, Six-sigma, Effectiveness of ISO 9001 etc. This research will focus on implementation of quality management and will address all aspects of quality management without going in detail of every aspect.

1.10 Outline of Thesis

The present research study is an effort to benchmark the cement industry in light of technical system and managerial system of quality management. The study includes six chapters, Introduction, Literature Review, Manufacturing Process of Cement, Research Methodology, Results and Discussions and at last Conclusions and Recommendations.

In chapter one the importance of construction industry for the development of country is discussed in addition the importance of quality for the construction project in view of construction materials is also elaborated. The chapter also covers the reasons those lead to the need of assessing the quality management of cement industry. In first chapter objectives of the research are also outlined.

Chapter two includes the review of literature related to quality management and two systems (technical system and managerial system) of quality management are discussed in detail. The third chapter of this thesis is on manufacturing process of cement which includes the process of cement from raw materials and standard specifications of Pakistan standards. It also incorporates the standard tests methods of the Pakistan standards. The fourth chapter of thesis is research methodology in which size of sample is established and design of questionnaire is carried out. It also discusses the method of carrying out research survey and techniques implied in analysis. Chapter five contains results of the research and discussion on the results.

The last chapter of thesis concludes the results and gives recommendations to improve the exiting level of quality management of cement industry of Pakistan. In addition this thesis contains, covering letter, questionnaire, coding of variables, data in SPSS and list of respondents given in the appendices from appendix A to appendix F.

CHAPTER 2

LITERATURE REVIEW

2.1 Quality Management (QM)

Quality management is the term being used now days have roots in late nineteenth century when F. W. Taylor introduced simple inspection of finish goods (Ahmed et al. 2002). This inspection followed a successive change by changing the concept of quality from the product meeting the specification to the whole cycle of design, production, use and disposal (Crosby 1980; Deming 1982; Ishikawa 1985;Feigenbaum 1991; Payne et al. 1996). In 1969 the first international conference on quality control was held in Tokyo, in which a paper presented by Feigenbaum the term total quality was used for the first time and referred to wider issues like, planning, organization and management. United States imported the modified form of total quality control from Japan in 1970s and appreciable training and implementation was undertaken in the following decades in the private sector (Melan 1998). Later this term total quality control changed to total quality management. These are parts of quality management development process (Paliska 2007) as given in Fig. 2.1.

Fig. 2.1. Parts of Quality Management Development Process (Paliska 2007)

Musa (1999) classifies the organizations with respect to quality management into following four categories.

i. Quality control oriented organizations
ii. Quality assurance oriented organizations
iii. Continual quality improvement oriented organizations
iv. Perfection champion oriented organizations

2.1.1 Quality control oriented organizations

Quality control oriented organizations consider laboratory and testing of products as the main activity of quality management. These organizations invest in developing their quality control labs and departments for quality management. The primary focus of quality control departments is to carry out standard tests and identify the nonconformities. The nonconformities identified are treated as defects and are removed or minimized. The defects in the products are considered inevitable but these organizations have not designed any formal mechanism to prevent these defects to happen. Quality control department is considered responsible for the quality and other departments only react to reported defective quality. Most manufacturing companies in Pakistan, and in other developing countries, usually fall under this category.

2.1.2 Quality assurance oriented organizations

Quality Assurance oriented companies understand that a product is the result of many processes; and unless these are controlled effectively, quality can not be delivered. These organizations adapt a system that prevents the defects to happen at first place. The responsible of quality is not only of the quality control department but whole organization is considered responsible.

ISO 9000 Standards are basically Quality Assurance Standards. These companies, therefore, try to standardize their core processes, and use Internal Audits to check this. The present popularity of ISO 9000 in Pakistan is essentially an era of up-gradation of companies from Quality Control to Quality Assurance. Most of the companies which implement these standards now realize the importance of Quality Assurance and usually accept it as an essential element of their quality management activity.

2.1.3 Continual quality improvement oriented organizations

Continual quality improvement oriented companies further realize that process improvements are directly proportional to the competence, commitment, and teamwork of employees at all levels. For them, mere conformance to the defined specifications is not enough to compete with the competitors. Each passing day requires Continual Performance Improvement at all levels, functions, and systems of organizations. Quality concept changes from quality of product to performance improvement of organization. ISO 9000 becomes insufficient for this level. Such organizations mobilize company-wide campaigns for developing skills of quality management at all levels, up to workers. Various TQM tools are taught and then practiced; a shadow organization of quality teams emerges; teams structures are developed and quality assignments are given and taken on daily and weekly basis. Each supervisor, section incharge and departmental head addresses every process in detail and improve them with his/her own departmental teams. A special culture evolves through people equipped with TQM tools, skills, and commitment. These companies focus on involvement and mobilization of all employees rather than any one person or department. Few companies fall under this category in Pakistan.

2.1.4 Perfection champion oriented organizations

Perfection champions companies are the global champions and dominate markets with their products and services. They have mature quality culture. They show long term survival and are also technologically advanced in introducing new products before their competitors. Others companies imitate them. In addition to quality improvement, they also set trends in R&D. These organizations show their superiority in the management as well as technological skills and resources. They provide benchmarks to others. Perfection here does not refer to absolute perfection in products. It is the complete satisfaction and trust of markets in their products and organizations. Their management practices are highly effective and efficient. No organization in Pakistan is presumably under this category.

2.2 Quality Management Tools

Policy alone is not adequate for QM, e.g., if the defects in the product or process can not be identified and reduced to acceptable level, the performance of the process or the quality of product is uncertain. On the other way if there is no tool to prevent the mistakes there is probability that mistake will happen. If the quality of product is not continually improved survival of the product in the market will be difficult.

The certification of ISO 9000 does not guaranty that the quality is continuously assured (Reimann and Hertz 1994). Ahmed et al (2002) has summarized some techniques as given in the following paragraphs. These techniques signify the importance of systematic and objective analyses, and thus the need of QM tools, have been felt more and a range of new tools has been developed.

A systematic and structured QM with the aid of relevant tools and techniques must be in action with regard to continuous improvement. One of the most important applications in manufacturing (or for industrial engineers) is Statistical Quality Control (SQC). As it is not practical to check each and every product or process continuously to meet the end results. Statistical Quality Control is a broad term which further can be divided into Subcategories based on the method used, descriptive statistics, statistic process control, acceptance sampling. Statistical Process Control (SPC) is the primary and one of the best techniques for controlling and improving product or service quality methodically, which is applicable for any type of organization.

The basic Statistical Process Control (SPC) tools are Pareto diagrams, cause-and-effect diagrams (fishbone or Ishikawa diagrams), check sheets, graphs, histograms, control charts (CCs), and scatter diagrams (Besterfield et al. 1999; Dale and Shaw 1999). These are not all really statistical. Dale and Shaw (1999) termed them as seven quality control tools or QC7. Including the process flow chart or process mapping these are the seven basic and simple statistical tools (Rao et al. 1996; Spring et al. 1998). From the point of presentation of data on a process, tools can be classified as graphical tools and flow diagrams. In the former class there are histogram, stem-and-leaf diagrams, line charts, bar charts, pie charts, run or time series charts, control charts (CCs), and Pareto diagrams, and in the latter class there are flow diagrams, process flow charts, cause-and-effect diagrams, and tree diagrams. To facilitate data collection and summarization, tools like check sheets, location plots, and data tables are used. These basic quality control tools are powerful and acceptable for analyzing Quality Management (QM) aspects.

To the top management of an organization, the use of hard data is a matter of exception, what Taylor in nineteen century phrases “theory of exception”. It mostly needs exceptional objective information and general subjective information. Some of the relevant management tools associated with quality management (QM) are force-field analysis, nominal group technique, affinity diagram, interrelationship diagram, tree diagram, matrix diagram, prioritization matrices, process decision program chart (PDPC), and activity network diagram (PERT, CPM, arrow diagram, AON) (Besterfield et al. 1999), to generate and treat soft data. Dale and Shaw (1999) listed them under M7, namely, affinity diagrams, relation diagrams, systematic diagrams, matrix data analysis, PDPCs, and arrow diagrams. According to Rao et al. (1996), the advanced tools are brainstorming, affinity diagrams (or structured brainstorming), process potential index Cp, process performance index Cpk, Taguchi’s loss function, and design of experiment (DoE). Antony et al. (1998) suggested a “successful” methodology to the use of advanced statistical quality improvement techniques. The fundamental techniques for presenting performance measures are time series graphs, control charts (CCs), capability indices, Taguchi’s loss function, cost of poor quality, and quality award criteria (Besterfield et al. 1999).

In processing a large volume of data associated with customer expectations and needs, numerous tools such as affinity diagrams, tree diagrams, why-why diagrams, interrelationship diagrams, and cause-and-effect diagrams are suited. The process capability indices, Cp and

Cpk, are the essential pieces of information because they indicate the propensity of a manufacturing process of respecting the product specifications. The Quality Function Deployment (QFD) is a powerful planning and product design technique in translating customer survey and case investigations needs and manufacturing constraints into product attributes and specifications. It successfully covers the areas like product design, engineering and production requirements, and product evaluation. Besterfield et al. (1999) maintain that, if an organization can properly implement QFD, it can improve engineering knowledge, productivity and quality, and reduce manufacturing costs, product development time, and engineering changes.

A systematic approach can yield very significant benefits in the long run. Deming's plan-do-study/check-act (PDSA/PDCA) is an excellent technique in monitoring and problem solving for continuous quality improvement where any brilliant ideas of individuals can be accommodated. However, to apply this properly, a good number of other tools and techniques are inviting. In other words, it integrates a few essential tools and techniques. In fact, any tool or technique should not be taken in isolation for use without a strategic disposition. Figure 2.2 defines the systematic use of various tools in different Operational stages.

"Do-it-right-the-first-time (DRIFT)" is the fundamental slogan of QM/TQM. For that, quality is required to be introduced at the design level. The tools that have direct linkage with the introduction of new products are QFD, DoE, FMEA, and fault tree analysis (Spring et al., 1998). Numerous other tools and methods such as Computer Aided (product/process) Design (CAD), computer Aided Manufacturing (CAM), Electronic Data Exchange (EDE), Total Productive Maintenance (TPM), 5Ss housekeeping, Finite Element Analysis (FEA), Design for Manufacture and Assembly (DFMA), Just-in-Time (JT), Computer Numerical Control (CNC), and Computer Integrated Manufacturing (CIM) are the modern ones.

The roles and benefits of those tools and techniques are explained in literature contributed by Antony et al. (1998), Besterfield et al. (1999), Dale and Shaw (1999), Motwani (2001), Powell (1995), Rao et al. (1996), Summers (2000) and Xie et al. (2001). The detail on role and benefits can be found in the literature. However, a few points in this regard are given below. The functions and activities of a manufacturing firm can be related to the following tools and techniques.

- New product introduction – brainstorming, DoE, QFD, cause-and-effect diagram.
- In stage of production – Pareto chart, process flow diagrams, control chart.

- In assessing the process or product – histogram, scatter diagram, pie chart, bar chart, etc.
- In every stage of data collection – check sheet or check list, capability indices, etc.

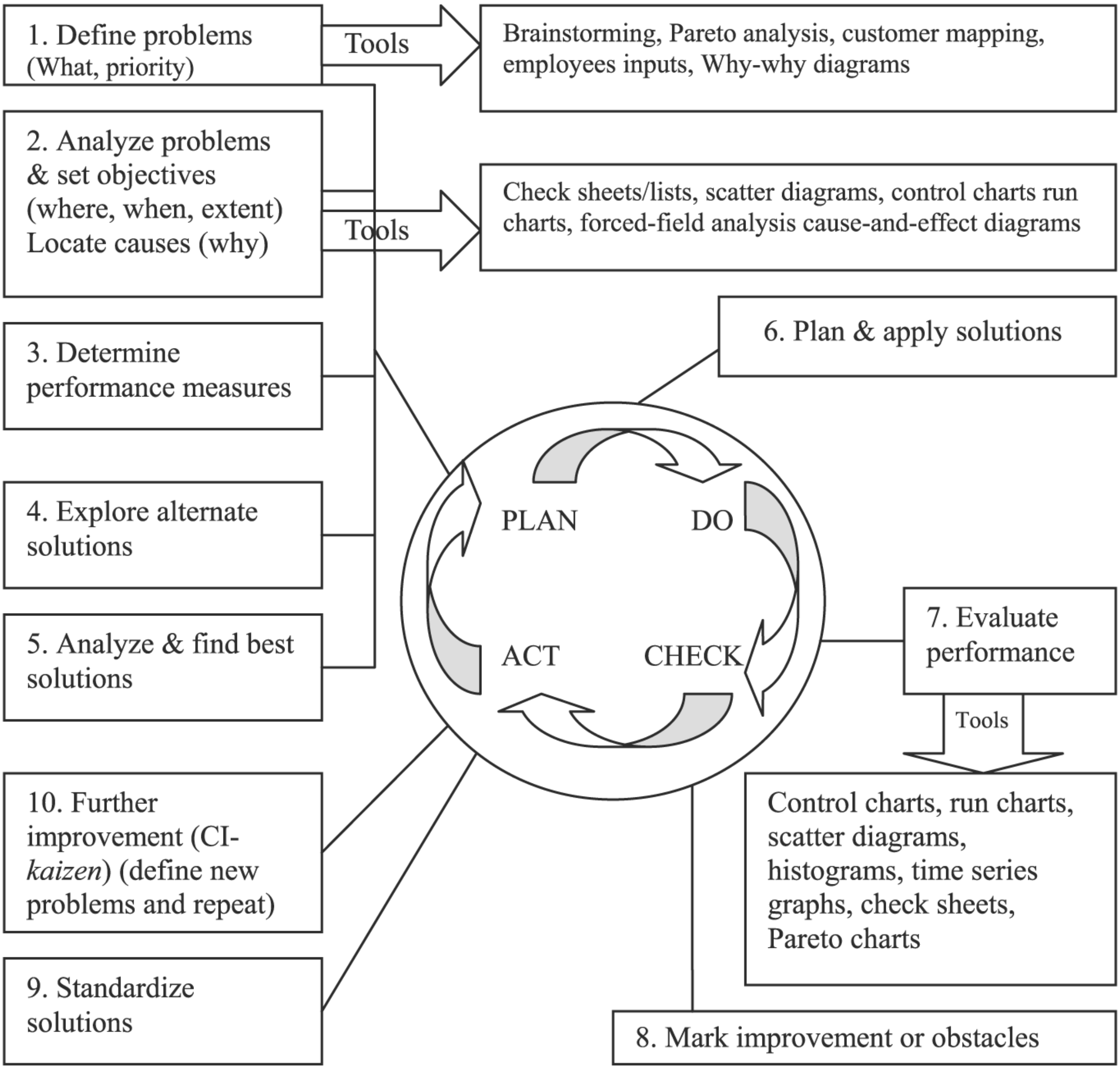

Fig.2.2 Steps in Application Deming's PDCA Technique and Associated Tools (Ahmed et al. 2002)

If applied correctly, they can provide repeatable and reliable results (Dale and Shaw 1999). The basic tools make quality improvement and monitoring activities, and giving feedback to quality improvement team (QIT) much easier (Rao et al. 1996). Essential to industry is to understand the distinction between a stable process and an unstable process. This is possible by developing CCs. The most powerful CCs are r- and x-bar charts (Duncan, 1974), which can be used jointly to present complex performance data in a simple form (Burney and Al-Darrab 1998) to show the case management from special causes (Walsh

2000) or training and development needs. Firms using more advanced tools can perform better than firms with less advanced tools (Powell 1995).

The choice of any tool or method is not just automatic, rather situation specific. One thing should be said in clear terms: tools are not to solve the existing or would-be problems, but to use as means of identifying the problems or strengths in specific terms through systematic manners. Therefore, the users must understand the applicability of a particular tool before being applied.

2.3 Critical Factors of Quality Management

The process of improving the performance of organizations is presently called Total Quality Management (TQM). The implementation state of this process is generally known as Quality Culture. A good quality culture, therefore, represents a good implementation state, and a bad quality culture implies a poor implementation of the TQM process. Even poor companies have a few high level characteristics and vice versa.

Ahire, Golhar and Waller (1996) defined constructs as latent variables, which cannot be measured directly. However, critical factors or constructs can be measured indirectly from their manifestations. For example, customer focus is a critical factor that cannot be measured directly. However, when a company is customer-focused, manufacturing managers will be aware of the results of customer satisfaction surveys. Thus, manufacturing managers being aware of customer satisfaction surveys can be one of the manifestations of the critical factor customer focus.

The development and validation of critical factors of quality management have been reported by established international researchers such as Saraph, Benson and Shroeder (1989), Flynn, Schoeder and Sakakibara (1994), Ahire, Golhar and Waller (1996), Black and Porter (1996), Zeitz, Johannesson and Ritchie Jr. (1997), Joseph, Rajendran and Kamalanabhan (1999) and Rao, Solis and Raghunathan (1999).

According to Sila and Ebrahimpour (2003), the critical factors of quality management were first utilized by Saraph et al. in 1989. Saraph et al. (1989) developed a quality management instrument, identifying 8 critical factors of quality management. These factors are top management support, quality reporting (which includes quality information availability and quality information usage), employee training, employee involvement, product design, supplier quality, process management and role of quality department. Sila and Ebrahimpour (2003) highlighted that the same critical factors were later used by Motwani, Mahmoud and Rice (1994), Badri and Davis (1995) and Quazi, Jemangin, Kit and

Kian (1998). These researchers had reported the instrument used by Saraph et al. as valid and reliable (Motwani et.al. 1994; Badri et al. 1995; Quazi et al. 1998 as cited in Sila and Ebrahimpour 2003). Flynn et al. (1994) developed 7 critical factors of quality management while Ahire et al. (1996) developed 12 critical factors. In addition, Black and Porter (1996) developed critical factors of quality management, Zeitz et al. (1997) developed 7, whereas Joseph et al. (1999) developed 10. Rao et al. (1999) made a significant contribution by developing and validating a measurement instrument for international quality management research which consisted of 13 critical factors of quality management.

A total of 27 different critical factors of quality management were developed and utilized by the 7 groups of established researchers who conducted research in different parts of the world. However, researchers in the field are unable to make a good comparison of the research findings in various countries due to the disparity in the critical factors used in the research instruments. This notion is supported by Sila and Ebrahimpour (2003). One or more researchers have discussed each of the critical factors. Each researcher, in his or her notion, discussed the properties of each critical factor. Out of the 27 different critical factors developed by the researchers, 8 were found to be the most popular critical factors; that is, 4 or more than 4 groups of researchers developed and utilized these critical factors in their research. These 8 critical factors, ranked from the highest level of popularity to the lowest level of popularity are:

(a) Top management support

(b) Quality information availability

(c) Quality information usage

(d) Employee training

(e) Employee involvement

(f) Product/process design

(g) Supplier quality

(h) Customer orientation

Recently, Hokoma et al. (2010) used a different way to measure the total quality management (TQM) implementation in the cement industry of Libya. In this study, the authors used key element of total quality management for its measurement.

CHAPTER 3

MANUFACTURING PROCESS OF CEMENT

3.1 Cement Manufacturing Process

3.1.1 Type of process of cement manufacturing

The portland cement is manufactured through three types of processes. dry process, semi wet process and wet process. Pakistan cement industry employs dry process for the manufacturing of cement.

3.1.2 Raw materials

The major raw materials required for the manufacturing of the Portland cement are limestone and clay/shale. Before the blasting the rock from queries are analyzed to evaluate the suitability of the raw material for the Portland cement manufacturing. If the materials are of appropriate quality then are blasted and carried to the cement plant.

3.1.3 Crushing of raw materials

The raw materials are brought to secondary crushers where all the materials are crushed separately so that the maximum size of particle is no more than the size of the tennis ball. They are piled and samples are taken to analyze the content of minerals if necessary some minerals are added.

3.1.4 Preparation of raw meal

The semi crushed raw materials from the secondary crushers are fed into the tertiary crushers where they are crushed fine and fed into the raw mill for blending. The out put of raw mill is raw meal. The samples are taken of raw meal to check the composition and adjusted if required. This raw meal is stored in the raw meal silo.

3.1.5 Preparation of clinker

The raw meal passes through different chemical reaction in kiln and come out in the form of the clinker. Clinker is cooled in the clinker cooler and stored. The samples of clinker are taken to check the quality of clinker.

3.1.6 Preparation of portland cement

The clinker is crushed in the cement mill with the desired amount of gypsum to prepare the cement and stored in the cement silos. The samples of cement are also taken to analyze if it meets the requirements of the Pakistan standard. A process flowchart of manufacturing of cement is given in Fig. 3.1.

3.2 Pakistan Standard Specifications for Portland Cement

The Pakistan Standards and Quality Control Authority (PSQ &CA) has revised cement standard in 2008 (PS: 232-2008(R)) which were initially prepared in 1962 and revised in 1983. The PS&QCA standards are given in Table 3.1.

3.3 Standard Procedures for Conducting Physical Tests

Pakistan standards for cement PS-232 (2008) (R) gives standard procedure for the following tests:

a) Fineness of cement

b) Compressive strength of cement

c) Setting time of cement

d) Soundness of cement

3.3.1 Fineness of cement

3.3.1.1 Test principle

The fineness of cement is determined by a procedure giving specific surface expressed as total surface area in square metres per kilogram. The following apparatus is required to carry out the test for fineness of cement.

I) Permeability cell

The permeability cell (Fig. 3.2) consists of a metal cylinder made in two flanged parts which are bolted together, containing a perforated plate on which is supported a medium filter-paper 32 mm in diameter. The joint between flanges is rendered airtight by means of rubber or other suitable gasket.

The permeability cell is provided with plunger by means of which the cement sample is formed, as described below, into a cylindrical bed supported by the filter paper.

