# ASSESSMENT OF IMPLEMENTATION LEVEL OF QUALITY MANAGEMENT STANDARDS IN RE-ROLLING STEEL MILLS (DEFORMED STEEL BARS) IN PAKISTAN

by

**Muhammad Usman Iqbal**

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**Department of Construction Engineering and Management**
**National Institute of Transportation**
**School of Civil & Environmental Engineering**
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This is to certify that the

thesis entitled

# ASSESSMENT OF IMPLEMENTATION LEVEL OF QUALITY MANAGEMENT STANDARDS IN RE-ROLLING STEEL MILLS (DEFORMED STEEL BARS) IN PAKISTAN

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has been accepted towards the partial fulfillment

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of

Master of Science in Construction Engineering and Management

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**DEDICATED**

**TO**

**MY PARENTS**

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# ABSTRACT

Quality of construction project is mainly depended on quality of construction materials and the workmanship. The construction industry of Pakistan has been struggling with quality issues since long. The ineffective quality regulatory body and non availability of local quality standard specifications could not give a clear direction to local construction materials industry and compelled to follow international standards for high quality products. This issue has also resulted in production of many substandard and counterfeit products. The purpose of this research is an attempt to evaluate the implementation of quality management standards in Re-rolling Steel Mills during manufacturing of steel bars looking insight the knowledge and registration of Re-rolling mills with Organizations of International Standardization and Standards. A small survey was conducted to gather information of prevalence of quality management system in Re-rolling steel mills. The survey starts with a questionnaire which is designed to collect data from the executives and quality assurance personnel of Re-rolling mills. By analyzing the response to the questionnaire, the opinion of the executives and quality responsible personnel of Re-rolling steel mills on the quality assurance and control in general and its particular application in the manufacturing of deformed steel bars was comprehended. The collected data was analyzed by SPSS software using four types of statistical analysis, namely Shapiro-Wilk test for normality distribution, Frequency distribution, Friedman One-way ANOVA for comparison of Means and test for outliers. This study tries to, by gathering the theories drawn from literature review and field survey, examine the prevalence of quality management standards in Re-rolling Steel Mills in order to give recommendations for the improvement of the service quality. The findings of this study shows that the overall ranking of Quality assurance and Quality control procedures basing on their means is (1) Specification (2) Control of non conforming products (3) Test equipment (4) Internal quality audits (5) Suppliers quality assurance (6) Quality plan and management procedures (7) Monitoring, inspection and testing (8) Handling, storage, packing and delivery (9) Involvement of workers (10) Customers focus (11) Continual improvement (12) Document control (13) Statistical techniques (14) Personnel training. Pakistan Standards and Quality Control Authority (PSQCA) has developed Pakistan standards as PS 1879 and PS 1612 based on ASTM 615A and BS 4449 respectively being adjusted to

Pakistan environment by participation of renowned construction firms, universities and steel Re-rolling mills. Only 31 % steel Re-rolling mills being surveyed are registered with PSQCA which shows less attraction to PS and more confidence on ASTM 615-A and BS 4449. The certification with ISO is not very high and only 40% are holding the ISO certification and most of the company respondents consider it very important but complex, demanding and formally procedural. The research indicates quality control and quality assurance factors are implemented in the Re-rolling industry but quality improvement factors are given less attention. The QMS is not implemented in true spirit even in the mills which are ISO certified. The research might be useful to advise the Re-rolling industry to stress upon the quality management factors which are lacking in practice. The high quality steel products can enhance the life of structures in Pakistan as well as increase the volume of exports by building the international confidence. Also further study can be done on study of quality management system implemented in manufacturing of other construction materials. The quality of construction materials can also be studied from client, contractor and consultant perspective.

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| | |
|---|---|
| A/E | Architecture / Engineer |
| ANOVA | Analysis of Variance |
| ASTM | American Standards of Testing Materials |
| BS | British Standards |
| CC&I | Chamber of Commerce and Industries |
| Dev | Deviation |
| ISO | Organization for International Standardization |
| NESPAK | National Engineering Services Pakistan |
| NHA | National Highways Authority |
| NUST | National University of Sciences and Technologies |
| PDCA | Plan, Do, Check, Act |
| PSQCA | Pakistan Standard and Quality Control Authority |
| PSRMA | Pakistan Steel Re-rolling Mills Association |
| QA | Quality Assurance |
| QC | Quality Control |
| QM | Quality Management |
| QMS | Quality Management System |
| Std | Standard |
| SQC | Statistical Quality Control |
| TQC | Total Quality Control |
| TQM | Total Quality Management |
| UET | University of Engineering and Technology |

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*Chapter 1*

# INTRODUCTION

## 1.1 General

Originally a manufacturing-industry concern, quality is now acknowledged to be a key issue for the construction sector whose clients increasingly demand quality certification (Chung 2007). Time, cost and quality are commonly known as 'Iron Triangle' defined by Atkinson (1999) as shown in the Figure 1.1.