THE PROCESS FLOW CHART OF ONE OF THE COMPANIES VISITED

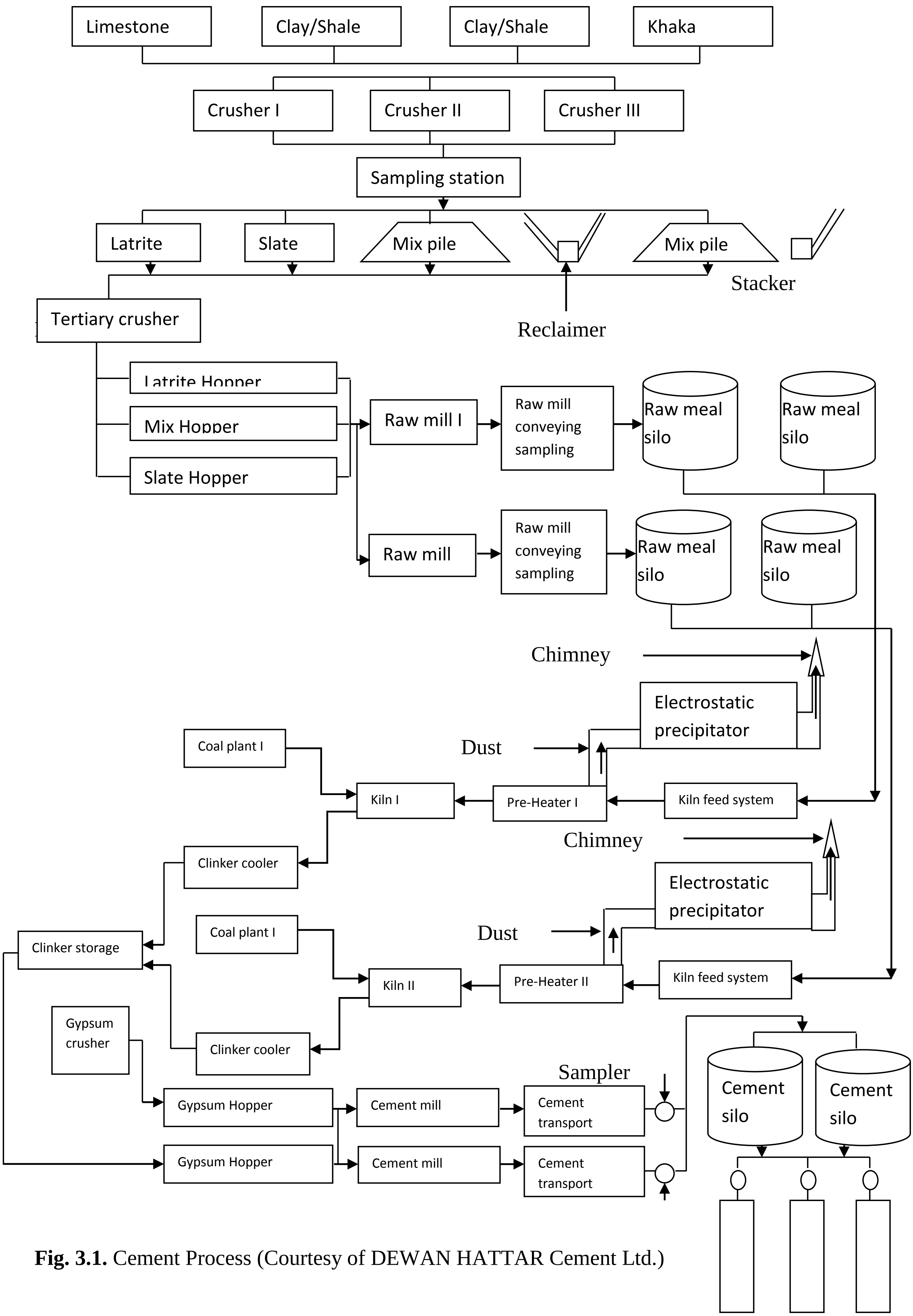

Fig. 3.1. Cement Process (Courtesy of DEWAN HATTAR Cement Ltd.)

Table. 3.1: Pakistan Standard Specifications for Portland Cement

Characteristics	**Not less than**	**Not more than**	**(Tricalcium aluminate 5% or less)**	**(Tricalcium aluminate more than 5%)**
Fineness	225 m2/kg			
Lime saturation factor	0.66	1.02		
Insoluble residue		1.5%		
Magnesia		4%		
Sulphuric anhydride			2.5	3
Loss on ignition		3% (for temperate climates) 4% for tropical climates		
Compressive strengthen	2200 psi of 3 days 3400 psi of 7 days 5000 psi of 28 days			
Initial setting time	45 min			
Final setting time		10 h		

The essential dimensions are given below:

Internal diameter of upper of cylinder	D = 25.00±0.03 mm or
	D = 25.40±0.03 mm
External diameter of plunger	D = 0.05 or mm 0.08
Depth of bed space when plunger is fully inserted	D = 10.00±0.03
Depth of recess in lower part of cylinder	1.6 ± 0.3 mm
Thickness of perforated plate	1.6 ± 0.03 mm

The perforated plate is a push fit in the recess.

II) Manometer and balance

The permeability cell is to be connected to a bed manometer and a flowmeter manometer as shown in Fig. 3.2. The arms of the manometer and of the flowmeter are about 600 mm long. The capillary tube of the flowmeter shall have a bore of not less than 0.5 mm and its dimensions shall be such that the flowmeter constant "C" is between 20×10^{-12} and 40×10^{-12} metric units. The liquid in both U-tubes is kerosene (paraffin oil). The necessary airflow may be produced by any convenient means, but the air entering the apparatus is to be dried by passing a through tower pecked with a suitable desiccant, e.g. silica gel.

The apparatus described above should be regarded as standard, alternative forms of air permeability apparatus may also be used provided they have been calibrated against the standard apparatus. A balance capable of weighing up to at least 10 grams to an accuracy of ± 0.0005 grams is required for the test. The following preparation is required for the test.

3.3.1.2 Preparation

I) Checking of the dimensions of the permeability cell

Check the dimensions of the cell when the apparatus is received, and after every 50 determinations, by suitable means. The depth of the bed space may be conveniently measured by using a test piece of hardened steel, of diameter D 0.2 mm and 10.10±0.03 mm deep to simulate the cement bed. Place the test piece on the filter-paper in the cell, insert the plunger and check with a feeler gauge that the gap between the shoulder of the plunger and the top of the cell is 0.10±0.03 mm.

II) Determination of the flow meter constant

Check the flow meter constant every three months. Pass dry air through the flow meter at a constant rate for a measured time interval. Collect the issuing air over kerosene and measure its volume. Note the flow meter reading. Calculate the flow meter constant "C" as follows:

$$C = \frac{Vn}{Th_2PL} \quad .... \quad 3.1$$

Where

V is the volume (in ml) of dry air passed

n is the viscosity (in Ns/m^2) of air at the calibration temperature

T is the time (in s) during which air is collected

h_2 is the flowmeter reading (in mm)

PL is the density (in Kg/m^3) of the Kerosine at the calibration temperature.

The viscosity of air in n s/m^2 at temperatures in the range of 15 ^oC to 25 ^oC is shown below multiplied by 10^6.

Temp. ^oC	15 to 16	17 to18	19 to20	21 to22	23 to	25 24
Viscosity	17.8	17.9	18.0	18.1	18.2	18.3

Repeat this process for five flowmeter readings over the range of 250 mm to 550 mm.

Calculate the average value of C and express the result o to the nearest 0.1 x 10^{-12} metric units.

III) Calibration of the apparatus

Calculate the value of K for each apparatus as follows and express the result to the nearest 10mm

$$K = \frac{14}{d(1 - \epsilon)} \sqrt{\frac{\epsilon^3 A}{CL}} \qquad \ldots\ldots\ldots\ldots \quad 3.2$$

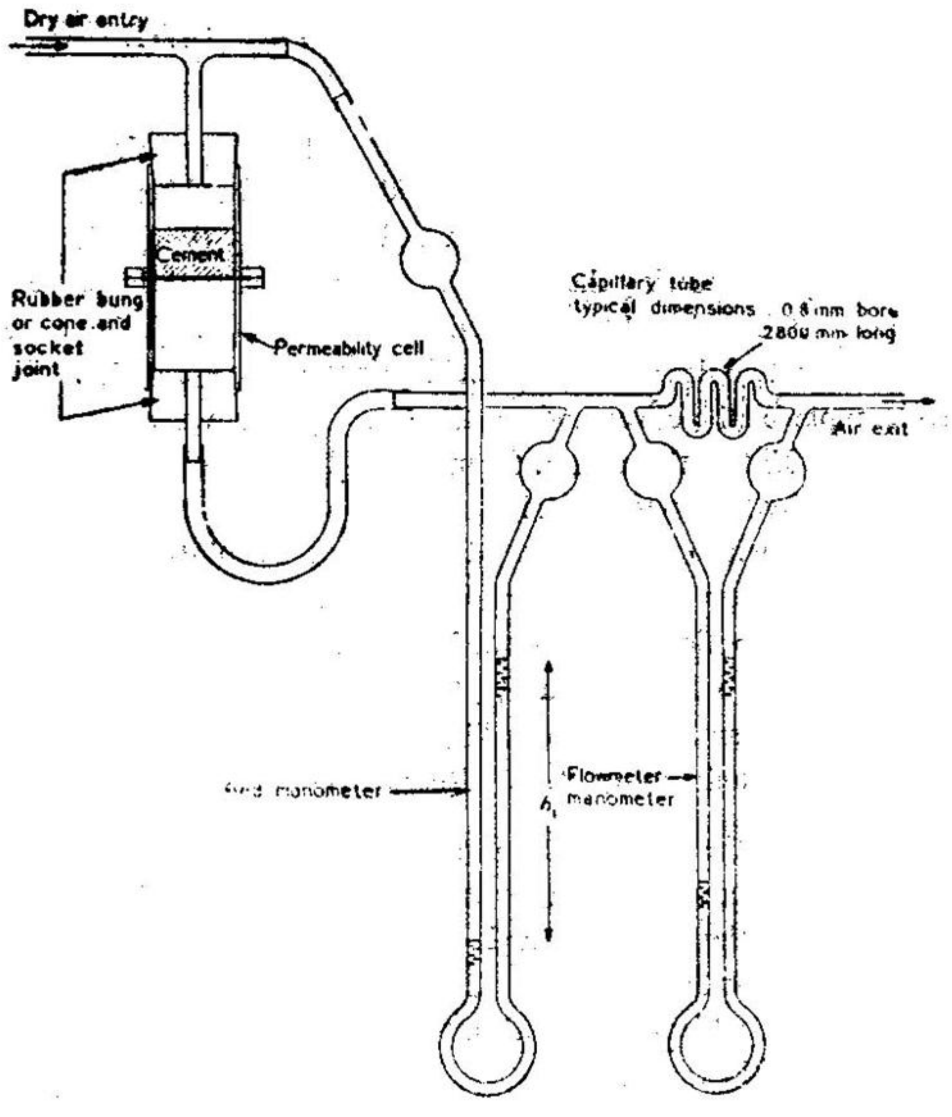

Fig. 3.2 Typical Permeability Apparatus with Manometer and Flowmeter (Pakistan Standard-232)

Where

Є	is the porosity, i.e., 0.475
A	is the area (in mm^2) of the cement bed.
L	is the depth (in mm) of the cement bed.
d	is Density of cement
C	is the flow meter constant.

For apparatus

D = 25.00 mm	25.40 mm
A = 490.9 mm^2	506.7 mm^2
L = 10.00 mm	10.00 mm
K = 612	612

IV) Assembling and testing of the apparatus

Change the filter-paper after every determination. In reassembling the permeability cell ensure that the two parts are firmly bolted together and test the cell and its connections for leakage.

This is best done by disconnecting at the manometer the rubber tube leading from the lower end of the cell, sealing the tube with a screw clip, applying air pressure until the monometer shows a difference in level of at least 500 mm and then sealing off the air inlet. The reading of the monometer should not change by more than 0.5 mm in a period of 1 min.

3.3.1.3 Procedure

Select a mass of cement from table 3.2 for a 25.00 mm cell or from table 3.3 for a 25.40 mm cell which, when compacted, will give a porosity of 0.475 at the measured density of the cement. (The porosity is defined as the ratio of the volume of pore space to the total volume of the bed). Weigh the cement to ± 0.0005 g and brush it into the permeability cell, which is gently shaken from side to side to level off the surface. If the cement is lumpy it may first be rubbed gently with a spatula on glazed paper.

Compact the contents by allowing the cell to fall four time from a height of about 10 mm on the bench. Next, slowly insert the plunger and push it home so that the shoulder of the plunger is in contact with the top of the permeability cell. Do not twist the plunger while in contact with the cement surface but slowly withdraw it with a twisting motion. If, on inspection, the cement bed is seen to be disturbed, knock the sample out and repeat the operation with a fresh sample.

Table 3.2: Mass of Cement (in g) Required to Form a Bed 25.00 mm in /diameter and 10.00 mm Deep having a Porosity of 0.475 over Density Range 2800 kg/m^3 to 3290 kg/m^3

Density Kg/m^3	0	10	20	30	40	50	60	70	80	90
2800	7.216	7.247	7.267	7.293	7.319	7.345	7.370	7.396	7.422	7.448
2900	7.474	7.499	7.525	7.551	7.577	7.602	7.628	7.654	7.680	7.705
3000	7.731	7.757	7.783	7.809	7.834	7.860	7.886	7.912	7.937	7.963
3100	7.989	8.015	8.040	8.066	8.092	8.118	8.144	8.169	8.195	8.221
3200	8.242	8.272	8.298	8.324	8.350	8.376	8.401	8.427	8.453	8.479

Insert the upper bung and slowly turn on the air and insert the lower bung slowly and carefully in order to avoid forcing air through the cement in the wrong direction. Adjust the rate of airflow until the flowmeter monometer shows a difference in level of 300 mm to 500 mm. When the levels are constant, indicating that steady conditions have been obtained, take readings of the difference in level h_1 of the bed monometer and of the difference in level h_2 of

Table 3.3: Mass of Cement (in g) Required to Form a Bed 25.40 in Diameter and 10.00 mm Deep having a Porosity of 0.475 over Density Range 2800 kg/m^3 to 3200kg/m^3

Density Kg/m^3	0	10	20	30	40	50	60	70	80	90
2800	7.449	7.475	7.502	7.528	7.555	7.582	7.608	7.635	7.661	7.688
2900	7.715	7.741	7.768	7.794	7.821	7.848	7.874	7.901	7.927	7.954
3000	7.981	8.007	8.034	8.060	8.087	8.114	8.140	8.167	8.193	8.220
3100	8.247	8.273	8.300	8.326	8.353	8.380	8.406	8.433	8.459	8.486
3200	8.513	8.539	8.566	8.592	8.619	8.646	8.672	8.699	8.725	8.752

the flowmeter monometer. Repeat these observations at a different airflow rate within the above range.

3.3.1.4 Calculation

Calculate the average value of the ratio h_1/h_2. Calculate the specific surface, S_w, as follows and express the result to the nearest 5 m^2 / kg.

$$S_w = \sqrt{K \frac{h_1}{h_2}} \qquad \text{.................. } 3.3$$

Where

K is the constant of the apparatus

$h_{1/}h_2$ is the average ratio of the monometer readings

3.3.2 Compressive strength of mortar cubes

3.3.2.1 Test principle

The strength of cement is determined by compressive strength tests on 70.7 mm mortar cubes, made with specified sand, mixed by hand and compacted by means of standard vibration machine. The following apparatus is required.

I) Mould and trowel

The moulds shall be 70.7 mm cubes, the area of each face being 5000 mm. The trowels shall have a cast steel blade. The procedure and requirements for the construction and tolerances iof the mould is as follows.

1. Construction

The mould shall be of metal that is not attached by cement mortar and rigid enough to prevent distortion. It shall be constructed in such a manner as to facilitate the removal of the moulded specimen without damage. The parts of the mould, when assembled, shall be positively and rigidly held together, by suitable means, both during the filling and on subsequent handling of the filled mould. Each mould shall be provided with a steel base plate to support it without leakage. The weight of the mould and base plate shall be such as to comply with the requirements given in 1.3.3, for the mass of the machine. The mould shall be such that, when assembled ready for use, the dimensions and internal faces are accurate within the following limits.

(a) Dimensions

The depth of the mould and the distance between either pair of opposite internal faces, each based on the average of four symmetrically placed measurements, is 70.7 ± 0.1 mm. The surface of each internal face shall lie between two parallel planes 0.5 mm apart which are perpendicular to the bottom surface of the mould and also to the adjacent internal faces.

(b) Flatness

The surface of each internal face shall lie between two parallel planes 0.03 mm apart. The Joints between the sections of the mould and between the bottom surface of the mould and the top surface of the base shall lie between two parallel planes 0.06 mm apart.

II) Vibration machine

The vibration machine shall consist of a table mounted on coil springs to carry the cube mould, and a revolving shaft provided with an eccentric. By means of a balance weight beneath the base plate attached rigidly to the table, the centre of gravity of the whole machine, including the cube and mould, shall be brought either to the centre of the eccentric shaft or within a distance of 25 mm below it. In consequence of this, the revolving eccentric imparts an equal circular motion to all parts of the machine and mould, this motion being equivalent to equal vertical and horizontal simple harmonic vibration 90^{o} out of phase.

The minimum running speed of the machine shall be well above its natural frequency on its supporting springs, so that the amplitude of vibration is supporting springs, so that the amplitude of vibration is independent of the speed. The motor shall be preferably of the synchronous type and the drive is by means of an endless belt running on a crowed pulley on the motor and a crowned pulley on the vibrator. The machine shall be provided with a suitable clamp to hold the assembled mould firmly on the table, and with a suitable hopper to facilitate filling of the mould.

The machine shall be constructed to comply with the following essential requirements.
Mass of machine on its supporting springs (excluding mass of solid eccentric but excluding mass of mould, mould clamp, hopper and cube) 29 Kg approx.

Out-of-balance moment of eccentric shaft	0.016 N m
Normal running speed of eccentric shaft	12000 ± 400 r/min

III) Tank and compression testing machine

The tank shall contain clean top water which shall be renewed at least every seven days with water at the specified temperature. The compression testing machine shall be of suitable capacity for the test. It shall be capable of applying load at the rate specified given in the standard.

3.3.2.2 Temperature and humidity conditions

The temperature throughout the entire test procedure shall be controlled about a midpoint of 20^{o}C with permitted variations as shown in table 3.4. The minimum relative humidity shall be as given in table 3.4. Before use, all materials, moulds and other appliances shall be brought to the same temperature as the air in the mixing room, by storing them in the room for a sufficient time.

The specimens shall be prepared by making three cubes for testing at each of the specified ages. The sand shall comply with the requirements of Pakistan Standard. The mass (es) of cement, sand and water for each cube are given in table 3.5.

Table 3.4: Temperature and Humidity Conditions

Situation	Permitted temperature variation	Minimum relative humidity
	^{o}C	%
Mixing room	± 2	65
Moist curing chamber	± 1	90
Water curing tank	± 1	---
Compression testing room	± 2	50

3.3.3 Standard test procedure for cement consistency

3.3.3.1 Test principle

The quantity of water required to give a cement paste of standard consistence is determined by using the vicat apparatus. This quantity of water gives the water content of the pastes for the determination of settings times and soundness test.

For high alumina cement this test is not carried out and a value of 22% is assumed.

3.3.3.2 Apparatus

I) Mould

The mould (Fig. 3.3) consists of a split ring (E). It shall have an internal diameter 80.0 ± 0.1 mm and a height of 40.0 ± 0.5 mm. The mould rests on a non-porous plate which is lightly greased. A metal plate 3 mm thick is suitable.

To ensure interchangeability of the clamping rings, the external diameter at the base of the mould shall be 89.0 ± 0.1 mm with a taper of 2^{o} on the side. Total taper shall be 4^{o} inwards from base to top. The outer clamping ring is similarly tapered. When assembled,

Table 3.5: Mixes for Mortar

Mix type	Material	Proportions by mass	All cements other than high alumina cement : mass
VI			g
	Cement	1.0	185 ± 1
	Sand	3.0	555 ± 1
	Water	0.4	74 ± 1
			High alumina cement: mass
V2			g
	Cement	1.0	190 ± 1
	Sand	3.0	570 ± 1
	Water	0.4	76 ± 1

this ring shall be clear above the base of the mould, by a distance of 15 mm to 18 mm.

II) Frame

The frame D (Fig. 3.3) bears a movable rod B supporting a cap A and carrying an indicator which moves over a graduated scale attached to the frame. The other end of the movable rod has a cylindrical hole and knurled screw the suitable for the insertion of various attachments. There shall be a clearance of about 6 mm between the lower end of the attachments, when they are raised, and the top edge of the mould to enable the mould to be located in position without damage to the attachments. The total mass of the moving unit, when in use, complete with attachments, shall be 300 ± 1 g.

III) Plunger and trowel

The plunger G (Fig. 3.3) is of polished brass 10.00 ± 0.05 mm in diameter with a projection at the fitting and for insertion into the movable rod B. Its length shall be 50.1 mm and the lower face is flat. Its mass shall be 9.0 ± 0.5 g. The trowels shall have a cast steel blade.

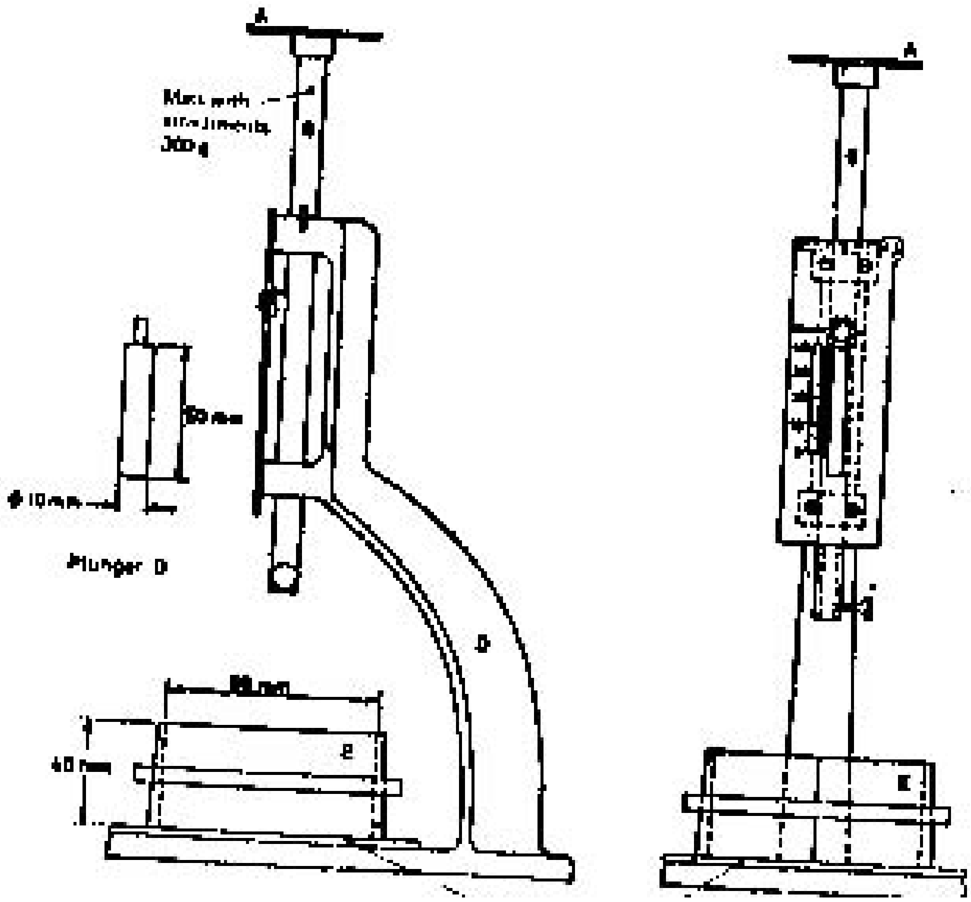

Fig. 3.3: Vicat apparatus for determining standard consistency

(Pakistan Standard-232)

3.3.3.3 Temperature and humidity conditions

Temperature and humidity conditions keep the temperature of the mixing room at 20. 2 ^{o}C and the relative humidity at not less than 65%. Before use, ensure that all materials, moulds and other appliances are at the same temperature as the air in the mixing room by storing them in the room for a sufficient time.

3.3.3.4 Procedure

I) General

Weigh, to ± 1 g, about 400 g of cement and a measured quantity of water. Mix these materials vigorously for 240 ± 5s on a non-porous surface, by means of the two trowels. Fill the mould with the cement paste within the next 15 s in one layer and smooth off the surface of the paste level with the top of the mould as quickly as possible. In filling the mould use gloved hands and the blade of the trowel only. Complete the operation within 255 s from the addition of the water to the cement. Immediately after filling the mould, place it centrally under the movable rod B bearing the plunger G. Lower the plunger gently into contact with the surface of the cement paste, then quickly release it and allow it to sink into the surface. Note the amount of settlement.

II) Determination of standard consistence

Make up trial pastes of varying quantities of water and carry out the procedure specified above, that quantity is found giving a paste which permits the settlement of the plunger G to a point 5.1 mm from the bottom of the mould. Record the quantity of water used.

3.3.4 Standard test procedure for setting times

3.3.4.1 Test principle

The initial and final setting times of cement are determined by using the Vicat apparatus. The Vicat apparatus shall comply with the requirement of the Pakistan standard-232 with initial setting time needle and final setting time needle of following specifications.

I) Initial setting time needle

The initial setting time needle, C, which is round, is made of hardened or tempered steel and shall be of diameter 1.13 ± 0.05 mm. Its effective length, excluding the hilt (fitting end) is 50 ± 1mm and the lower face is flat. Its mass shall be 9.0 ± 0.5 g.

II) Final setting time needle

The final setting time needle, F, is made of the same material and shall have the same mass, shape and section as the needle (C) but it shall be 30 ± 2 mm in length, and be fitted with a metal attachment hollowed out so as to leave a circular cutting edge 5.0 ± 0.1 mm in diameter. The depth hollowed out shall be 0.5 ± 0.1 mm. A vent hole 0.76 mm diameter is provided. The length of projection of the needle beyond the cutting edge shall be 0.5 ± 0.1 mm.

3.3.4.2 Temperature and humidity conditions

The temperature throughout the entire test procedure shall be controlled about a mid point of 20^{o} with permitted variations as shown in table 3.6. The minimum relative's humidity shall be as given in table 3.6.

Table 3.6: Temperature and Humidity Conditions Situations

	PERMITTED TEMPERATURE VERIATION	MINIMUM RELATIVE HUMIDITY
	^{o}C	%
Mixing room	. . . ± 2	65
Moist curing chamber	. . . ± 1	90

3.3.5 Standard procedure for testing of cement soundness

3.3.5.1 Testing principle

The soundness of cement is determined by the 'Le Chatelier' method of measuring its expansion, either after immersion in cold and in boiling water or, for supersulphated cement, after immersion in cold water. The following apparatus is required.

I) Split cylinder and glass plates

Small split cylinder of spring brass or other suitable metal of 0.5 mm thickness, forming a mould 30mm internal diameter and 30 mm high. The inside surface of the mould shall be thinly coated with mould oil. On either side of the split are attached two pointers (AA). The distance from these ends to the centre of the cylinder shall be 165 mm. The split shall be not more than 0.5 mm wide. Two glass plates to cover the mould.

3.3.5.2 Procedure

I) Immersion in cold and boiling water

Using the standard procedure of measuring cement consistency, mix about 100 g of cement with the quantity of water required to give a paste of standard consistency. Place the mould on one glass plate and fill it with the cement paste, taking care to keep the split of the mould gently closed whilst this operation is being performed. Cover the mould with the other glass plate, upon which a small weight is placed. Immerse the whole immediately in water at a temperature of 20 ± 1 ^{o}C and leave there for 24 ± 0.5h.

Then remove the mould from the water. Measure the distance separating the indicator points to the nearest 0.5 mm and again immerse in water at a temperature of 20 ± 1 ^{o}C. Bring the water the boiling point in 25 min to 30 min and keep boiling for 1 h. Next remove the mould from the water and allow the cooling. Again measure the distance separating the indicator points to the nearest 0.5 mm. /the difference between the two measurements represents the expansion of the cement.

II) Immersion in cold water

Using the standard procedure of measuring cement consistency, mix about 100 g of cement with the quantity of water required to give a paste of standard consistency. Place the mould on one glass plate and fill it with the cement paste, taking care to keep the split of the mould gently closed whilst this operation is being performed. Then cover the mould with the other glass plate, upon which a small weight is placed. Measure the distance separating the indicator points to the nearest 0.5 mm. Immerse the whole immediately in water at a temperature of 20 ± 1 ^{o}C and leave there for 24 ± 0.5 h.

Then remove the mould from the water. Measure the distance separating the indicator points to the nearest 0.5 mm. The difference between the two measurements represents the expansion of the cement.

Chapter 4

RESEARCH METHODOLOGY

4.1 Introduction

Research methodology is a systematic way to solve a research problem. Research can be grouped within the boundaries of the research like exploratory research (which structures and identifies new problems), Constructive research (which develops solutions to the problems) etc. more over a research can be quantitative or qualitative depending upon the properties of subject matter and objectives of the study.

This chapter will elaborate the research methodology adopted in the present research study which includes research design, survey sample and design of surveys.

4.2 Research Design

The purpose of research design is to turn the research question into testing project. To achieve the objectives and find answers to the research questions a research approach or method need to be adopted. Researchers' categories the research methods in a variety of ways, the main divide in research methods is made into two broad categories qualitative research and quantitative research.

Quantitative research uses objective measurement and statistical analysis of numerical data, to understand and explain the phenomena. It generally requires a well controlled setting. Qualitative research in contrast, focuses on understanding of social phenomena from the perspective of the human participant in the study.

The non-experimental (qualitative) research is true representation of the real world. In the qualitative research, it is believed that the people assign meaning to the objective world that their valued experiences are situated within a historical and social context and there can be multiple realities. It is concluded that the realities can not be studied independently from their contexts; hence the qualitative methodology is valuable and distinctive.

It is much more useful (and potentially liberating) to see these terms as simply adjectives for types of data and their corresponding modes of analysis i.e. qualitative data, data that is represented through numbers and analyzed using statistics.

Certain questions can not be answered by quantitative methods, while others can not be answered by qualitative one. Thus, the selection of qualitative or quantitative method depends on the demands of particular research. If researcher seek to understand a phenomenon by focusing on the total picture rather breaking it down into variables this effort to get a "holistic picture and depth of understanding" can be called qualitative method of research.

In the present research study to get a holistic picture of the quality management qualitative approach will be adopted. A questionnaire is a good tool to collect data in qualitative research which is mostly done in the social science. As required for this research, a questionnaire was designed after studying research papers by Ahmed et al. (2002) for quality management tools part of questionnaire, for critical factors the research paper by Kanapathy (2008) was consulted.

As per requirement of the questions, the respondents were given either three scale options Yes, No and Don't know or selecting from the choices given in the questionnaire (Apendix C).

Johnson (2003) gives following modes of survey:

i. Personal (Face-to-Face)
ii. Telephone
iii. Mail
iv. Web
v. Combination of all methods

Johnson (2003) also gives comparison of different modes shown in the table 4.1.

First e-mails were selected as mode of survey but after two weeks there was negligible response so mode of survey was changed to phone calls and face-to-face interviews. These modes are costly but fast and precise.

The SPSS (Statistical Package for Social Sciences) and MS-Excel (2007) were used for the analysis of the data (Apendix D and E). A flow chart of research methodology is represented in figure 4.1.

4.3 Survey Sample

Survey sampling describes the process of selecting a sample of elements from a target population in order to conduct a survey. Following sampling methods were employed based on nature and quality, availability of auxiliary information, accuracy requirements, and operational costs of the survey.

Table 4.1: Different Modes of Survey

Variable	Mail	Phone	F/F
Cost	Cheapest	Moderate	Costly
Speed	Moderate	Fast	Slow
Response rate	Low to moderate	Moderate	High
Sampling need	Address	Telephone number	Address
Burden on respondent	High	Moderate	Low
Control participation of others	Unknown	High	Variable
Length of questionnaire	Short	Moderate	Long
Sensitive questions	Best	Moderate	Poor
Lengthy answer choices	Poor	Good	Best
Open-ended Reponses	Poor	Good	Best
Complexity of Questionnaire	Poor	Good	Best
Possibility of interview bias	None	Moderate	High

4.3.1 Simple random sampling

In simple random sampling a subset is selected from the population, each element of the sample has equal probability of selection. Further more, any given pair of elements has the same chance of selection as any such other pair. This minimizes bias and simplifies analysis of results. In particular, the variance between individual results with in the sample is good indicator of the overall variance of the population, which makes it relatively easy to estimate the accuracy of results.

4.3.2 Systematic sampling

In systematic sampling the population is arranged according to some order first then elements are selected at regular intervals through that arranged population. The first element of systematic sampling is selected randomly then every kth element is selected. A systematic sample may not be representative of the population if periodicity is present.

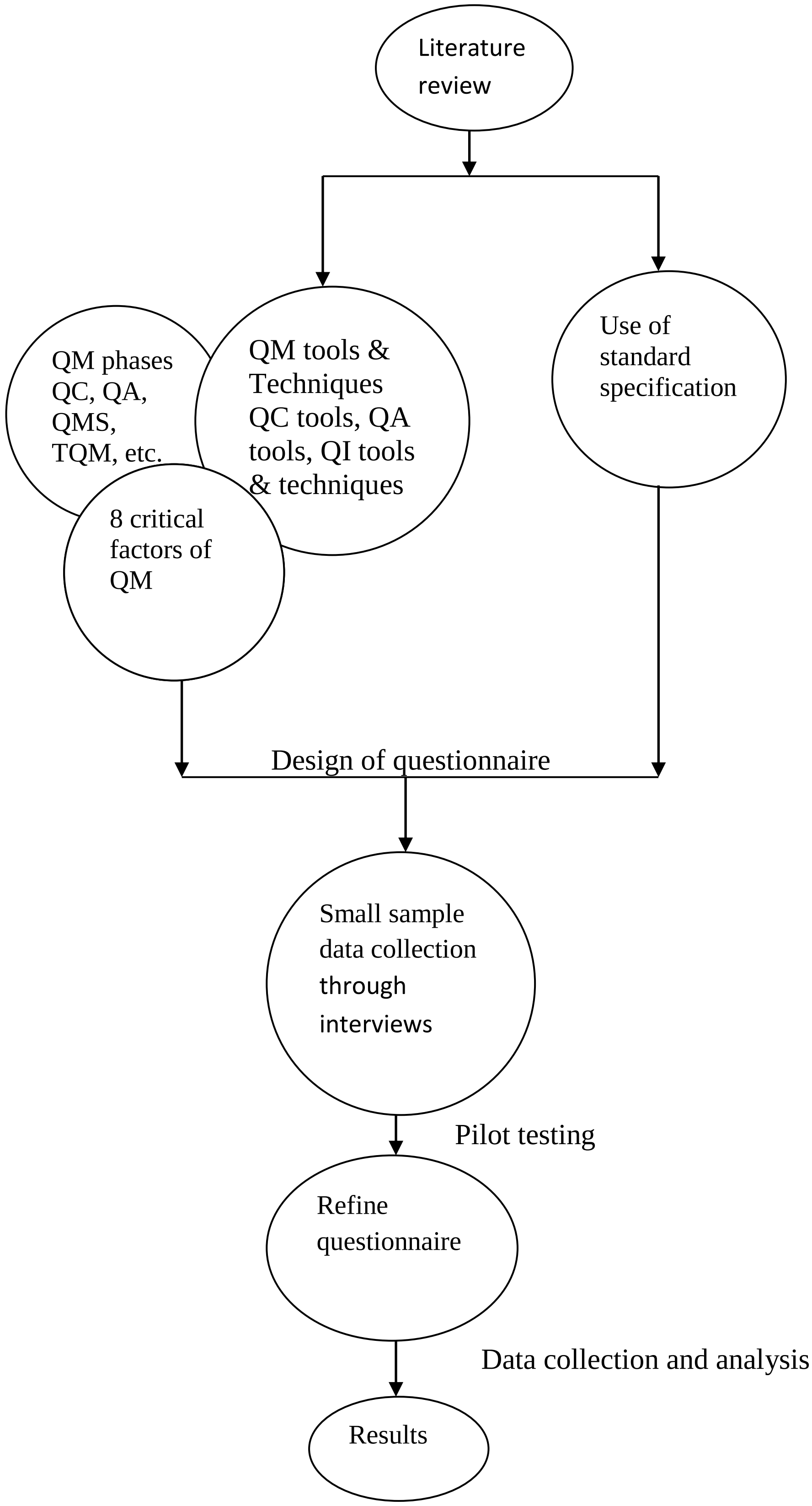

Fig. 4.1: Flow Chart of Research Methodology

4.3.3 Stratified sampling

Stratified sampling is used where the population can be divided into distinct categories. These divided categories are taken as sub-population out of which a random sample can be selected. As the population is stratified it is easy for researches to make inferences about each stratum which may be lost in more generalized sampling.

4.3.4 Cluster sampling

Sometime it is cheaper to cluster the sample by selecting the respondents from the certain areas only or certain periods only. Cluster Sampling can reduce the travel expenses and administrative costs. The variability of sample becomes more as compared to the simple random sampling, depending upon the clusters difference between them. In this research whole the population of cement companies is taken as sample.

The Board of Investment Government of Pakistan enlists 29 cement production units operating in Pakistan in 2007. The addresses and valid phone numbers of 21 companies out of twenty nine production units were available thorough internet or phone directories. Out of 21 production units twelve cement production units were visited and interviews were taken face to face other nine production units were contacted through e-mails or phone numbers.

The personals related to quality management were addressed as the research respondents those are assumed to be having enough knowledge to respond the questionnaire.

4.4 Sample Size

Glasow (2005) has reported following five factors while determining the size of the sample.

- Desired degree of precision
- Statistical power required
- Ability of the researcher to gain access to the study subjects
- Degree to which the population can be stratified
- Selection of the relevant units of analysis

He described two measures of degree of precision, first is level of significance (the amount of Type-1 error) and second is the confidence interval.

Statistical power is the probability that the researcher rejects the null hypothesis given that the alternate hypothesis is true, where the null hypothesis is erroneously accepted and the alternate hypothesis is true, a Type II error is said to exist. Statistical power is determined, in part, by effect size and sample size.

Effect size is the extent to which the distributions of means for the null and alternate hypotheses do not overlap. The greater the difference in the distributions of means, the higher the power where as the sample size increases, the distribution of means becomes narrower and the variance decreases, thereby reducing the overlap between the two distributions and increasing power.

The third factor is the ability of the researcher to gain access to the study subjects which can be mitigated to some extent by using theoretical sampling. The fourth factor is the degree of stratification that can be made in a given population. By using stratification the research will be able to relate the differences in mean of different strata.

The fifth factor is the unit of analysis i.e. individuals, teams, or groups. The individual responses can be aggregated across a team which helps to lessen the effects of individual attitudes.

The above factors give a good picture how the sample size can be affected by the different factors but it doesn't give any numerical formula to find out the sample size.

The raosoft (www.raosoft.com) gives a numerical value of the sample size including the following variables.

i. Margin of error
ii. Confidence interval
iii. Population size
iv. Response distribution

The population size is estimated to be 29 cement manufacturing units as mentioned in survey sample. Taking 10% margin of error and 90% of confidence interval and assuming 50% response distribution which is a conservative value. The sample size comes out to be 21 cement manufacturing companies. These calculations are based on the normal distribution (30 sample or more).

4.5 Design of Questionnaire

Questionnaire is an easy way to collect data from a large population. A well designed questionnaire can effectively collect all the data required for the analysis of the system. If the questionnaire includes the demographic questions on the participants, they can be used to correlate performance and satisfaction with the test system among different groups of users.

The questionnaire design is a multistage process so every step in the questionnaire should be designed carefully as the final results are only as good as the weakest link in the questionnaire process.

Questionnaires are flexible what they can measure, but the questionnaires are not good for measuring all types of data. Classifying data in two ways, Objective vs. Subjective and Qualitative vs. Quantitative. During the administration of the questionnaire the researcher have limited control over the environment. The loss of control means that the validity of the results is more dependent on the honesty of the respondents. So the results from the lab test are more reliable than the questionnaire results. Questionnaires are more suited to gather more subjective measures like user satisfaction of the system.

Quantitative questions are more exact than the qualitative questions because of their very nature. Qualitative questions may be biased because of one word might be having different meanings for the different respondent. Even though the questionnaires can measure both type of data but the qualitative questions require more care, administration and interpretation.

At this point, the kind of the data to be collected, the objective of the study and respondents groups have been decided. So the next step is to compose the questionnaire.

4.5.1 Questions included in the survey

First an extensive research was conducted through the literature to make an understanding of the quality management. From the literature review it is concluded that quality management implementation is assessed mainly through three aspects, Quality management phases, quality management tools and techniques, constructs of quality management. The main theme of research is to asses the quality management implementation in construction material industry of Pakistan. These three aspects of the quality management are whether correlated is out of the scope of the research. The information about the three aspects of the quality management are collected and analyzed. The industry will be benchmarked with respect to three aspects separately but the supporting information can be extracted from any of the aspects.

Initially five construction materials were selected (cement, concrete blocks, paints, electrical cables, false ceiling) but during the initial survey and pilot testing it was known that first there is too much variation in the level of quality management among the materials manufactures and second there is too low response for the research which will effect the schedule of the research completion. So the materials were first reduced to two (cement, paints) and then cement was finally selected for better study.

The questionnaire is based on five parts, respondent information, company information, quality awareness, quality application (tools and techniques, documentation & certifications, critical factors). In respondent information and company information some of the questions are optional to keep the confidentiality of respondent.

In the initial questionnaire all quality tools & technique were included but after pilot testing only those tools & technique are included in the questionnaire, who have a probability to be used in cement industry. Other questions on quality application are designed in such a way to minimize the duplication of questions which is possible if one factor of quality management is discussed in all three aspects of quality management. More over some questions are included to check the future trend of the quality management in target industry of Pakistan.

4.6 Response Rate

One of the important factors of survey research methodology is response rate. Response rate can be increased by paying attention to some variables. The research includes following variables for the response rate.

4.6.1 Advance notice

Response rate can be increased by advance notice. An advance notice indicates the willingness of respondent to take part in the research survey. In this research telephone calls were made as advance notices.

4.6.2 Follow-ups

In the research the follow ups were made through e-mails and phone calls after asking a question in the distribution phase because some respondent may not like the follow up calls.

4.6.3 Monetary incentives

Higher response rates are associated with the use of monetary incentives such as including a dollar bill in the questionnaire. There was no monetary incentive given to respondent but "handbook on improving quality by analysis of process variables", "continues quality improvement techniques" and book on statistical quality control were distributed on the choice of the respondents. A copy of research thesis is also promised if they desired it.

4.6.4 Personalization

Personalization of the cover letter and or address of mail surveys has been associated with higher response rates. The respondents were first identified through phone calls and the questionnaires were distributed to specific persons.

4.7 Reliability and Validity of Surveys

Reliability means the consistency or repeatability of the measure. This is especially important if the measure is to be use on on-going basis to detect change. There are several forms of the reliability.

Test-retest reliability. If the questionnaire is repeated under the same conditions produces the same results or not. Validity means that we are measuring what we want to measure. There is a number of type's validity including:

4.7.1 Face validity

Whether at face value, the questions appear to be measuring the construct. This is largely a "common-sense" assessment, but also relies on knowledge of the way people respond to survey questions and common pitfalls in questionnaire design.

4.7.2 Content validity

Whether all important aspects of the construct are covered. Clear definitions of the construct and its components come in useful here. Content validity of questionnaire was done through face-face interview of field experts.

4.7.3 Criterion validity

Whether scores on the questionnaire successfully predict a specific criterion. For example, does the questionnaire used in selecting executives predict the success of those executives once they have been appointed?