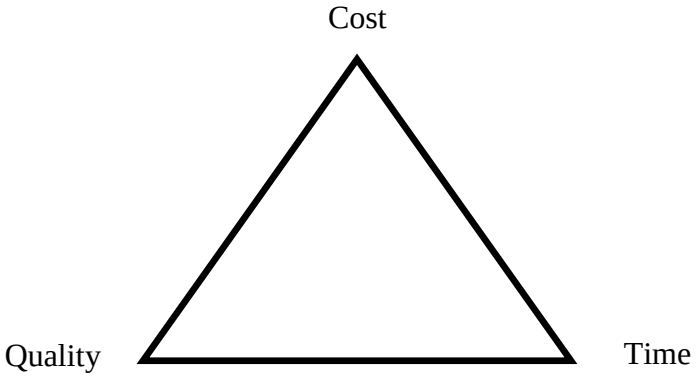


**Figure 0.1:** Project Constraint Triangle (*Atkinson, 1999*)

Quality in construction is defined as the conformance to requirements, as defined by the owner, architecture / engineer (A/E), contractors and the regulatory agencies (ASCE 1990). The responsibility of meeting these requirements rests with suppliers, A/E and contractors.

Product quality in the construction industry may refer to achieving quality in the materials, equipment and technology that go into the building of a structure (David and Murat 1997). Manufacturer's quality assurance plan is one of the most important functions besides the supplier's quality performance and pre-shipment verification. Effective quality management plans and systems are quite effective to overcome the pressure of time and competition.

Construction quality relies on accurate, clear statements of quality control requirements arrived at by translating user needs into specification and project quality

plans and programs (Stukhart 1989). Quality assurance is important in the engineering and construction industry because of the risk involved in any project (Bubshait 2000). The leading construction organizations select those suppliers and contractors whom they know based on their experience produce quality products.

Quality management (QM) can be considered to have four main components: quality planning, quality control, quality assurance and quality improvement (Rose 2005). In summary of the above, the quality assurance and control are back bone of material industry and ultimately the construction industry. The quality assurance and control are although similar in essence but they do differ. The purpose of QC is to find a production mistake or low quality material by testing the end-result of the product. The purpose behind QA is to test the materials and the quality of production during production process in an attempt to catch mistakes before the production process goes too far.

## 1.2 Problem Statement

Lack of confidence of consumers on the quality of deformed steel bars is still a question mark even after following the International standards like ASTM, BS and ISO certification being held by the Steel Re-rolling Mills, which restricts to reliable and time tested vendors for procurement of steel bars in the projects of important nature. This research aims at evaluating the satisfactory implementation of Quality Management Standards in re-rolling steel industry of Pakistan.

## 1.3 Objectives

In view of the above, the objectives of this research work are as follows:-

a. To evaluate the implementation of Quality Management Standards (QMS) for deformed steel bars in local Re-rolling steel industry.

b. To investigate the status of registration with national controlling authorities and international organization of standardization for local re-rolling steel mills.

c. To determine the standards / specifications being followed for deformed steel bars.

d. To recommend the areas to be stressed upon for increase of quality

services in steel re-rolling industry.

## 1.4 Scope

The areas of study selected were Islamabad, upper Punjab (Lahore, Gujranwala, Rawalpindi and Rawat), Peshawar and Hattar in Khyber Pukhtunkhuwa province as shown in Figure 1.2.