4.7.4 Concurrent validity

Whether results of a new questionnaire are consistent with results of established measures.Reliability with in the scale, that all the questions designed to measure a particular trait are indeed measuring the same trait.

A through study of literature was carried out before the questionnaire was designed. After the design of questionnaire, interviews were carried out to check validity and reliability of the questionnaire. Corrections are made in the questionnaire to give more reliable results even though the reliability and validity of questionnaire mostly depend on honesty of the respondents.

4.8 Data Analysis Technique

The data analysis is done by Statistical Package for Social Sciences (SPSS-16). MS Excel 2007 was used for constructing the charts and graphs of the data out put from SPSS-16.

4.8.1 Test for normality

Most of the statistical tests require normality of the data. The normality of the sample can be determined If the sample size is 30 or more, then the sample means are NORMALLY distributed even when the underlying data is NOT normally distributed! If the sample size is less than 30, then the distribution of the samples means is normal if and only if the underlying data is normally distributed (www.comfsm.fm).

4.8.2 Frequency analysis

Frequency analysis is particularly useful for describing the discrete categories of data having multiple choice questions or yes/no responses. This analysis involves constructing a frequency distribution. The frequency distribution is number of scores that fall within each response category.

These frequencies converted to percentage of each response to give view of application of that variable. The frequencies are then averaged for all variables to get one figure trepresent each category.

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 Sample

A sample of 21 cement companies was selected through the internet search and the field search. 12 plants were visited personally, all twelve companies participated. Other nine were contacted through phone calls and emails only 6 have responded. 90% of the respondents were with master's degree while 10% of the respondents were graduates. Only 5% of the companies are multinational other all companies are working nationally. The experience below 5 years was 3.3%, 6-10 years was 33.3%, 11-15 years was 16.7%, 16-20 years was 20%, 21-25 16.7% and above 25 years was 10%.40% of respondents were quality control managers, 30% were assistant managers, and 26.7% were chemist. The age of plants after establishment was from 4 years to 40 years with a mean of 21 years. These results are presented graphically in Fig. 5.1 to 5.4.

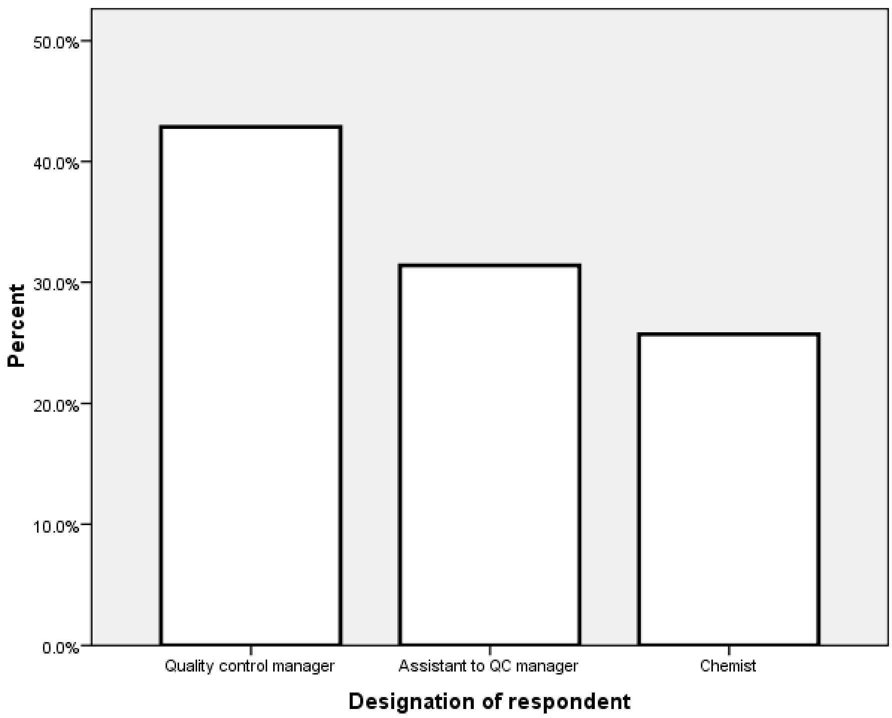

Fig. 5.1: Designation of Respondents

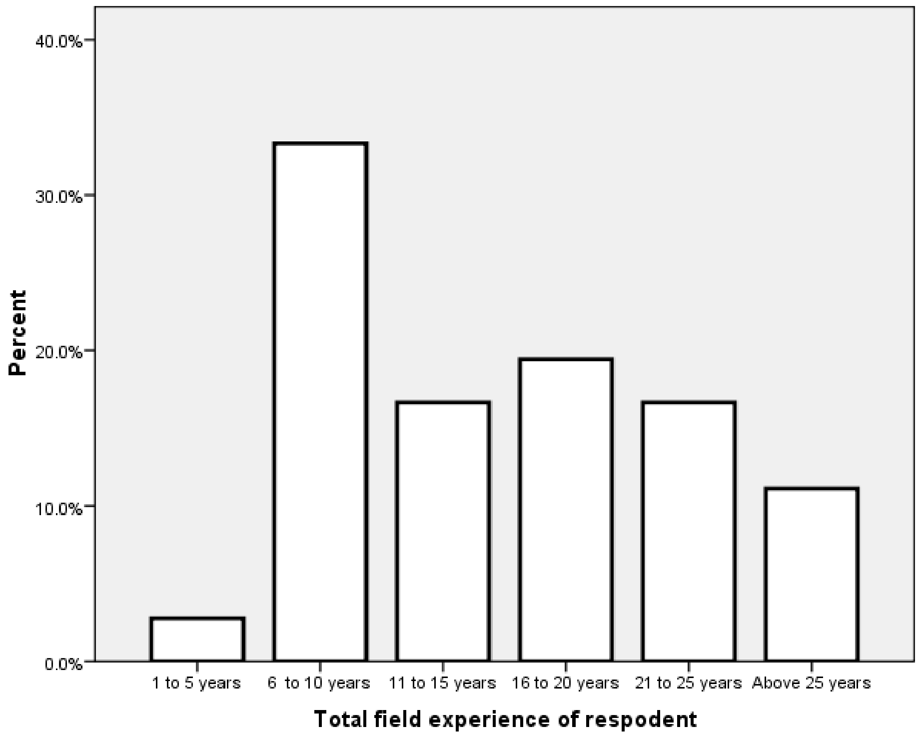

Fig. 5.2: Total Field Experience of Respondents

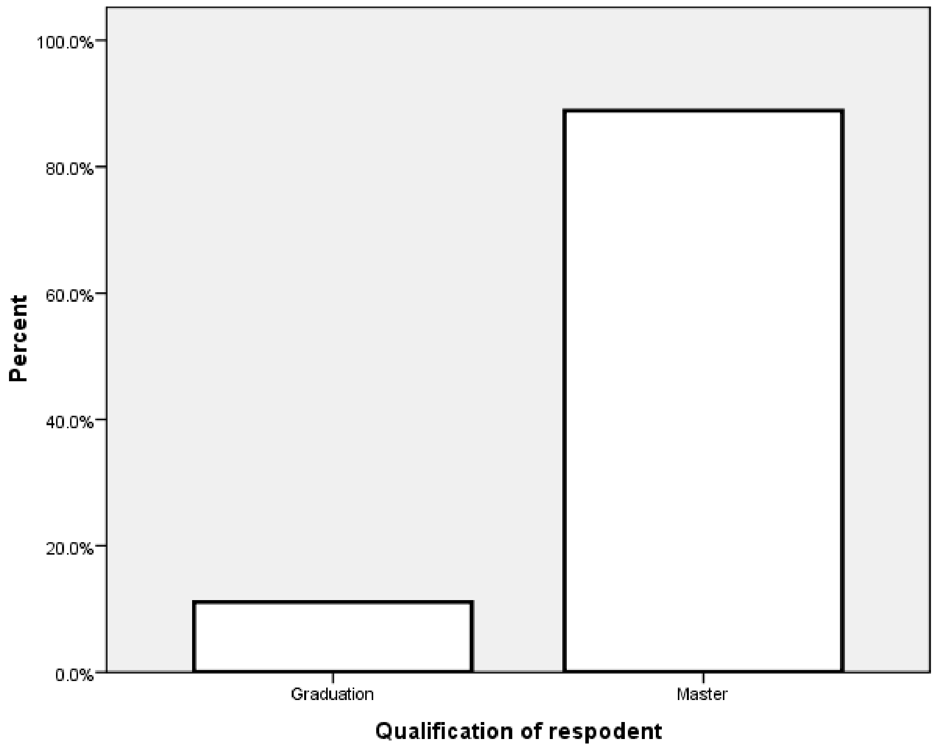

Fig. 5.3: Qualification of Respondents

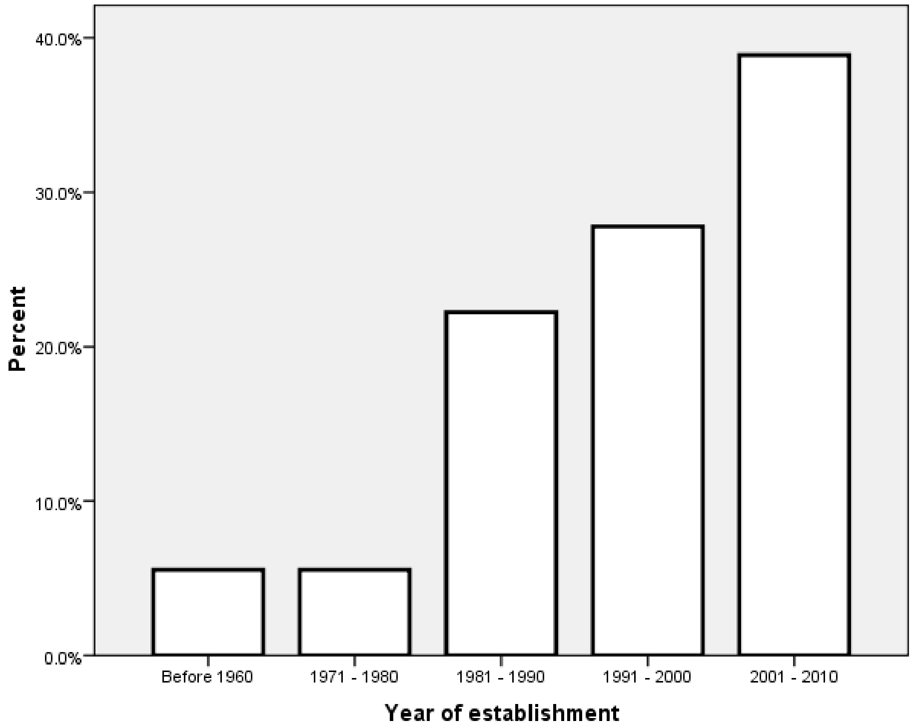

Fig. 5.4: Year of Establishment of Cement Production Units

5.2 Quality Management Awareness

Table 5.1 outline results regarding awareness of quality management. These questions are on

Table. 5.1: Awareness of Quality Management

Questions	Yes	No	Don't know
Quality control is different from quality assurance	67.7%	33.3%	
Quality control focuses on detection of errors.	58.3%	13.9%	27.8%
Quality assurance focuses on prevention of errors.	69.4%		30.6%
Quality control is subpart of quality assurance	83.3%	13.9%	2.8%
The international quality management system is ISO 9000 series	97.2%	2.8%	
The ISO 9000 certified companies should have their own quality management system	80.6%	13.9%	5.6%
The most appreciated technique is Total Quality Management	100%		

basic terminologies used in different phases of the quality management development in the history. These phases were given by the Paliska (2007) as quality control, quality assurance, quality management system, total quality management and quality award.

Only 58% of the respondents agreed that quality control focuses on the detection of errors where 42% of the respondents did not agree with the statement. The face to face interviews indicated that these 42% of the respondents were confusing the quality control with quality assurance. For these respondents the quality control is to identify the errors and their correction.

69% of the respondents agreed that the quality assurance focuses on the prevention of errors where as 31% did not agree with the statement. The interviews showed that most of the respondents who did not agree with the statement were not familiar with the concept of quality assurance and argue that the physical tests carried out at the end of final product were quality assurance.

68% of respondents recognized quality assurance different from quality control whereas 32% did not agree with the statement due to their lack of knowledge of quality control and quality assurance.

83% of respondents agreed with the statement that the quality control was subpart of quality assurance. This high rate of agreement with the statement is rational because the respondents those perceive quality control and quality assurance as a same thing will automatically will be in the same group.

97% of the respondents knew the ISO 9000 series as international quality management standards whereas 80% of respondents had knowledge that the companies should have their own quality management system for their ISO quality management standards certification.

These above results indicate that the cement industry is more aware and focusing on the new terminologies as compared to the old terminologies. In practice it is necessary to have knowledge about the old terminologies as well as the new terminologies. The figure 5.5 indicates the level of awareness of different terms used in the quality management.

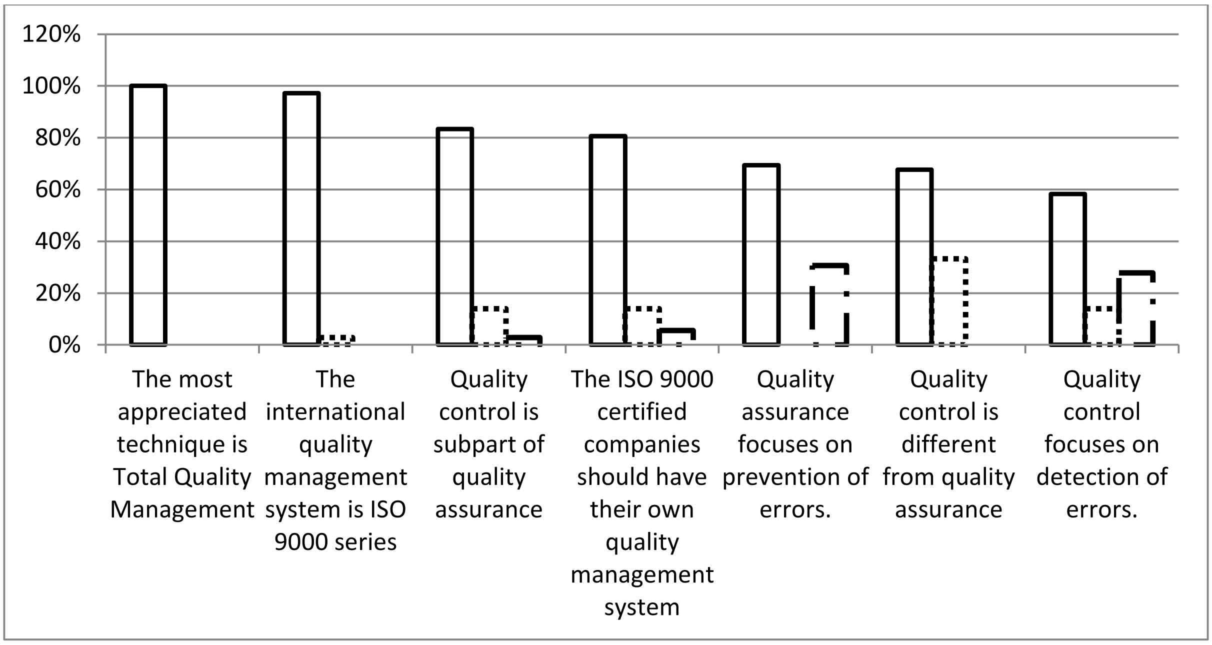

Fig. 5.5: Awareness of Quality Management Terminologies

5.3 Quality Management Application

The quality management application was divided into three sections namely, Sec-1: Use of tools and techniques, Sec-2: Documentation and organization and certification, Sec-3: Critical factors of quality management (managerial system).

First of all analysis of quality tools and techniques were carried out. Quality tools and techniques were further divided into three sub-categories namely quality control, quality assurance and quality improvement. Use of quality control techniques is listed in the Table 5.2.

5.3.1 Application of quality management tools and techniques

Quality management can not be effectively applied without tools and techniques. Different tools and techniques are applied in different phases of quality management. In table 5.2 quality control tools and techniques were grouped in four categories based on the frequency of use. The last column includes the weighted average of all four categories.

In table 5.2 in the first category of the quality control tool and techniques most of the companies use control charts with 44% of the sample while the statistical process control was 19% and acceptance sampling 28%. 8% of the companies rely on the descriptive statistic only. Even though the importance of the tools and techniques depends upon the specific case but research indicates that statistical process control is an advance and efficient technique in the manufacturing. After statistical process control the control chart was important for

Table. 5.2: Quality Control Techniques

Quality Control Techniques	Frequency of use				Weighted Average
	Always use = 4	**Very often use = 3**	**Sometime use = 2**	**Rarely use = 1**	
Visual inspection	0.00%	0.00%	5.60%	60.00%	7.12%
Descriptive statistics	8.30%	2.80%	25.00%	5.70%	9.73%
Control charts	44%	16.70%	8.30%		24.43%
Statistical process control	19%	16.70%	5.60%	8.60%	14.75%
Acceptance sampling	28%	52.80%	8.30%		28.62%
Date driven inventory system		5.60%	13.90%	17.10%	6.17%
Software packages			19.40%	2.90%	4.17%
Check sheets		5.60%	5.60%		2.8%
Graphs			*8.30%*	*5.70%*	2.23%

manufacturing. The use of control charts was more than the statistical process control which was an indication that cement industry still need to improve their quality control by more focusing on statistical process control.

In the second category of the quality control tools and techniques acceptance sampling was rated high by the respondents which was almost 53% even though statistical process control and control charts were also used in this category after acceptance sampling but their rate was very low as compared to the acceptance sampling. Acceptance sampling is very old statistical technique being in practice from World War-II and still important in the manufacturing industry.

In third category of quality control tools and techniques descriptive statistics and software packages had high rate 25% and 20% respectively. Software with equipment is used in the cement industry to check the percentage amount of different elements present in the cement. It is also used to check the chemical structural bonding of the cement.

In rarely used tools and techniques category visual inspection is highly used in the cement industry. Even though it is very simply technique but it can be applied before detail tests are carried out. The reliance on visual inspection changes with experience of the inspector.

The fourth column of table 5.2 gives a simple comparison of quality control tools and techniques irrespective of their category. The category in each column is assign a weight and corresponding to each quality control tool and technique a weighted average value is calculated which gives a overall percentage use of that particular tool and technique.A graphical representation of fourth column of table 5.2 is given in Fig. 5.6.

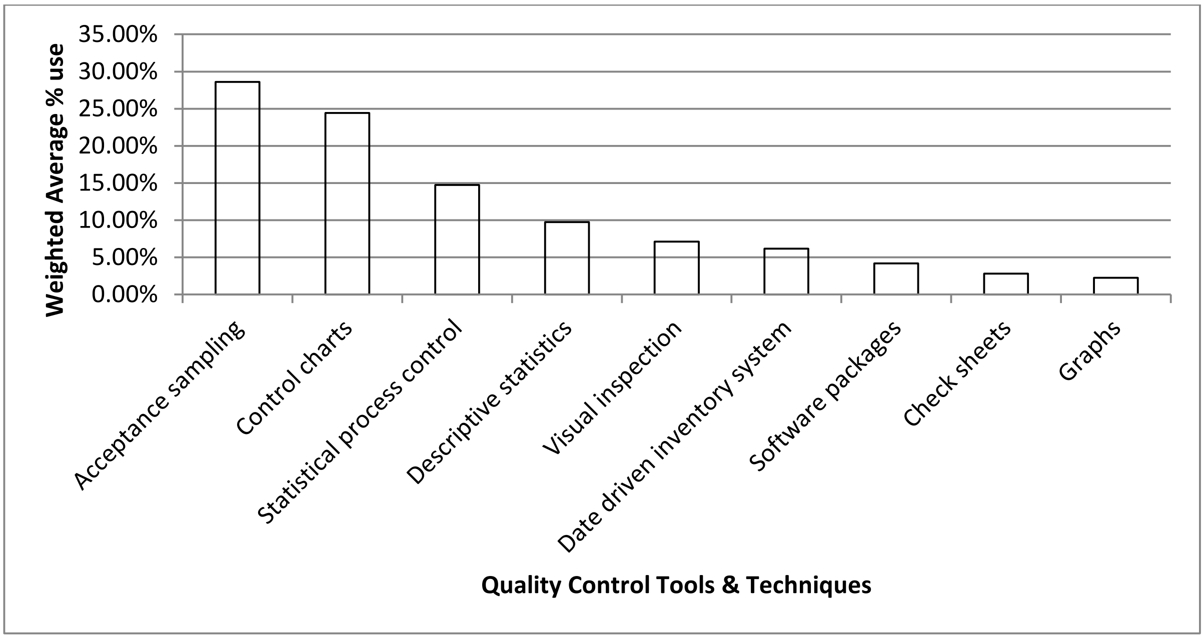

Fig.5.6: Percentage Use of Quality Control Tools and Techniques

The second phase of quality management is quality assurance. The tools and techniques used in this phase are enlisted in table 5.3 with their percentage use as responded by the respondents.

Work instructions are displayed for every process that includes precautions and guidelines to handle the process so that an economical and efficient out put can be achieved. In the first category of use the respondents indicated high use of work instruction (36%) which was also prominent from the testing laboratory and plant visits. Control plans are used 33% that is an encouraging indication but improvement needs to be made in control plans by continually updating the control plants. The Laboratory visits indicated that some control plan used include work instructions and setting inspection and testing requirements also and very difficult to follow. These things can be incorporated in control plans if the process is simple otherwise the control plan will become too lengthy to follow. Setting testing and inspection requirements are generally established by the Standard Developing Organizations. In always use category it is ranked third.

In the second category of quality assurance tools and techniques Work instructions, Setting inspection and testing requirements and Control plans are still highly used but more focus is given to Setting inspection and testing requirements with almost 42% use. This result is also logical because with out following Work instructions and Control plans the output may not be worthy of inspection.

Table. 5.3: Quality Assurance Techniques

Quality Assurance Techniques	**Frequency of use**				**Weighted average**
	Always use = 4	**Very often use = 3**	**Sometime use = 2**	**Rarely use = 1**	
Work instructions (SOP)	36.10%	16.70%	25.00%	5.60%	25.01%
Setting inspection & testing requirements	19%	41.70%		16.70%	21.94%
Control plans	33.30%	25.00%	5.60%		21.94%
Finished product record review		5.60%	36.10%	11.10%	10.01%
Knowledge management		5.60%			1.68%
Regular Quality Audit	5.60%	5.60%	13.90%	36.10%	10.31%
Automation	5.60%		16.70%	16.70%	7.25%
Supplier evaluation			2.80%	13.90%	1.95%

The results in the third category depict more focus on finished product record review with 36% of use. Cement loses quality with the time of storage so it is also an important quality assurance technique. Quality audit is also done in the cement industry but it is done once a year and rated high in the rarely used tools and techniques of quality control. Fig. 5.7 show weighted average percentage use of quality assurance techniques.

In third phase of quality management focus was given not only to control and ensure the good quality but continuously improve it. In an effort to improve the quality management different quality improvement tools and techniques are implied in the manufacturing industry. These tools and techniques were divided into four groups based on frequency of used given in table 5.4.

The most appreciated way of managing quality in current era is total quality management. Philosophy of total quality management strongly emphases on the customer focus for better quality. Customer feedback is one of the ways to know the customer satisfaction regarding the product and improvement need to made in the product. In the cement industry of Pakistan customer feedback is focused highly. Customer feedback is done on websites of the cement companies or on customer feedback form. In the first category of quality improvement tools and technique customer feedback is used 42% even though it can be designated as high but still it indicates that cement industry is adopting the philosophy of total quality management to improve the quality management.

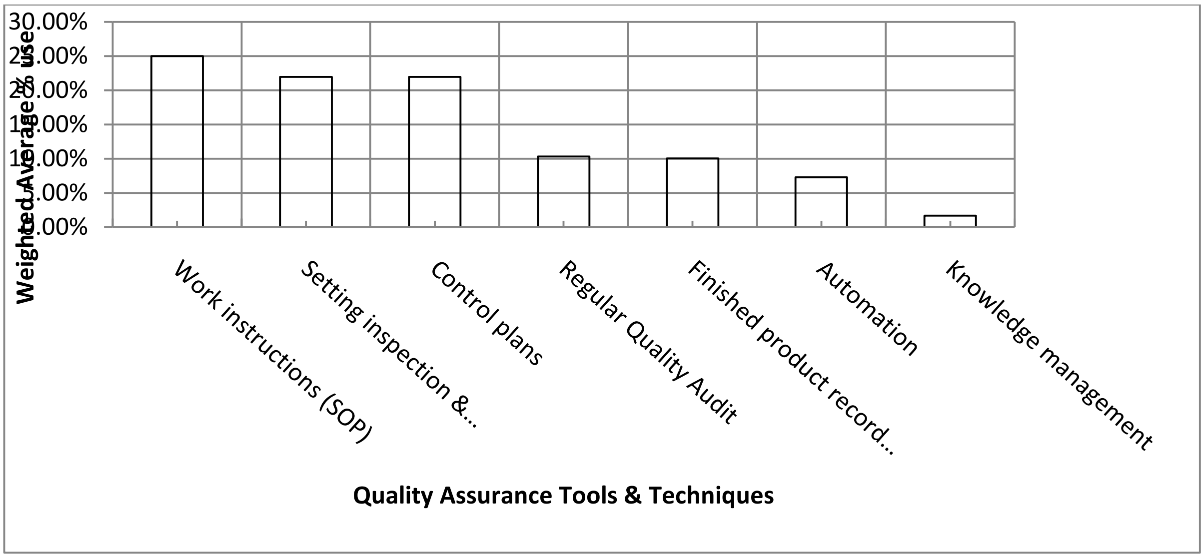

Fig. 5.7: Quality Assurance Tools and Techniques

Table. 5.4: Quality Improvement Techniques

Quality Improvement Techniques	Frequency of use			Weighted Average
	Always use = 4	Very often use = 3	Sometime use = 2	
Customer feedback	42%	36%		30.63%
Bench marking	27.80%	11.10%	8.80%	18.01%
Employee suggestion scheme	5.60%	11.10%	8.80%	8.14%
Improvement teams	2.80%	2.80%		2.17%
Corporate social responsibility	5.60%	11.10%	5.90%	7.5%
lean		8.30%	32.40%	9.96%
SWOT analysis	5.60%	8.30%	29.40%	11.78%
Quality function deployment	5.60%	5.60%	14.70%	7.62%
Plan-do-check-act cycle	5.60%	5.60%		4.35%

Bench marking is used on the second rank in the cement industry. Bench marking produces a sense of competition in the industry whereas SWOT analysis is used on third rank by the sales and marketing department of the cement industry. Lean is to minimize the wastage and it is used by the production department of cement industry. The results show low level of employee involvement which is also important for an effective and efficient quality management system. Fig. 5.8 graphically represents the percentage use of quality improvement tools and techniques.

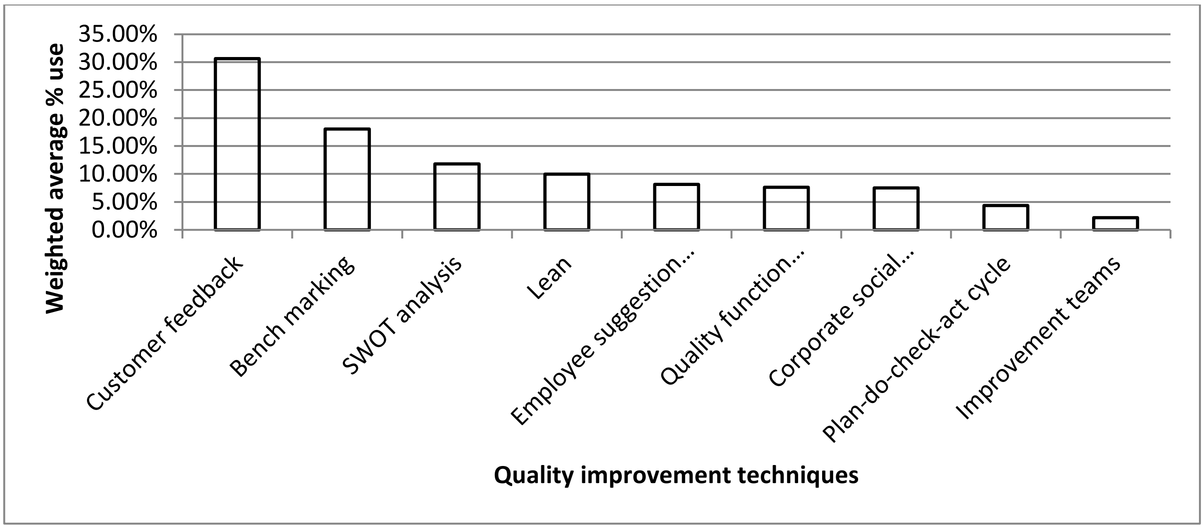

Fig. 5.8: Percentage Use of Quality Improvement Techniques

5.3.2 Quality management documentation and organization

Quality management documentation includes quality policy, quality management programs, quality audit reports, certificates and awards whereas quality management organization are designated as departments. Table 5.5 below enlists the responses for documentation and quality management organization of the cement industry.

The first step in quality management is to establish the quality policy. In the table 5.5 it is clear that all the cement companies have established quality policy. The statement of quality policy defines the importance of quality for the organization. The second step of documentation is to prepare a quality management programme in light of quality policy. The above results indicate that this step is also taken by the cement industry in Pakistan. Next step for documentation is to get certification from the International standards organization for quality management (ISO 9001). The results show that only 80% of cement companies are successful to get ISO 9001 certification. The visits to cement manufacturing units made clear that the ISO 9001 certification was under process for these non-certified units and these cement manufacturing units were newly established. The last part of quality management documentation is the quality award. No cement manufacturing unit has able to get any quality award.

Table. 5.5: Documentation and Organization of Cement Companies

Questions	**Yes**	**No**
Does your Company have a clear policy about the quality?	100%	
Does your company have any quality management system?	100%	
Does your Company have a quality control department?	100%	
Does your company have a quality assurance department?	40%	60%
Does your company is ISO 9001 certified?	80%	20%
ISO certification is regularly renewed?	80%	20%
Quality management system edited regularly?	100%	

To implement the quality management an organization is mandatory as without assigning the responsibility quality management programme will be only a peace of paper. The survey indicates that all the cement manufacturing units have quality control departments. The responsibilities of quality control departments vary from company to company. 40% of companies responded that quality assurance is also responsibility of quality control department while 60% of companies have established different department for the quality assurance. Lastly to meet with the requirement of dynamic quality management the organization need to maintain the documentation as per the demands of customers. Cement industry responded 100% that the quality management system is edited regularly.

5.3.3 Questions to measure critical factors

In the previous sections technical system of quality management was discussed in addition documentation and organization of quality management were also included. The second part of quality management is managerial system. The managerial system includes the critical factors which can not be measured directly. To measure the critical factors of quality management questions responses are enlisted in table 5.6.

Table. 5.6: Questions to Measure Critical Factors

Questions	**Strongly disagree**	**Disagree**	**Undecided**	**Agree**	**Strongly agree**
Top management is fully committed for better quality product				59.7%	40.3%
The company allocates appreciable resources for quality management				47.2%	52.8%
The documentation is satisfactory to review the product if required				68%	31.95%
Quality audit is done	10%	30%	50%		10%
The communication within organization is good			4.15%	50%	45.85%
Use of knowledge management	70%	15.5%	12.5%		2%
Use of pareto charts	80%	10%	10%		0%
The Quality management system is edited regularly				87.5%	12.5%
Company gives training in quality management				48.6%	51.4%
Use of employee suggestion scheme	17.1%	23.5%	39.8%		19.6%
Existence of improvement teams	79.9%	13.5%			6.6%

Questions	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
Use of supplier evaluation	24.4%	43.9%	11.7%	10%	10%
Use of supplier development	85%	15%			0%
Customer feedback	10.1%	13%	45.9%	10%	21%
Use of quality function deployment	15.7%	14.6%	61.7%		8%

The questions addressed the elements of the eight critical factors of quality management. The critical factors and corresponding elements are as follows.

1. **Top management support**

The top management support to quality management is a strong indicator of good quality culture. Quality management of an organization can only survive and grow if the top management is committed for it and ready to allocate resources for quality.

Top management support is measured on these two elements. Results show that in the cement industry top management support is good with quality commitment (100%) and quality investment (100%). These results seem unrealistic keeping in view the other factors of quality management but at the same time it is an indication that management intention toward quality management is encouraging.

2. **Quality information availability**

Quality information availability is another important critical factor. Quality information includes six items documentation and their availability to the concern staff. These are namely “cost of quality, quality information, quality performance, defects information, scrap data, and rework data. In more compact form all items can be summed up in three questions quality documentation, quality audit and its communication. The results show that respondent agree with good quality of documentation and communication (100%) but quality audit (10%) in quality assurance tools and techniques is very rarely done.

3. **Quality information use**

If the data regarding quality is available but knowledge is not gained by analyzing it then the chain of maintaining and improving the quality can not sustain. Pareto chart is an important tool for analyzing the quality data. The results of quality control tools and techniques identify that pareto charts are not used in the cement industry but quality assurance tools and technique indicate the knowledge management is used only 2% (weighted average). All the respondents agree that the quality management system is edited. The interviews with the quality management personals shows that proper analysis of the quality data is not done rather a visual guess is made from the available data and quick fixes are carried out.

4. Employ training

A direct question was included to measure the employ training. All the respondents agreed that the company provide some sort of training. Considering the low level of employee involvement which is fifth critical factor of quality management, employ training seems to be unproductive. It is also evident from the conclusion that without implementation of all critical factors, the effort of good quality management system might be jeopardized.

5. Employee involvement

Employee involvement can be ensured in two ways either take the suggestions from the employee or empower them to improve the quality. From the results of quality improvement tools and techniques it can be inferred that the employee suggestion scheme (8%) and improvement teams (2%) are not encouraging for the quality management.

6. Process and product design

The factor is related to quality planning of cement manufacturing. Cement process is established once and remains in operation continuously. Business process re-engineering is widely used for auditing manufacturing process. But in case of cement industry business process re-engineering is not used instead process is controlled and maintained for the desired output. The second element of process and product design is clarity of specifications. The specifications are defined by the cement standards so from the results it is known that 100% of the sample selected uses the cement standards.

7. Supplier quality

The quality of raw material is directly dependent on the quality of supplier. The quality of supplier can be assessed by two sub-factors, supplier evaluation and supplier development. The results of quality assurance tools and techniques depict that supplier evaluation is done about 2% where as no company is focusing on the supplier development. The supplier development is to support the supplier to improve their quality management for better raw materials or services.

8. Customer orientation

Customer orientation is considered very crucial for the successful strategic planning of the business. In the cement industry the customer orientation can be assessed through customer feedback which surround the customer requirements and complains in addition the quality function deployment which represents the incorporation of these requirements in the real product. The table 5.6 enlists the customer feed back is used approximately 31% (weighted average) whereas quality function deployment is used 8%.

5.3.4 Critical factors assessment

To assess the critical factors of the quality management four point scale was converted in to two point scale as follows:

a. The statements with agree and strongly agree responses were included in the category of good use.
b. The tools & techniques which are always used or very often used were included in the category of good use.

Table 5.7 lists the results of critical factors assessment for cement industry of Pakistan.
Top management support, employee training and quality information availability were above 50% where as quality information usage, customer orientation and employee involvement was below 50%. Supplier quality is least focused in the cement industry of Pakistan.

Table. 5.7: Critical Factors Assessment for Cement Industry of Pakistan

Factor	**Sub factors**	**% of companies reported good**	**Average of all sub factors**
Top management support	Quality Commitment is good	100%	100%
	Quality Investment is good	100%	
Quality information availability	Documentation is good,	100%	70%
	Quality audit is done	10%	
	Communication is good	100%	
Quality information usage	Knowledge management	2%	34%
	Pareto charts	0%	
	QMS is edit	100%	
Employee training		100%	100%
Employee involvement	Employee suggestion scheme	8%	5%
	Improvement teams	2%	
Process and Product design	Clarity of specifications	100%	50%
	Business process re engineering	0%	
Supplier quality	Supplier evaluation	2%	1%
	Supplier development	0%	
Customer orientation	Customer feedback	31%	19.5%
	Quality function deployment	8%	

Graphical representation of above results is given in Fig.5.9.

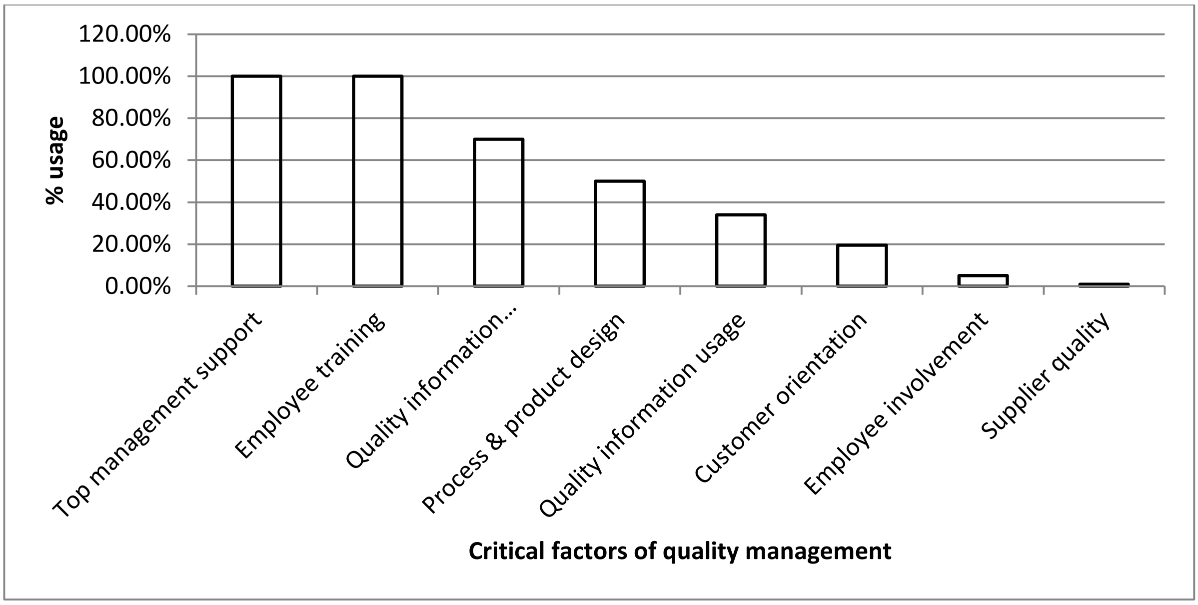

Fig. 5.9: Percent Application of Critical Factors of Quality Management.

5.3.5 Total quality management implementation assessment

The critical factors of quality management also represent the total quality management to some extent but they are designed to measure the quality culture. The total quality management in the cement industry is measured by the key elements. The percent implementation of key elements of total quality management is given in table 5.8.

Table. 5.8: Total Quality Management Assessment for the Cement Industry of Pakistan

Key TQM Element	**Application**
Implementing any ISO Practices or their Equivalent	80%
Implementing Quality Function Deployment (QFD)	8%
Implementing Failure Modes & Effect Analysis (FMEA) & Control Plans	22%
Implementing any Experimental or Taguchui Methods	0%
Implementing Statistical Process Control (SPC) practices	15%
Implementing any Benchmarking	18%
Implementing internal and external communication networks	100%

The results displayed in the table 5.8 depict that cement industry is more focused on communication networks and implementing the ISO practices for total quality management whereas implementing experimental or Taguchui methods are not used by the cement manufacturing units. The results of table 5.8 are graphically represented in Fig. 5.10.

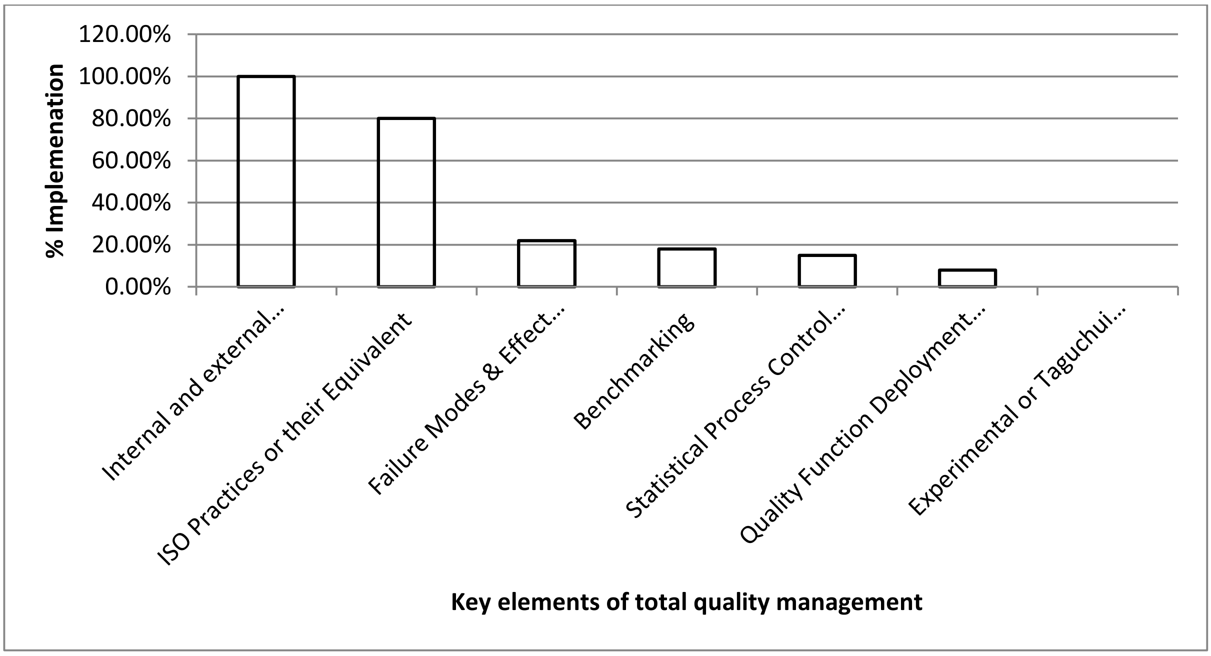

Fig. 5.10: Implementation of Key Elements of Total Quality Management.

Considering the results of technical system, managerial system and total quality management given above the phase of quality management of the cement industry of Pakistan can be established. The first phase of quality management is quality control in which defects are identified by the supervision and tests with the help of tools & techniques used in the quality control. The cement industry achieved this phase as all the industry has a separate department for the supervision and control of quality and tools and techniques are implied. The second phase of quality management is quality assurance. The industry is also full filling the requirement of quality assurance phase as the industry is following the ISO practices and tools and techniques of quality assurance are implied. Third phase of quality management is quality management system which includes all the procedures, processes in a documented form. The results indicate that the industry has achieved this phase also by implementing a quality management programe. Forth phase of quality management is total quality management and relatively new idea of managing quality. The critical factors and key element of quality total quality management indicate that this phase is not achieved by the cement industry even though some of the elements are implemented. The last phase of quality management is quality award no cement company of Pakistan is in this phase of quality management.

From the above conclusions it can be inferred that the cement industry of Pakistan is in transition state from the quality management system to total quality management as indicated in Fig 5.11. The implementation of total quality management in the cement industry of Pakistan is not encouraging. It seems that lack of knowledge of quality management in the cement industry is responsible for low level of total quality management implementation.

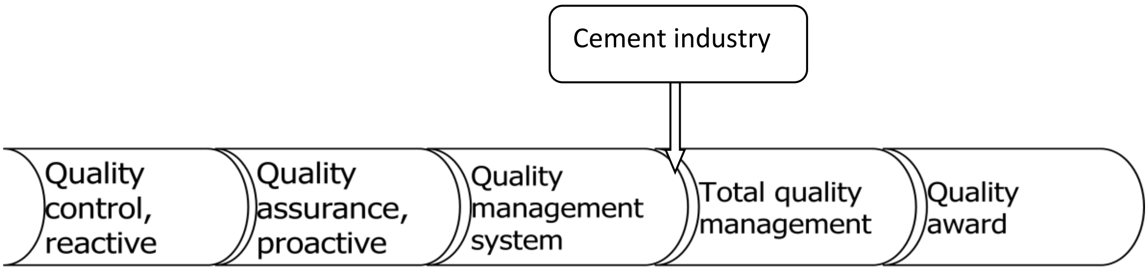

Fig. 5.11: Phase of Quality Management in Cement Industry

5.3.6 Future growth trend for quality management

In the previous section the level of quality management implementation in the cement industry of Pakistan was established. This establishment of level of quality management in the cement industry is carried out with the help of literature review and survey questionnaires. This depicts the current situation of quality management and does not predict the future trends of quality management. It will be interesting if we have an idea about the quality management growth trend in near future. Questions were included in table 5.9 to assess the growth trend of quality management.

Table: 5.9: Questions on Quality Management Future Growth Trend.

Questions	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
The company is satisfied with the quality management being used				80.5%	19.45%
The company is planning to implement new quality management technique		13.9%	62.5%	16.7%	6.95%
The company focuses on quality assurance than the quality improvement		50%	5.5%	27.75%	16.7%
The company encourages the teamwork approach in employees				59.7%	40.3%

The growth trend was assessed in the following aspects of the quality management. The below paragraph discuss the importance and trend of each aspect.

I. Quality management satisfaction

Quality management satisfaction is an important indicator of its future growth trend. If the company is not satisfied with the implemented way of managing the quality then chances are high that company will plan for better way of managing it. The results in table 5.9 indicate high level of quality management satisfaction by the respondents. This high level of satisfaction will lead the companies to existing way of quality management.

II. Implementation of new quality technique

This question becomes important when it is assumed that there are companies which are satisfied with the existing quality management system but they still try new ways of managing the quality. The results in table 5.9 show high percentage of undecided respondents and can be interpreted as no attention to the quality growth. 23% of the respondents agree to strongly agree for implementation of new quality management techniques. The interviews with the quality managers points to an interesting fact that most of the managers relates new quality managing technique to the latest equipment.

III. Quality improvement

The quality management can grow not only by implementing new quality management technique but also improving the existing quality management techniques. The results in table 5.9 indicate that companies are focusing on quality improvement rather just maintaining the quality. These findings advise that there will be growth in the quality management of cement industry with the improvement of existing way of managing quality.

IV. Teamwork approach

According to new philosophy of the quality management, quality is responsibility of every employee not just the quality department. Quality department is responsible to lead the organization for better quality. The improvement and changes carried out by the quality department can only be effective if quality department assign this task to organization as whole. The results in table 5.9 interpret the strong coherence of the organization towards quality. So a new technique of managing quality or improvement in quality management designed by the quality department will be able to integrate through out the organization.

5.4 Conclusion for Cement Industry

The quality management of cement industry is considered to be in the phase of total quality management. Total quality management comes on the fourth stage of quality development process. Even though the cement industry can be said to accomplish the first three phases of quality management but room for improvement is there for each phase of quality management. As in quality control more use of control charts then the statistical process control proves cement industry to be more product focus then the process whereas the modern models of quality management emphasis more focus on the process.

In the same way quality assurance phase of quality management in the cement industry lacks effective use of control plans. Control plans can only be effective if they are regularly evaluated and updated while the interviews with the quality managers identify that control plans are prepared once and then used for long period of time. ISO 9001 quality standards predominantly are quality assurance standards which are also not fully implemented in the cement industry.

Customer focus is relatively new philosophy of quality management and it is good aspect of the cement industry that it is applying this philosophy comparatively more than any other quality improvement technique. The industry seems ineffective in the matter of involving employees for the improvement of quality management.

It can also be concluded that quality documentation is done satisfactorily but the use of this documentation can be questioned. It is generally perceived that top management is mostly the big hurdle in quality management implementation but for Pakistan cement industry lack of knowledge of quality management can be attributed to unsatisfactory results. The interviews with the quality managers indicated that the departments were following conventional ways of controlling and assuring the quality instead of improving the techniques based on their knowledge and skill.

This is also prominent that technical system of quality management of cement industry is better than the managerial system of quality management and it is easy to assess technical system than managerial system. The cement industry is emphasizing more on the technical system for the quality management and managerial system seems to be more on paper.

In near future the quality management of cement industry predicted to be unchanged but existing quality management will be improved by implementing quality improvement techniques and focusing on new equipment for the quality control.

Chapter 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The following conclusions can be drawn from the study:

- The level of awareness of basic terms of quality management is 73% overall where as the familiarity of respondents with difference between quality control and quality assurance is 32% and awareness is 100% for Total quality management.
- These results indicate that the quality managers are well aware with the new terminologies of the quality management compare to the old terminologies as in the case with ISO 9001 and TQM with quality control and quality assurance and rely on the existing conventional methods being used in the industry.
- In the category of quality control tools, control charts are used by 43% which indicates the focus of industry on effects or defects rather than causes. It also means that the industry is focused on the product rather on the process.
- In the category of quality assurance 36.7% use the tool of control plans. It is a good tool given that it is continuously monitored and updated.
- In the category of quality improvement tool & techniques, 40% always use customer feedback & and 26.7% benchmarking. It shows a low level of customer focus approach.
- In the critical factors of quality management, there is a 100% support of top management, 100% employees are trained with 13% employee involvement and only 10% supplier quality. The first two results seem to be unrealistic, because with 100% management support and 100% employee training the quality management performance should have been lot better and employee involvement along with supplier quality should not have been that low.
- 80% respondents think that ISO practices are essential for TQM implementation, and 50% give weight age to “Implementing internal and external communication networks “. Where as no body supports the idea that “implementing experimental methods” and “failure mode & effect analysis” can support TQM implementation. It shows a trust on ISO practices that it can improve the processes leading to TQM.
- The Pakistan standard & quality control authority is responsible to keep an eye and ensure the implementation of quality management practices in the industry but face-face interviews indicate that it doesn’t performing its function properly.

6.2 Recommendations

- The results show that the top management is fully committed for better quality and training is provided to the employees but interviews with the managers show that the training is provided on the existing methods of quality management so it is recommended that the employees should be trained for new methods of quality management which should be economical time wise as well as cost wise.

- From the conclusion it is evident that the cement industry is focusing on the product by using control charts but it is recommended that the industry should focus on process improvement also by using statistical process control and cause and effect diagrams.

- Control plan is good tool for quality assurance but it is recommended that control plan should be updated and evaluated for their effectiveness and it should not be one time effort as currently in practice obvious from the face-face interviews.

- 8% Employee involvement is a very low figure keeping in view its importance for quality management and steps need to be taken to improve the team work leading to improvement in employee involvement.

- A better input can be obtained from suppliers for quality management by providing them “technical support & training” to improve their products.

- Applying third party management practices (i.e. ISO 9001) which most of companies are implementing can be economical but it may not guarantee the good quality product so some internal experiments (Taguchui Methods) which is almost not implemented in the cement industry should be done to improve the existing system for better quality.

6.3 Future Guidelines

- In the present research study, only the survey was carried out how many companies were ISO 9001 certified. A need is felt to check the effectiveness of the ISO 9001 in cement industry of Pakistan.

- The research included only the basic questions to check the quality management awareness but during the survey it was felt that there is need to check the awareness of industries in regard to the tools and techniques of quality management, as some respondents were using the tools but they did not know what was name of this tool.

- There should be a survey merely targeting the quality management personal skills, and qualification of the industries.

- If a research is carried out in which the quality management system of the companies is compared, this will give a better view of the quality management of different companies and an over all view of the industry.

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APPENDICES

APPENDIX-A

EXPLANATION OF TECHNIQUES

1. Activity on Node

Activity On Node (AON) is an activity sequencing tool and also known as Precedence Diagramming Method (PDM). Activity sequence diagrams use boxes or rectangles to represent the activities which are called as nodes. The nodes are connected with other nodes by arrows, which show the dependencies between the connected activities **(**www.pmtoolbox.com**).**

2. Benchmarking (BM)

Benchmarking is a process that enables comparison of inputs, processes or outputs between institutions (or parts of institutions) or within a single institution over time. (Harvey, L., 2004–11, Analytic Quality Glossary, Quality Research International, www.qualityresearchinternational.com).

3. Balanced Scorecard (BSC)

The balanced scorecard (BSC) is a strategic performance management tool, a semi-standard structured report supported by proven design methods and automation tools that can be used by managers to keep track of the execution of activities by staff within their control and monitor the consequences arising from these actions (Wikipedia).

4. Business Process Reengineering (BPR)

The analysis and design of workflows and processes within an organization. A business process is a set of logically related tasks performed to achieve a defined business outcome (Wikipedia).

Thorough rethinking of all business processes, job definitions, management systems, organizational structure, work flow, and underlying assumptions and beliefs. BPR's main objective is to break away from old ways of working, and effect radical (not incremental) redesign of processes to achieve dramatic improvements in critical areas (such as cost, quality, service, and response time) through the in-depth use of information technology. Also called business process redesign (www.businessdictionary.com).

5. Computer Numerical Control (CNC)

Computer numerically controlled machine (CNC) tools form the basis of flexible manufacturing systems and computer integrated manufacturing systems. CNC machines make the most important means for CAD/CAM technologies today (cnc.fme.vutbr.cz).

6. Computer Aided Design/Manufacturing (CAD/CAM)

CAD/CAM (computer-aided design/computer-aided manufacturing) is software used to design products such as electronic circuit boards in computers and other devices.

7. Computer-integrated Manufacturing

Computer-integrated manufacturing (CIM) is the manufacturing approach of using computers to control the entire production process. This integration allows individual processes to exchange information with each other and initiate actions. Through the integration of computers, manufacturing can be faster and less error-prone, although the main advantage is the ability to create automated manufacturing processes.

8. Corporate Social Responsibility (CSR)

A company's sense of responsibility towards the community and environment (both ecological and social) in which it operates. Companies express this citizenship (1) through their waste and pollution reduction processes, (2) by contributing educational and social programs, and (3) by earning adequate returns on the employed resources (www.businessdictionary.com).

9. Critical Path Method (CPM)

CPM is commonly used with all forms of projects, including construction, aerospace and defense, software development, research projects, product development, engineering, and plant maintenance, among others. Any project with interdependent activities can apply this method of mathematical analysis. Although the original CPM program and approach is no longer used, the term is generally applied to any approach used to analyze a project network logic diagram (Wikipedia).

10. Customer Surveys (CS)

Customer polling to identify their level of satisfaction with an existing product, and to discover their express and hidden needs and expectations for new or proposed product(s) (www.businessdictionary.com).

11. Employee Suggestion Scheme (ESS)

An employee suggestion Scheme is a formal mechanism, which encourages the employees to contribute constructive idea for improving their organization. It is common tool for factory improvement and as a way to develop better workplace relations. (International labor organization)

12. Improvement Teams (IT)

Group of multi-skilled employees charged with the responsibility of improving a production process or designing a new one (www.businessdictionary.com).

13. Knowledge Management (KM)

Knowledge Management (KM) comprises a range of strategies and practices used in an organization to identify, create, represent, distribute, and enable adoption of insights and experiences. Such insights and experiences comprise knowledge, either embodied in individuals or embedded in organizational processes or practice (www.scientificpapers.org).

14. Lean

Doing more with less by employing 'lean thinking.' Lean production involves never ending efforts to eliminate or reduce 'muda' (Japanese for waste or any activity that consumes resources without adding value) in design, manufacturing, distribution, and customer service processes (www.businessdictionary.com).

15. Mission and Vision Statements (MVS)

A mission statement is a formal, short, written statement of the purpose of a company or organization. The mission statement should guide the actions of the organization, spell out its overall goal, provide a sense of direction, and guide decision-making. It provides "the framework or context within which the company's strategies are formulated.(Wikipedia)

Vision Statements and Mission Statements are the inspiring words chosen by successful leaders to clearly and concisely convey the direction of the organization. By crafting a clear mission statement and vision statement, you can powerfully communicate your intentions and motivate your team or organization to realize an attractive and inspiring common vision of the future.

16. Plan-Do-Check-Act Cycle (PDC)

The plan–do–check–act cycle (Figure 1) is a four-step model for carrying out change. Just as a circle has no end, the PDCA cycle should be repeated again and again for continuous improvement.

17. Process Capability (PC)

Process capability is also defined as the capability of a process to meet its purpose as managed by an organization's management and process definition structures (en.wikipedia.org).

18. Process Capability Index (PCI)

In process improvement efforts, the process capability index or process capability ratio is a statistical measure of process capability.

19. Quality Function Deployment (QFD)

Quality function deployment (QFD) is a “method to transform user demands into design quality, to deploy the functions forming quality, and to deploy methods for achieving the design quality into subsystems and component parts, and ultimately to specific elements of the manufacturing process. As described by Dr. Yoji Akao, who originally developed QFD in Japan in 1966, when the author combined his work in quality assurance and quality control points with function deployment used in Value Engineering (en.wikipedia.org).

20. Quality Management System (QMS)

A quality management system (QMS) can be expressed as the organizational structure, procedures, processes and resources needed to implement quality management (en.wikipedia.org).

These below are the elements of the quality management system.

a. Organizational Structure
b. Responsibilities
c. Methods
d. Data Management
e. Processes
f. Resources
g. Customer Satisfaction
h. Continuous Improvement
i. Monitoring
j. Product Quality.

21. Six Sigma (6S)

Six Sigma at many organizations simply means a measure of quality that strives for near perfection. Six Sigma is a disciplined, data-driven approach and methodology for eliminating defects (driving toward six standard deviations between the mean and the nearest specification limit) in any process from manufacturing to transactional and from product to service (www.isixsigma.com).

22. Supplier Development (SD)

Supplier development can be loosely defined as the process of working collaboratively with suppliers to improve or expand their capabilities. An example may be teaching a supplier how to manufacture a type of item that they never manufactured before for the purposes of giving you the option to buy, rather than make, that item (www.nist.gov).

23. Supplier Evaluation (SE)

Supplier evaluation is a term used in business and refers to the process of evaluating and approving potential suppliers by factual and measurable assessment. The purpose of supplier evaluation is to ensure a portfolio of best in class suppliers is available for use. Supplier evaluation is also a process applied to current suppliers in order to measure and monitor their performance for the purposes of reducing costs, mitigating risk and driving continuous improvement (Wikipedia).

24. SWOT Analysis (SWOT)

SWOT analysis is a tool for auditing an organization and its environment. It is the first stage of planning and helps marketers to focus on key issues. SWOT stands for strengths, weaknesses, opportunities, and threats. Strengths and weaknesses are internal factors. Opportunities and threats are external factors (marketingteacher.com).

25. Total Quality Management (TQM)

At its core, Total Quality Management (TQM) is a management approach to long term success through customer satisfaction. In a TQM effort, all members of an organization participate in improving processes, products, services and the culture in which they work.

The term “Total Quality Management” has lost favor in the United States in recent years “Quality management” is commonly substituted. “Total Quality Management,” however, is still used extensively in Europe (asq.org).

26. 5S

Sort: (Seiri), The first S focuses on eliminating unnecessary items from the workplace.

Set In Order: (Seiton), is the second S and focuses on efficient and effective storage methods.

Shine: (Seiso), Once you have eliminated the clutter and junk that has been clogging your work areas and identified and located the necessary items, the next step is to thoroughly clean the work area.

Standardize: (Seiketsu), Now that the first three 5S’s have been implemented, you should concentrate on standardizing best practice in your work area.

Sustain: (Shitsuke), This is by far the most difficult S to implement and achieve. (www.leanexpertise.com)

27. Acceptance Sampling

Acceptance sampling uses statistical sampling to determine whether to accept or reject a production lot of material. It has been a common quality control technique used in industry and particularly the military for contracts and procurement. A wide variety of acceptance sampling plans are available (Wikipedia).

28. Analytical Quality Control

While quality control often relates to an end-product, procedures may also be needed to monitor the actual quality measurements. Such quality control techniques are often known as analytical quality control. Both technological competence and workforce intelligence may be gauged with these standards. For example, one employee may deem a product as acceptable because it meets specifications, but another may argue that its failure points are outside the intended ranges. Analytical quality control often works to safeguard the ways in which quality is measured and how control techniques are used (www.wisegeek.com).

29. Employee Monitoring

Employee monitoring refers to any method of tracking what an employee does while at work (Wikipedia).

30. On-Machine Inspection

On-machine inspection not only means checking the part, but also checking machine performance that affects part quality and machine productivity (www.marposs.com).

31. Statistical Process Control (SPC)

Statistical process control (SPC) is the application of statistical methods to the monitoring and control of a process to ensure that it operates at its full potential to produce conforming product. Under SPC, a process behaves predictably to produce as much conforming product as possible with the least possible waste. While SPC has been applied most frequently to controlling manufacturing lines, it applies equally well to any process with a measurable output. Key tools in SPC are control charts, a focus on continuous improvement and designed experiments (Wikipedia).

32. Visual Inspection

Visual inspection is a common method of quality control, data acquisition, and data analysis. Visual Inspection, used in maintenance of facilities, mean inspection of equipment and structures using either or all of human senses such as vision, hearing, touch and smell. Visual Inspection typically means inspection using raw human senses and/or any non-specialized inspection equipment. Inspections requiring Ultrasonic, X-Ray equipment, Infra-red, etc are not typically considered as Visual Inspection as these Inspection methodologies require specialized equipment and training (Wikipedia).

33. Control Plans

Control Plans assure a system is in place to control the risks of the same failure modes as identified in the PFMEA. While Control Plans can be developed independently of PFMEAs, it is time and cost-effective to link Control Plans directly to PFMEAs.

The primary intent of Control Plans is to create a structured approach for control of process and product characteristics while focusing the organization on characteristics important to the customer (www.qualitytrainingportal.com).

34. Control Charts

In general, control charts are used to plot production values and variation over time. These charts can then be analyzed to determine if changes in production values or variation are due to the inherent variability of the process or a specific correctable cause. Control charts for variables are fairly straightforward and can be quite useful in material production and construction situationsA graph that charts data and provides a picture of how a process is performing over time. It includes the upper and lower limits within which the process should operate (pavementinteractive.org).

35. Cause-and-effect Analysis

Group exercise in which participants try to list all possible causes and their effects (and identify how they are linked) associated with a particular problem or situation. It aims at discovering possible or probable causal factors and their outcomes (not necessarily the root cause, the removal of which will stop the recurrence of the problem) and may lead to the creation of a cause and effect diagram (www.businessdictionary.com).

39. Check Sheets/Tally Sheets

A check sheet is a structured, prepared form for collecting and analyzing data. This is a generic tool that can be adapted for a wide variety of purposes **(**asq.org)**.**

38. Graphs

A graphic (such as a chart or diagram) depicting the relationship between two or more variables used, for instance, in visualising scientific data (Wikipedia).

39. Histograms

In statistics, a histogram is a graphical representation, showing a visual impression of the distribution of data. It is an estimate of the probability distribution of a continuous variable and was first introduced by Karl Pearson (Wikipedia).

40. Pareto Analysis

Pareto analysis is a statistical technique in decision making that is used for selection of a limited number of tasks that produce significant overall effect. It uses the Pareto principle – the idea that by doing 20% of work, 80% of the advantage of doing the entire job can be generated. Or in terms of quality improvement, a large majority of problems (80%) are produced by a few key causes (20%) (Wikipedia).

41. Scatter analysis

A scatter plot or scattergraph is a type of mathematical diagram using cartesian coordinates to display values for two variables for a set of data.

APPENDIX-B

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March 2011

To whom it may concern

Subject: **<u>MS Thesis Research Work</u>**

1. National Institute of Transportation (NIT) is a constituent institute of National University of Sciences and Technology (NUST). The institute offers MS/PhD level program in various disciplines of Civil Engineering. NUST student Mr. Muhammad Zubair enrolled in MS Construction Engineering and Management is carrying out research on "Study of current practices of standards, quality control and quality assurance procedures for the selected construction materials industry of Pakistan".

2. In view of above, you are requested to provide all necessary cooperation and help in collection of relevant data for the research study. This research is of purely academic nature and the collected data will not be used for other purposes.

3. Thanking you in anticipation

For Associate Dean
(Mansoor Ahmed Malik)

APPENDIX-C

Questionnaire

Personal information: (will be kept confidential)

Name:		Total Field experience:	
Designation:		Experience with this company:	
Qualification:		Gender:	
Nationality:			

Company information: (will be kept confidential)

Company Name:		Type of Industry:	
Year of establishment:		National or Multinational:	
City of main head office		Annual Turnover/workers	

Standard information:

For questions (1-2) Tick (X) on the appropriate option and for questions (4-7) choose a number to show how much you agree with the statement. (as per below scale)

1	2	3	4	5
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

Sr. No	Question	Yes	No	Don't Know
1.	Is your company following any standard?	☐	☐	☐
2.	Pakistan has standard for this manufacturing process	☐	☐	☐
3.	Which standard does your company use in manufacturing? (write standard name)			
4.	The company selected this standard because of the quality it gives			
5.	The standard is being fully followed			
6.	The standard used by my company fulfills the requirements of region			
7.	The company should use Pakistani standard if it existed			

Information about quality

- **Quality awareness**

For questions (1-7) Tick (X) on the appropriate option and for questions (4-7) choose a number to show how much you agree with the statement.

Sr. No	Question	Yes	No	Don't Know
1.	Quality control is same as quality assurance.	☐	☐	☐
2.	Quality control is to find the defects.	☐	☐	☐
3.	Quality assurance is to prevent the defects.	☐	☐	☐
4.	Quality control is subpart of quality assurance.	☐	☐	☐
5.	The international quality management system is ISO 9000 series.	☐	☐	☐
6.	The ISO 9000 certified companies should have their own quality management system.	☐	☐	☐
7.	The most appreciated technique is Total Quality Management.	☐	☐	☐

- **Quality application:**

For questions (1-6) Tick (X) on the appropriate option and for questions (7-9) select options from Table-1 and questions (10-19) choose a number to show how much you agree with the statement

1	2	3	4	5
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

Sr. No	Question	Yes	No	Don't Know	
1.	Does your Company have a clear policy about the quality?	☐	☐	☐	
2.	Does your company have quality management system?	☐	☐	☐	
3.	Does your Company have quality control department?	☐	☐	☐	
4	Does your Company have a quality assurance department?	☐	☐	☐	
5.	Does your company ISO 9001 certified?	☐	☐	☐	
6.	ISO certification is regularly renewed?	☐	☐	☐	
7.	Insert corresponding **quality control technique** number from (Table-1) from left to right in the sequence (always use), (very often use), (sometime use), (rarely use).				
8.	Insert corresponding **quality assurance technique** number from (Table-1) from left to right in the sequence (always use), (very often use), (sometime use), (rarely use).				
9.	Insert corresponding **quality improvement technique** number from (Table-1) from left to right in the sequence (always use), (very often use), (sometime use), (rarely use).				
10.	Top management is fully committed for better quality product?				
11.	Company gives quality management training to its workers?				
12.	The company allocates appreciable resources for quality management?				
13.	Company encourages the teamwork approach among employees towards quality				
14.	Documentation is satisfactory to review the product if required.				
15.	The communication within organization is good.				
16.	The company focuses on quality assurance than the quality improvement.				
17.	Quality management system is edited regularly.				
18.	The company is satisfied with the quality management techniques being used				

19.	The company is planning to implement new quality management technique.	

Comments:

Table-1

No	**Quality control techniques**	**Quality assurance techniques**	**Quality improvement techniques**
1	No technique at all	No technique at all	No technique at all
2	Visual inspection	Work instructions (SOP)	Customer feedback
3	Standard tests (1)	Setting inspection & testing requirements	Bench marking
4	Descriptive statistics	Control plans	Employee suggestion scheme
5	Control charts	Finished product record review	Improvement teams
6	Statistical process control	Knowledge management	Corporate social responsibility
7	Acceptance sampling	Regular Quality Audit	lean
8	Date driven inventory system	Automation	SWOT analysis
9	Software packages	Supplier evaluation	Quality function deployment
10	Prato charts	Failure mode analysis	Total quality management
11	Histograms		Business process reengineering
12	Scatter charts		Plan-do-check-act cycle (kaizen)
13	Check sheets		Six sigma
14	Graphs		Balance score card
15			Supplier development

APPENDIX-D

CODING OF VARIABLES

Variable Information

Variable	Position	Label	Measurement Level	Column Width	Alignment	Print Format	Write Format
DESIGNAT	1	Designation of respondent	Ordinal	20	Left	F2	F8
TFIELDEXP	2	Total field experience of respodent	Scale	8	Right	F2	F8.2
EXWITHCO	3	Experience with company	Scale	8	Right	F2	F8.2
QUALIFIC	4	Qualification of respodent	Ordinal	8	Right	F2	F8.2
TYPEIND	5	Type of industry	Nominal	8	Right	F2	F8.2
YEAREST	6	Year of establishment	Scale	8	Right	F2	F8.2
NFWORK	7	Number of workers	Scale	8	Right	F2	F8.2
FOLANYS	8	Is your company is following any standard.	Nominal	8	Right	F2	F8.2
PAKHAS	9	Pakistan has standard for this manufacturing process.	Nominal	8	Right	F2	F8.2
QCSAME	10	Quality control is same as quality assurance	Nominal	7	Right	F2	F8.2
QCDEFIN	11	Quality control is to find the defects.	Nominal	8	Right	F2	F8.2
QADEFIN	12	Quality assurance is to prevent the defects.	Nominal	8	Right	F2	F8.2
QCSUBQA	13	Quality control is subpart of quality assurance	Ordinal	8	Right	F2	F8.2
ISQMSISO	14	The international quality management system is ISO 9000 series	Ordinal	8	Right	F2	F8.2
ISOSHOQ	15	The ISO 9000 certified companies should have their own quality management system	Ordinal	8	Right	F2	F8.2
TQMMOST	16	The most appreciated technique is Total Quality Management	Ordinal	8	Right	F2	F8.2
COPOLICY	17	Does your Company have a clear policy about the quality?	Nominal	8	Right	F2	F8.2

COANYQMS	18	Does your company have any quality management system?	Nominal	8	Right	F2	F8.2
COQCDEPT	19	Does your Company has a quality assurance department	Nominal	8	Right	F2	F8.2
COQADEPT	20	Does your company has quality assurance department.	Scale	8	Right	F2	F8.2
COISOCRT	21	Does your company is ISO 90001 certified	Nominal	8	Right	F2	F8.2
WHICHSTP	22	Which standard your company does use in manufacturing primarily.	Nominal	8	Right	F2	F8.2
OTHER1	23	Other than the primery stanadard 1	Nominal	8	Right	F2	F8.2
OTHER2	24	Other than the primery stanadard 2	Nominal	8	Right	F2	F8.2
OTHER3	25	Other than the primery stanadard 3	Nominal	8	Right	F2	F8.2
OTHER4	26	Other than the primery stanadard 4	Nominal	8	Right	F8	F8.2
WQCTQUS	27	Which quality control technique your company use always	Nominal	13	Right	F2	F8.2
QCTUSE2	28	Which quality control technique your company very often use	Nominal	8	Right	F2	F8.2
QCTUSE3	29	Which quality control technique your company use some time	Nominal	8	Right	F2	F8.2
QCTUSE4	30	Which quality control technique your company use rarely	Nominal	8	Right	F2	F8.2
WQATQUS	31	Which quality assurance technique your company use always	Nominal	8	Right	F2	F8.2
QATUSE2	32	Which quality assurance technique your company use very often	Nominal	8	Right	F2	F8.2

QATUSE3	33	Which quality assurance technique your company use some time	Nominal	8	Right	F2	F8.2
QATUSE4	34	Which quality assurance technique your company use rarely	Nominal	8	Right	F2	F8.2
WQITQUS	35	Which quality improvement technique your company use always	Nominal	8	Right	F2	F8.2
QITUSE2	36	Which quality improvement technique your company very often	Nominal	8	Right	F2	F8.2
QITUSE3	37	Which quality improvement technique your company use sometime	Nominal	8	Right	F2	F8.2
TMANFUL	38	Top management is fully committed for better quality product	Ordinal	8	Right	F2	F8.2
COGIVTR	39	Company gives training on QC/QA.	Ordinal	8	Right	F2	F8.2
ALCATRES	40	The company allocates appreciable resources for quality management	Ordinal	8	Right	F2	F8.2
TEAMWRK	41	The company encourages the teamwork approach in employees	Ordinal	8	Right	F2	F8.2
DOCSATR	42	The documentation is satisfactory to review the product if required	Ordinal	8	Right	F2	F8.2
COMGOOD	43	The communication within organization is good	Ordinal	8	Right	F2	F8.2
FOCUSQ	44	The company focuses on quality assurance than the quality improvement	Ordinal	8	Right	F2	F8.2
QMSEDIT	45	The Quality management system is edited regularly	Scale	8	Right	F2	F8.2
COSTSUS	46	The company is satisfied with the quality management being used	Ordinal	8	Right	F2	F8.2

CONEWTQ	47	The company is planning to implement new quality management technique.	Ordinal	8	Right	F2	F8.2
COSELB	48	The company selected this standard because it gives best quality.	Ordinal	8	Right	F2	F8.2
FULLYFOL	49	My company is fully following the standard applied in the manufacturing.	Ordinal	8	Right	F2	F8.2
FULLFILLS	50	The standard used by my company fulfills the requirements of region	Ordinal	8	Right	F2	F8.2
COSHOUL	51	The company should use Pakistani standard	Ordinal	8	Right	F2	F8.2

Variables in the working file

Variable Values

Value		Label
DESIGNAT	1	Director technical
	2	Quality control manager
	3	Assistant to QC manager
	4	Company Head
	5	Company manager
	6	worker
	7	Chemist
	8	Sales representative
	9	Production manager
	10	TQM specialist
TFIELDEXP	1	1 to 5 years
	2	6 to 10 years
	3	11 to 15 years
	4	16 to 20 years
	5	21 to 25 years
	6	Above 25 years
EXWITHCO	1	1 to 5 years
	2	6 to 10 years
	3	11 to 15 years

	4	16 to 20 years
	5	21 to 25 years
	6	Above 25 years
QUALIFIC	0	under materic
	1	SSC
	2	HSSC
	3	Graduation
	4	Master
	5	PhD
TYPEIND	1	Cement
	2	Paints
YEAREST	1	Before 1960
	2	1960 - 1970
	3	1971 - 1980
	4	1981 - 1990
	5	1991 - 2000
	6	2001 - 2010
NFWORK	1	Less than 300
	2	300 - 400
	3	401 - 500
	4	501 - 600
	5	601 - 700
	6	Above 700
FOLANYS	1	Yes
	2	No
	3	Don't know
PAKHAS	1	Yes
	2	No
	3	Don't know
QCSAME	1	Yes
	2	No
	3	Don't know
QCDEFIN	1	Yes
	2	No
	3	Don't know
QADEFIN	1	Yes

	2	No
	3	Don't know
QCSUBQA	1	Yes
	2	No
	3	Don't know
ISQMSISO	1	Yes
	2	No
	3	Don't know
ISOSHOQ	1	Yes
	2	No
	3	Don't know
TQMMOST	1	Yes
	2	No
	3	Don't know
COPOLICY	1	Yes
	2	No
	3	Don't know
COANYQMS	1	Yes
	2	No
	3	Don't know
COQCDEPT	1	Yes
	2	No
	3	Don't know
COQADEPT	1	Yes
	2	No
	3	Don't know
COISOCRT	1	Yes
	2	No
	3	Don't know
WHICHSTP	0	Non
	1	ASTM
	2	BS
	3	IS
	4	PS-232-2008(R)
	5	IEC
	6	IEC and BS

	7	Other
	8	PS-232-2008(R) & Other
	9	European
	10	SLS
	11	SABS
	12	Nigeria
	13	Italian
	14	Chinese
	15	Japanese
	16	Defence standards
	17	Mylasian
	18	ISO
OTHER1	0	Non
	1	ASTM
	2	BS
	3	IS
	4	PS-232-2008(R)
	5	IEC
	6	IEC and BS
	7	Other
	8	PS-232-2008(R) & Other
	9	European
	10	SLS
	11	SABS
	12	Nigeria
	13	Italian
	14	Chinese
	15	Japanese
	16	Defence standards
	17	Mylasian
	18	ISO
OTHER2	0	Non
	1	ASTM
	2	BS
	3	IS
	4	PS-232-2008(R)

	5	IEC
	6	IEC and BS
	7	Other
	8	PS-232-2008(R) & Other
	9	European
	10	SLS
	11	SABS
	12	Nigeria
	13	Italian
	14	Chinese
	15	Japanese
	16	Defence standards
	17	Mylasian
	18	ISO
OTHER3	0	Non
	1	ASTM
	2	BS
	3	IS
	4	PS-232-2008(R)
	5	IEC
	6	IEC and BS
	7	Other
	8	PS-232-2008(R) & Other
	9	European
	10	SLS
	11	SABS
	12	Nigeria
	13	Italian
	14	Chinese
	15	Japanese
	16	Defence standards
	17	Mylasian
	18	ISO
OTHER4	0	Non
	1	ASTM
	2	BS

	3	IS
	4	PS-232-2008(R)
	5	IEC
	6	IEC and BS
	7	Other
	8	PS-232-2008(R) & Other
	9	European
	10	SLS
	11	SABS
	12	Nigeria
	13	Italian
	14	Chinese
	15	Japanese
	16	Defence standards
	17	Mylasian
	18	ISO
WQCTQUS	1	No technique at all
	2	Visual inspection
	3	Descriptive statistics
	4	Control charts
	5	Statistical process control
	6	Acceptance sampling
	7	Date driven inventory system
	8	Software packages
	9	Prato charts
	10	Histograms
	11	Scatter charts
	12	Check sheets
	13	Graphs
QCTUSE2	1	No technique at all
	2	Visual inspection
	3	Descriptive statistics
	4	Control charts
	5	Statistical process control
	6	Acceptance sampling
	7	Date driven inventory system

	8	Software packages
	9	Prato charts
	10	Histograms
	11	Scatter charts
	12	Check sheets
	13	Graphs
QCTUSE3	1	No technique at all
	2	Visual inspection
	3	Descriptive statistics
	4	Control charts
	5	Statistical process control
	6	Acceptance sampling
	7	Date driven inventory system
	8	Software packages
	9	Prato charts
	10	Histograms
	11	Scatter charts
	12	Check sheets
	13	Graphs
QCTUSE4	1	No technique at all
	2	Visual inspection
	3	Descriptive statistics
	4	Control charts
	5	Statistical process control
	6	Acceptance sampling
	7	Date driven inventory system
	8	Software packages
	9	Prato charts
	10	Histograms
	11	Scatter charts
	12	Check sheets
	13	Graphs
WQATQUS	1	No technique at all
	2	Work instructions (SOPs)
	3	Setting inspection & testing requirments

	4	Control plans
	5	Finished product record review
	6	Knowledge management
	7	Regular Quality audit
	8	Automation
	9	Supplier evaluation
	10	Failure mode analysis
QATUSE2	1	No technique at all
	2	Work instructions (SOPs)
	3	Setting inspection & testing requirments
	4	Control plans
	5	Finished product record review
	6	Knowledge management
	7	Regular Quality audit
	8	Automation
	9	Supplier evaluation
	10	Failure mode analysis
QATUSE3	1	No technique at all
	2	Work instructions (SOPs)
	3	Setting inspection & testing requirments
	4	Control plans
	5	Finished product record review
	6	Knowledge management
	7	Regular Quality audit
	8	Automation
	9	Supplier evaluation
	10	Failure mode analysis
QATUSE4	1	No technique at all
	2	Work instructions (SOPs)
	3	Setting inspection & testing requirments
	4	Control plans
	5	Finished product record review
	6	Knowledge management
	7	Regular Quality audit

	8	Automation
	9	Supplier evaluation
	10	Failure mode analysis
WQITQUS	1	No technique at all
	2	Customer feedback
	3	Bench marking
	4	Employee suggestion scheme
	5	Improvement teams
	6	Corporate social responsibility
	7	Lean
	8	SWOT analysis
	9	Quality function deployment
	10	Total quality management
	11	Business porcess reengineering
	12	PDCA cylcle
	13	Six sigma
	14	Balance scorecard
	15	Supplier development
	16	Research & Development
QITUSE2	1	No technique at all
	2	Customer feedback
	3	Bench marking
	4	Employee suggestion scheme
	5	Improvement teams
	6	Corporate social responsibility
	7	Lean
	8	SWOT analysis
	9	Quality function deployment
	10	Total quality management
	11	Business porcess reengineering
	12	PDCA cylcle
	13	Six sigma
	14	Balance scorecard
	15	Supplier development
	16	Research & Development
QITUSE3	1	No technique at all

	2	Customer feedback
	3	Bench marking
	4	Employee suggestion scheme
	5	Improvement teams
	6	Corporate social responsibility
	7	Lean
	8	SWOT analysis
	9	Quality function deployment
	10	Total quality management
	11	Business porcess reengineering
	12	PDCA cylcle
	13	Six sigma
	14	Balance scorecard
	15	Supplier development
	16	Research & Development
TMANFUL	1	Strongly disagree
	2	Disagree
	3	Undecided
	4	Agree
	5	Strongly agree
COGIVTR	1	Strongly disagree
	2	Disagree
	3	Undecided
	4	Agree
	5	Strongly agree
ALCATRES	1	Strongly disagree
	2	Disagree
	3	Undecided
	4	Agree
	5	Strongly agree
TEAMWRK	1	Strongly disagree
	2	Disagree
	3	Undecided
	4	Agree
	5	Strongly agree
DOCSATR	1	Strongly disagree

	2	Disagree
	3	Undecided
	4	Agree
	5	Strongly agree
COMGOOD	1	Strongly disagree
	2	Disagree
	3	Undecided
	4	Agree
	5	Strongly agree
FOCUSQ	1	Strongly disagree
	2	Disagree
	3	Undecided
	4	Agree
	5	Strongly agree
QMSEDIT	1	Strongly disagree
	2	Disagree
	3	Undecided
	4	Agree
	5	Strongly agree
COSTSUS	1	Strongly disagree
	2	Disagree
	3	Undecided
	4	Agree
	5	Strongly agree
CONEWTQ	1	Strongly disagree
	2	Disagree
	3	Undecided
	4	Agree
	5	Strongly agree
COSELB	1	Strongly disagree
	2	Disagree
	3	Undecided
	4	Agree
	5	Strongly agree
FULLYFOL	1	Strongly disagree
	2	Disagree

	3	Undecided
	4	Agree
	5	Strongly agree
FULLFILLS	1	Strongly disagree
	2	Disagree
	3	Undecided
	4	Agree
	5	Strongly agree
COSHOUL	1	Strongly disagree
	2	Disagree
	3	Undecided
	4	Agree
	5	Strongly agree

APPENDIX-E

DATA IN SPSS

1	Assistant t	Quality co	Quality co	Assistant t	Assistant t	Quality co	Chemist	Quality co	Chemist
2	11 to 15 ye	21 to 25 ye	21 to 25 ye	6 to 10 ye	6 to 10 ye	21 to 25 ye	11 to 15 ye	16 to 20 ye	6 to 10 ye
3	11 to 15 ye	11 to 15 ye	6 to 10 ye	1 to 5 year	6 to 10 ye	11 to 15 ye	6 to 10 ye	6 to 10 ye	1 to 5 year
4	Master	Master	Master	Master	Master	Master	Master	Master	Master
5	Cement	Cement	Cement	Cement	Cement	Cement	Cement	Cement	Cement
6	1981 - 199	1981 - 199	1981 - 199	1981 - 199	2001 - 201	2001 - 201	2001 - 201	2001 - 201	2001 - 201
7	Above 70	Above 70	601 - 700	601 - 700	501 - 600	501 - 600	401 - 500	401 - 500	401 - 500
8	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
9	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
10	No	No	Yes	No	No	No	Yes	No	Yes
11	Don't kno	Don't kno	Yes	Yes	Yes	Yes	Don't kno	Yes	No
12	Don't kno	Don't kno	Yes	Yes	Yes	Yes	Don't kno	Yes	Don't kno
13	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
14	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
15	Yes	Yes	Yes	Don't kno	No	Yes	No	No	Yes
16	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
17	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
18	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
19	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
20	No	No	No	No	No	No	Yes	Yes	No
21	Yes	Yes	Yes	Yes	No	No	No	No	No
22	PS-232-20	PS-232-20	PS-232-20	PS-232-20	PS-232-20	PS-232-20	PS-232-20	PS-232-20	PS-232-20
23									
24									
25									
26									
27	Control ch	Control ch	Statistical	Acceptanc	Acceptanc	Acceptanc	Descriptiv	Control ch	Control ch
28	Statistical	Acceptanc	Acceptanc	Descriptiv	Statistical	Control ch	Check she	Check she	Acceptanc
29	Acceptanc	Statistical	Control ch	Statistical	Visual ins	Date drive	Software	Descriptiv	Descriptiv
30	Date drive	Date drive	Visual ins	Date drive	Date drive	Statistical	Visual ins	Software	Visual ins
31	Control pl	Work instr	Setting ins	Work instr	Control pl	Control pl	Control pl	Control pl	Work instr
32	Work instr	Control pl	Control pl	Control pl	Finished p	Finished p	Work instr	Work instr	Control pl
33	Finished p	Finished p	Work instr	Finished p	Work instr	Work instr	Regular Q	Regular Q	Finished p
34	Setting ins	Setting ins	Regular Q	Setting ins	Supplier e	Supplier e	Automatic	Automatic	Setting ins
35	Quality fu	Improvem	Customer	Bench ma	Quality fu	Customer	Customer	Customer	Bench ma
36	Improvem	Total qual	Lean	Customer	SWOT ana	Bench ma	Employee	Employee	SWOT ana
37			Quality fu	SWOT ana	Employee	Lean	SWOT ana	SWOT ana	Lean
38	Agree	Strongly a	Agree	Agree	Agree	Strongly d	Agree	Agree	Agree
39	Agree	Strongly a	Strongly a	Agree	Agree	Agree	Strongly a	Strongly a	Agree
40	Strongly a	Agree	Agree	Strongly a	Agree	Strongly a	Agree	Strongly a	Agree
41	Agree	Agree	Agree	Agree	Strongly a	Agree	Strongly a	Agree	Strongly a
42	Agree	Strongly a	Strongly a	Strongly a	Strongly a	Agree	Agree	Agree	Agree
43	Strongly a	Agree	Agree	Agree	Undecide	Agree	Strongly a	Strongly a	Agree
44	Strongly a	Disagree	Disagree	Agree	Agree	Disagree	Agree	Agree	Disagree
45	Agree	Agree	Agree	Strongly a	Agree	Agree	Agree	Agree	Agree
46	Agree	Agree	Agree	Strongly a	Agree	Agree	Agree	Agree	Agree
47	Undecide	Undecide	Agree	Undecide	Undecide	Undecide	Strongly a	Agree	Undecide
48	Strongly a	Agree	Disagree	Agree	Agree	Agree	Agree	Agree	Disagree
49	Strongly a	Strongly a	Agree	Agree	Strongly a	Strongly a	Strongly a	Strongly a	Agree
50	Agree	Strongly a	Agree	Strongly a	Agree	Agree	Strongly a	Agree	Agree
51	Strongly a	Agree	Strongly a	Agree	Agree	Agree	Strongly a	Agree	Agree

1	Chemist	Quality co	Assistant	Quality co	Assistant	Quality co	Chemist	Assistant	Chemist	Quality co
2	6 to 10 ye	21 to 25 ye	11 to 15 ye	16 to 20 ye	6 to 10 ye	Above 25	6 to 10 ye	16 to 20 ye	11 to 15 ye	16 to 20 ye
3	1 to 5 year	16 to 20 ye	6 to 10 ye	1 to 5 year	6 to 10 ye	6 to 10 ye	1 to 5 year	11 to 15 ye	6 to 10 ye	6 to 10 ye
4	Master	Master	Master	Master	Master	Graduatio	Master	Master	Master	Master
5	Cement	Cement	Cement	Cement	Cement	Cement	Cement	Cement	Cement	Cement
6	2001 - 201	1991 - 200	1991 - 200	2001 - 201	2001 - 201	2001 - 201	2001 - 201	1981 - 199	1981 - 199	Before 19
7	401 - 500	501 - 600	501 - 600	601 - 700	601 - 700	501 - 600	501 - 600	501 - 600	501 - 600	Above 700
8	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
9	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
10	No	Yes	Yes	No	Yes	No	No	No	No	No
11	Yes	Don't kno	Don't kno	Yes	No	Yes	Yes	Yes	Yes	Yes
12	Yes	Don't kno	Don't kno	Yes	Yes	Yes	Yes	Yes	Yes	Yes
13	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
14	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
15	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
16	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
17	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
18	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
19	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
20	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No
21	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
22	PS-232-20	PS-232-20	PS-232-20	PS-232-20	PS-232-20	PS-232-20	PS-232-20	PS-232-20	PS-232-20	PS-232-20
23				ASTM	ASTM			European	European	
24				European	European			ASTM	ASTM	
25				BS	BS					
26				SLS	SLS					
27	Control ch	Control ch	Control ch	Control ch	Acceptanc	Acceptanc	Acceptanc	Control ch	Control ch	Statistical
28	Acceptanc	Acceptanc	Acceptanc	Acceptanc	Date drive	Statistical	Statistical	Acceptanc	Acceptanc	Acceptanc
29	Descriptiv	Descriptiv	Descriptiv	Date drive	Graphs	Software	Software	Date drive	Date drive	Descriptiv
30	Visual ins	Visual ins	Date drive	Statistical	Visual ins	Visual ins	Visual ins	Visual ins	Visual ins	Visual ins
31	Work inst	Work inst	Setting ins	Control pl	Setting ins	Work inst	Work inst	Control pl	Control pl	Setting ins
32	Setting ins	Setting ins	Work inst	Regular Q	Knowledg	Setting ins	Setting ins	Setting ins	Setting ins	Control pl
33	Finished p	Finished p	Control pl	Finished p	Automatic	Finished p	Finished p	Work inst	Work inst	Automatic
34	Regular Q	Regular Q	Automatic	Work inst	Regular Q	Regular Q	Regular Q	Finished p	Finished p	Finished p
35	Bench ma	Bench ma	Bench ma	Customer	Employee	Customer	Customer	PDCA cylc	PDCA cylc	Customer
36	No techni	Customer	Customer	Bench ma	PDCA cylc	Corporate	Corporate	Customer	Customer	Employee
37	Lean	SWOT ana	Quality fu	Lean	SWOT ana	Lean	Lean	Bench ma	Bench ma	Quality fu
38	Strongly a	Agree	Agree	Strongly a	Strongly a	Strongly a	Agree	Strongly a	Strongly a	Strongly a
39	Agree	Agree	Strongly a	Agree	Strongly a	Agree	Agree	Strongly a	Strongly a	Strongly a
40	Strongly a	Strongly a	Agree	Agree	Agree	Strongly a	Agree	Agree	Agree	Strongly a
41	Strongly a	Agree	Strongly a	Strongly a	Agree	Strongly a	Agree	Agree	Agree	Agree
42	Agree	Strongly a	Agree	Strongly a	Agree	Agree	Agree	Agree	Agree	Strongly a
43	Agree	Strongly a	Strongly a	Strongly a	Agree	Strongly a	Agree	Strongly a	Strongly a	Agree
44	Disagree	Strongly a	Disagree	Strongly a	Agree	Agree	Agree	Strongly a	Strongly a	Disagree
45	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Strongly a
46	Agree	Agree	Strongly a	Agree	Agree	Strongly a	Agree	Agree	Agree	Strongly a
47	Undecide	Undecide	Undecide	Agree	Agree	Strongly a	Agree	Undecide	Undecide	Undecide
48	Disagree	Agree	Disagree	Agree	Agree	Strongly a	Agree	Strongly d	Strongly d	Agree
49	Strongly a	Strongly a	Strongly a	Agree	Agree	Strongly a	Agree	Strongly a	Strongly a	Strongly a
50	Strongly a	Strongly a	Agree	Agree	Strongly a	Strongly a	Strongly a	Agree	Agree	Agree
51	Agree	Agree	Agree	Agree	Strongly a	Strongly a	Agree	Strongly a	Agree	Undecide

1	Chemist	Quality co	Chemist	Quality co	Assistant t	Assistant t	Chemist	Quality co	Assistant t	Quality co
2	1 to 5 year	21 to 25 ye	6 to 10 ye	16 to 20 ye	6 to 10 ye	Above 25	11 to 15 ye	16 to 20 ye	6 to 10 ye	Above 25
3	1 to 5 year	11 to 15 ye	1 to 5 year	1 to 5 year	6 to 10 ye	1 to 5 year	6 to 10 ye	1 to 5 year	1 to 5 year	6 to 10 ye
4	Master	Master	Master	Master	Master	Graduatio	Master	Master	Master	Graduatio
5	Cement	Cement	Cement	Cement	Cement	Cement	Cement	Cement	Cement	Cement
6	Before 19	1981 - 199	1981 - 199	1991 - 200	1991 - 200	1971 - 198	1971 - 198	1991 - 200	1991 - 200	1991 - 200
7	Above 70	Above 70	Above 70	Above 70	Above 70	501 - 600	501 - 600			
8	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
9	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
10	No	No	Yes	No	No	Yes	Yes	No	No	No
11	Yes	Yes	Don't kno	Yes	Yes	Don't kno	Don't kno	Yes	Yes	No
12	Yes	Yes	Don't kno	Yes	Yes	Don't kno	Don't kno	Yes	Yes	Yes
13	Yes	Yes	Don't kno	Yes	Yes	No	No	Yes	Yes	Yes
14	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
15	Yes	Yes	Don't kno	Yes	Yes	Yes	Yes	Yes	Yes	Yes
16	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
17	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
18	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
19	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
20	No	No	No	Yes	Yes	No	No	No	No	Yes
21	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
22	PS-232-20	PS-232-20	PS-232-20	PS-232-20	PS-232-20	PS-232-20	PS-232-20	PS-232-20	PS-232-20	PS-232-20
23						European	European	ASTM	ASTM	IS
24								BS	BS	SABS
25								IS	IS	SLS
26								European	European	Nigeria
27	Statistical	Acceptanc	Control ch	Statistical	Statistical	Control ch	Control ch	Descriptiv	Descriptiv	Statistical
28	Acceptanc	Control ch	Acceptanc	Control ch	Control ch	Acceptanc	Acceptanc	Acceptanc	Acceptanc	Control ch
29	Descriptiv	Visual ins	Graphs	Acceptanc	Acceptanc	Check she	Check she	Control ch	Control ch	Software
30	Visual inspection		Visual ins	Descriptiv	Descriptiv	Graphs	Graphs	Visual ins	Visual ins	Visual ins
31	Setting ins	Work instr	Control pl	Control pl	Control pl	Work instr	Work instr	Regular Q	Regular Q	Automatic
32	Control pl	Control pl	Work instr	Setting ins	Setting ins	Setting ins	Setting ins	Control pl	Control pl	Setting ins
33	Automatic	Regular Q	Supplier e	Work instr	Work instr	Regular Q	Regular Q	Automatic	Automatic	Work instr
34	Finished p	Supplier e	Regular Q	Automatic	Automatic	Supplier e	Supplier e	Setting ins	Setting ins	Regular Q
35	Customer	Bench ma	Customer	SWOT ana	SWOT ana	Bench ma	Bench ma	Customer	Customer	Corporate
36	Employee	Customer	Bench ma	Customer	Customer	Customer	Customer	Quality fu	Quality fu	Lean
37	Quality fu	Employee	Employee	Lean	Lean	SWOT ana	SWOT ana	Corporate	Corporate	SWOT ana
38	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Strongly a	Strongly a	Strongly a
39	Agree	Agree	Strongly a	Strongly a	Strongly a	Strongly a	Strongly a	Agree	Agree	Strongly a
40	Strongly a	Agree	Strongly a	Agree	Agree	Strongly a	Strongly a	Strongly a	Strongly a	Strongly a
41	Strongly a	Agree	Agree	Agree	Agree	Strongly a	Strongly a	Agree	Agree	Strongly a
42	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Strongly a
43	Agree	Strongly a	Agree	Strongly a	Strongly a	Agree	Agree	Strongly a	Strongly a	Agree
44	Undecide	Agree	Undecide	Disagree	Disagree	Disagree	Disagree	Disagree	Disagree	Disagree
45	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Strongly a	Strongly a	Agree
46	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Strongly a
47	Disagree	Undecide	Undecide	Disagree	Disagree	Undecide	Undecide	Disagree	Disagree	Undecide
48	Agree	Undecide	Disagree	Agree	Agree	Strongly a	Strongly a	Agree	Agree	Disagree
49	Strongly a	Agree	Strongly a	Agree	Agree	Strongly a	Strongly a	Strongly a	Strongly a	Strongly a
50	Agree	Agree	Strongly a	Agree	Agree	Strongly a	Strongly a	Agree	Agree	Agree
51	Agree	Undecide	Agree	Undecide	Undecide	Strongly a	Undecide	Agree	Agree	Undecide

1		Quality co	Assistant t	Quality co	Assistant t	Quality co	Chemist	
2	6 to 10 ye	16 to 20 ye	6 to 10 ye	21 to 25 ye	11 to 15 ye	Above 25	6 to 10 years	
3	1 to 5 year	1 to 5 year	6 to 10 ye	16 to 20 ye	6 to 10 ye	6 to 10 ye	1 to 5 years	
4	Master	Master	Master	Master	Master	Graduatio	Master	
5	Cement	Cement	Cement	Cement	Cement	Cement	Cement	
6	1991 - 200	2001 - 201	2001 - 201	1991 - 200	1991 - 200	2001 - 201	2001 - 2010	
7		601 - 700	601 - 700	501 - 600	501 - 600	501 - 600	501 - 600	
8	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
9	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
10	No	No	Yes	Yes	Yes	No	No	
11	No	Yes	No	Don't kno	Don't kno	Yes	Yes	
12	Yes	Yes	Yes	Don't kno	Don't kno	Yes	Yes	
13	Yes	Yes	Yes	Yes	No	Yes	Yes	
14	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
15	Yes	Yes	Yes	No	Yes	Yes	Yes	
16	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
17	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
18	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
19	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
20	Yes	Yes	Yes	No	No	Yes	Yes	
21	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
22	PS-232-20	PS-232-20	PS-232-20	PS-232-20	PS-232-20	PS-232-20	PS-232-2008(R) & Oth	
23	IS	ASTM	ASTM					
24	SABS	European	European					
25	SLS	BS	BS					
26	Nigeria	SLS	SLS					
27	Statistical	Control ch	Acceptanc	Control ch	Control ch	Acceptanc	Acceptance sampling	
28	Control ch	Acceptanc	Date drive	Acceptanc	Acceptanc	Statistical	Statistical process co	
29	Software	Date drive	Graphs	Descriptiv	Descriptiv	Software	Software packages	
30	Visual ins	Statistical	Visual ins	Visual ins	Date drive	Visual ins	Visual inspection	
31	Automatic	Control pl	Setting in	Work instr	Setting in	Work instr	Work instructions (S	
32	Setting in	Regular Q	Knowledg	Setting in	Work instr	Setting in	Setting inspection &	
33	Work instr	Finished p	Automatic	Finished p	Control pl	Finished p	Finished product rec	
34	Regular Q	Work instr	Regular Q	Regular Q	Automatic	Regular Q	Regular Quality audit	
35	Corporate	Customer	Employee	Bench ma	Bench ma	Customer	Customer feedback	
36	Lean	Bench ma	PDCA cylc	Customer	Customer	Corporate	Corporate social resp	
37	Bench ma	Lean	SWOT ana	SWOT ana	Quality fu	Lean	Lean	
38	Strongly a	Strongly a	Strongly a	Agree	Agree	Strongly a	Agree	
39	Strongly a	Agree	Strongly a	Agree	Strongly a	Agree	Agree	
40	Strongly a	Agree	Agree	Strongly a	Agree	Strongly a	Agree	
41	Strongly a	Strongly a	Agree	Agree	Strongly a	Strongly a	Agree	
42	Strongly a	Strongly a	Agree	Strongly a	Agree	Agree	Agree	
43	Agree	Strongly a	Agree	Strongly a	Strongly a	Strongly a	Agree	
44	Disagree	Strongly a	Agree	Strongly a	Disagree	Agree	Agree	
45	Agree	Agree	Agree	Agree	Agree	Agree	Agree	
46	Strongly a	Agree	Agree	Agree	Strongly a	Strongly a	Agree	
47	Undecide	Agree	Agree	Undecide	Undecide	Strongly a	Agree	
48	Disagree	Agree	Agree	Agree	Disagree	Strongly a	Agree	
49	Strongly a	Agree	Agree	Strongly a	Strongly a	Strongly a	Agree	
50	Agree	Agree	Strongly a	Strongly a	Agree	Strongly a	Strongly agree	
51	Undecide	Agree	Strongly a	Agree	Agree	Strongly a	Agree	

APPENDIX-F

LIST OF SAMPLE COMPANIES

A. CEMENT COMPANIES THOSE RESPONDED.

1. **ASKARI CEMENT LTD. (WAH)**
   Address: AWT Plaza, 4th Floor, Cantt. Rawalpindi.
   Phone:(92-51) 5567814 / 5567812 / 5586218 Fax:(92-51) 5567750
   Face-to-face interview with QC & Assistant QC manager, Nadeem Kosar

2. **ASKARI CEMENT LTD. (Nizampur)**
   Address: AWT Plaza, 4th Floor, Cantt. Rawalpindi.
   Phone:(92-51) 5567814 / 5567812 / 5586218 Fax:(92-51) 5567750
   Face-to-face interview with QC & Assistant QC manager, Nadeem Kosar

3. **CHERAT CEMENT COMPANY LTD.**
   Address: Modern Motors House,3rd Floor, Beaumont Road, Karachi.
   Phone:(92-21) 5683567 / 5683566 / 5689538 / 5688348 Fax:(92-21) 5683425
   Respondent. Zaffar iqbal; Ph. 091-5270531-4; e-mail: zaffar.iqbal@gfg.com.pk

4. **D.G. KHAN CEMENT COMPANY LTD.**
   Address: Nishat House,53-A,Lawrence Road Lahore
   Phone:(92-42) 6367820 / 6367812 / 6367813 / 6367814 Fax:(92-42) 6367414
   Factory Information:
   P.O.D.G.Khan Cement D.G.Khan.
   Phone:(92-641) 63760 / 63889 (92-641) 62392

   Face –to- face interview & e-mail; Cell: 0334-8768850; e-mail: galvi@dgcement.com)

5. **BESTWAY CEMENT LTD. (Hattar)**
   Address: UBL Building, 5th Floor, Jinnah Avenue, Blue Area Islamabad.
   Phone:(92-51) 2206151 / 2206146 / 2206147 / 2206178 Fax:(92-51) 2272150
   Face-to-face interview with QC & Assistant QC, Cell: 0343-8480225)

6. **BESTWAY CEMENT LTD. (Kalar kahar)**
   Address: UBL Building, 5th Floor, Jinnah Avenue, Blue Area Islamabad.
   Phone:(92-51) 2206151 / 2206146 / 2206147 / 2206178 Fax:(92-51) 2272150
   Face-to-face interview with QC & Assistant QC, Cell: 0343-8480225)

7. **DANDOT CEMENT COMPANY LTD.**
   Address: 26-Empress Road, P.O.Box:1285 Lahore.
   Phone:(92-42) 6365249 / 6365549 / 6365576 Fax:(92-42) 6278900
   Response through phone call, cell: 0334-8628115, QC Manager Sabar Husain

8. **FAUJI CEMENT COMPANY LTD.**
   Address: 61 Harley Street, P.O.Box:84 Rawalpindi.
   Phone:(92-51) 5514474 / 5514965 / 5515512 / 5525740 Fax:(92-51) 5517311
   Face-to-face interview, QC Malik Mehmood)

9. **FECTO CEMENT LTD.**
   35,Darul-Aman-Housing Society,Block 7 & 8,Shahrah-e- Faisal, Karachi.
   Phone:(92-21) 4530122 / 4530120 / 4530121 / 4530124 Fax:(92-21) 4530123
   email:cement@cyber.net.pk Web:
   Factory Information:
   Sangjani Islamabad.
   Phone:(92-51) 2296065 / 2296066
   Respondent: Face-Face interview with QC Manager, Assistant QC Manager
   Cell: 03018561322)

10. **KOHAT CEMENT COMPANY LIMITED**
    43/1-FCC,Syed Muratib Ali Road,Gulberg-IV, Lahore.
    Phone:(92-42) 5754358 / 5754357 / 5752699 Fax:(92-42) 5754084
    email:kccl@wol.net.pk
    Factory Information:
    Pindi Road, Kohat.
    Phone:(92-922) 560404 / 560401 / 560402 / 560403
    Response through e-mail and Phone call, e-mail: Quality@kohatcement.com
    Cell: 0333-9629500 Mosad Quarashi)

11. **LAFARGE PAKISTAN Ltd.**
    Chhoie Mallot Road, Tehsil Kalar Kahar, Dist. Chakwal; Phone 0543-4020230
    Face-to-face interview with QC/QA Team

12. LUCKY CEMENT LIMITED

6-A,Muhammad Ali H. Society,A. Aziz Hashim Tabba Street, Karachi.

Phone:(92-21) 4530450 / 4530454 / 4537390 Fax:(92-21) 4534302

Email:luckycm@cyber.net.pk Web:http://www.lucky-cement.com

Factory Information:

Pezu District Lakki Marwat,N.W.F.P. Bannu.

Phone:(92-928) 780126-780123-780124-780125 (92-928) 780122

Response through phone call & E-mail; e-mail: managerqc@hotmail.com

Cell: 0321-2483026, Assistant QC manager, Wajid

13. MAPLE LEAF CEMENT FACTORY LTD.

42-Lawrence Road Lahore.

Phone:(92-42) 6305883-6278904-6278905 Fax:(92-42) 6306049

Factory Information:

Skindarabad, Daud Khail, Distt. Mianwali.

Response through e-mail & phone call: E-mail:nadeemnoor116@hotmail.com ;

Cell: 0345-7643158)

14. MUSTEHKAM CEMENT LTD.

Gul-e-Akra Plaza,147 Murree Road,Cantt.,P.O.Box 174, Rawalpindi.

Phone:(92-51) 5580422-5568993-5566776-5564795 Fax:(92-51) 5568607

Factory Information:

Hattar Haripur.

Phone:(92-995) 2866-7243-7245

Face-to-face interview with QC & Assistant QC Manager

15. DEWAN HATTAR CEMENT Ltd.

Trade Centre,A-14,Block 7/8,K.C.H.S.,Shahrah-e-Faisal, Karachi.

Phone:(92-21) 4559175-4559171-4383872-4383874 Fax:(92-21) 4550767

E-mail:pakland@pakland.khi.erum.com.pk

Face-to-face interview. Cell:0313-9026608,Chemist, Babar)

16. PIONEER CEMENT LIMITED.

7th Flr,Lakson Square Bldg.#3,Sarwar Shaheed Road, Karachi.

Phone:(92-21) 5685055-5685052-5685054-5685053 Fax:(92-21) 5685051

E-mail:noonpcl@cyber.net.pk

Response through phone call: Ph#: 0454-898103;

E-mail: mqc@pioneercement.com

17. THATTA CEMENT COMPANY LTD.

Progressive Plaza,Beaumont Road Karachi.

Phone:(92-21) 5682771-5686556-5219522 Fax:(92-21) 5683219

Factory Information:

Makli Ghulamullah Road Thatta.

Phone:(92-29) 770733-770731-770735-770536 (92-29) 770479

Response through Phone call & e-mail; e-mail: gmworks_tcc@yahoo.com)

18. D.G. KHAN CEMENT COMPANY LTD.

Address: Nishat House,53-A,Lawrence Road Lahore

Phone:(92-42) 6367820 / 6367812 / 6367813 / 6367814 Fax:(92-42) 6367414

Factory Information:

P.O.D.G.Khan Cement D.G.Khan.

Phone:(92-641) 63760 / 63889 (92-641) 62392

Face-to-face interview & e-mail; Cell: 0334-8768850;

E-mail: galvi@dgcement.com)

B. CEMENT COMPANIES CONTACTED BUT NOT RESPONDED

1. ATTOCK CEMENT PAKISTAN LTD.

Address: 5th Floor,PNSC Building,M.T.Khan Road,P.O.Box:1120, Karachi.

Phone:(92-21) 5611020 / 5611019 / 5611841 / 5611842

Fax:(92-21) 5610820

Contacted through E-mail: E-mail: Salim.Muhammad41@yahoo.com

2. GHARIBWAL CEMENT Ltd.

Ismailwal, Distt. Chakwal, Punjab, Pakistan.

Phone: (92-544)-435167-8 Fax: (92-544)-430469

3. A.C.-Rori Cement Limited:

Tel: 0092- (0)42- 7598 312

Fax: 0092- (0)42- 7574 846

Email: info@cement.com.pk

Web: www.cement.com.p

C. CEMENT COMPANIESWITH INCORRECT ADDRESSES

1. **ZealPak CEMENT Ltd.**
2. **JAVEDAN CEMENT Ltd.**

   Manghopir, Karachi-75890

   Ph.92-21-6980026

   info@jcl.com.pk
3. **Al-ABBAS CEMENT Ltd.**
4. **DADABHOY CEMENT Ltd.**
5. **FLY CEMENT Ltd.**