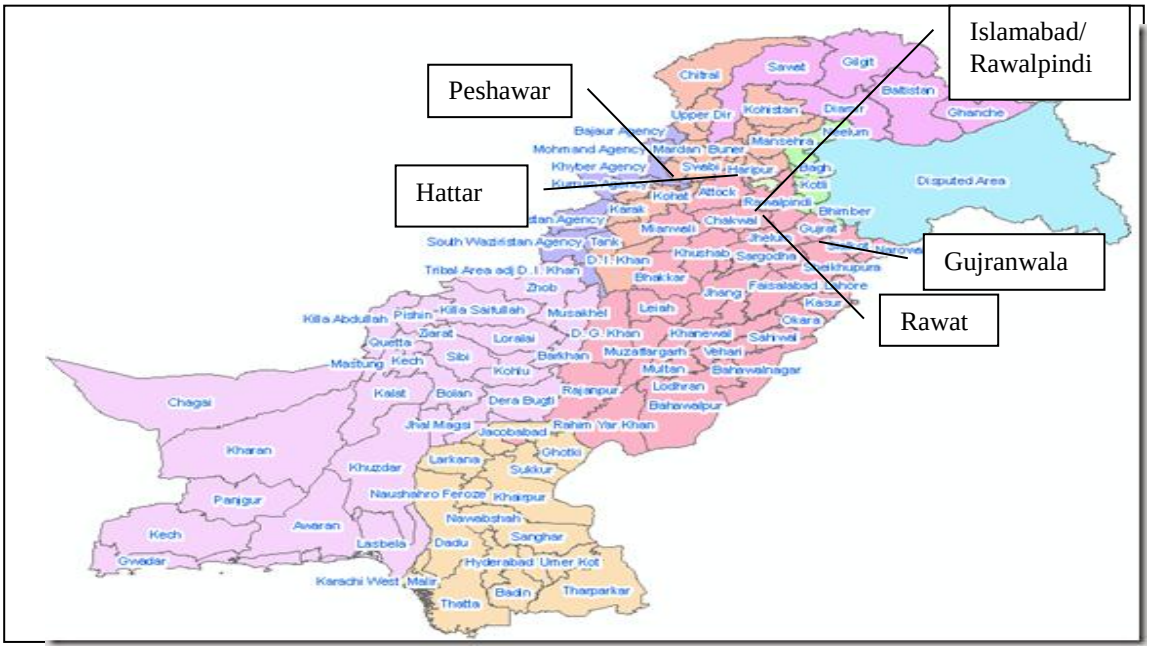


**Figure 0.2:** Areas Selected for Study

## 1.5 Research Significance

The study will give an insight of implementation of QMS in local re-rolling steel industry. The research will generate useful database of standards / specifications being followed for the manufacturing of deformed steel bars. The study will provide data base to controlling authorities for implementation of quality standards in re-rolling mills. The weak areas can be capitalized for enhancing the quality services.

## 1.6 Layout of Thesis

The study has been divided into five chapters. Chapter 2 covers the relevant literature review consisting of quality theories and philosophies given by researchers,

scholars and Gurus, previous studies on quality management and QA / QC procedures & practices for construction materials especially steel bars. Chapter 3 covers the methodology of the study and strategy for data analysis. Chapter 4 includes statistical results and analysis of the questionnaire based survey conducted. Finally Conclusions and Recommendations have been made in Chapter 5.

## 1.7 Summary

This chapter gave a brief introduction to importance of implementation of quality management system for construction material industry and listed the objectives of the research. This chapter briefly highlighted the research significance, its scope and provided overview of this dissertation.

# *Chapter 2*

# LITERATURE REVIEW

## 2.1 Introduction

Quality improvement is difficult to achieve unless quality is accurately and periodically measured (Trobica 1999).This chapter gives an overview of literature which is related to the research problem. This chapter introduces the importance of quality, its evolution, contribution of various researchers in developing concept and attributes of quality and eventually identification of quality assurance and control procedures for local construction material industry.

## 2.2 Evolution of Quality

Quality has its historical route through manufacturing. The existing quality procedures and processes have evolved through ages. The pursuit for quality distinction continued in all spheres of social and industrial life. This pursuit for quality is the real spirit of a never ending improvement process. The quality journey started with manual inspection by an artisan and now has reached to in-process self inspection and monitoring by machine eyes. Instruments and gauges are used extensively where required. Sub assemblies and systems are tested for performance evaluation. Statistical techniques are used for data collection, analysis and presentation. In recent times many firms have started to use many new operational methodologies for Quality Management such as Six Sigma and Lean Six Sigma. The general view of the evolution process starting from the artisan era, the supervisor era, the inspection era, the quality control era including Statistical Quality Control (SQC), Statistical Process Control (SPC) & Total Quality Control (TQC), The Quality Management System Era and Total Quality Management (TQM) philosophy based national quality awards era has been depicted in Figure 2.1.

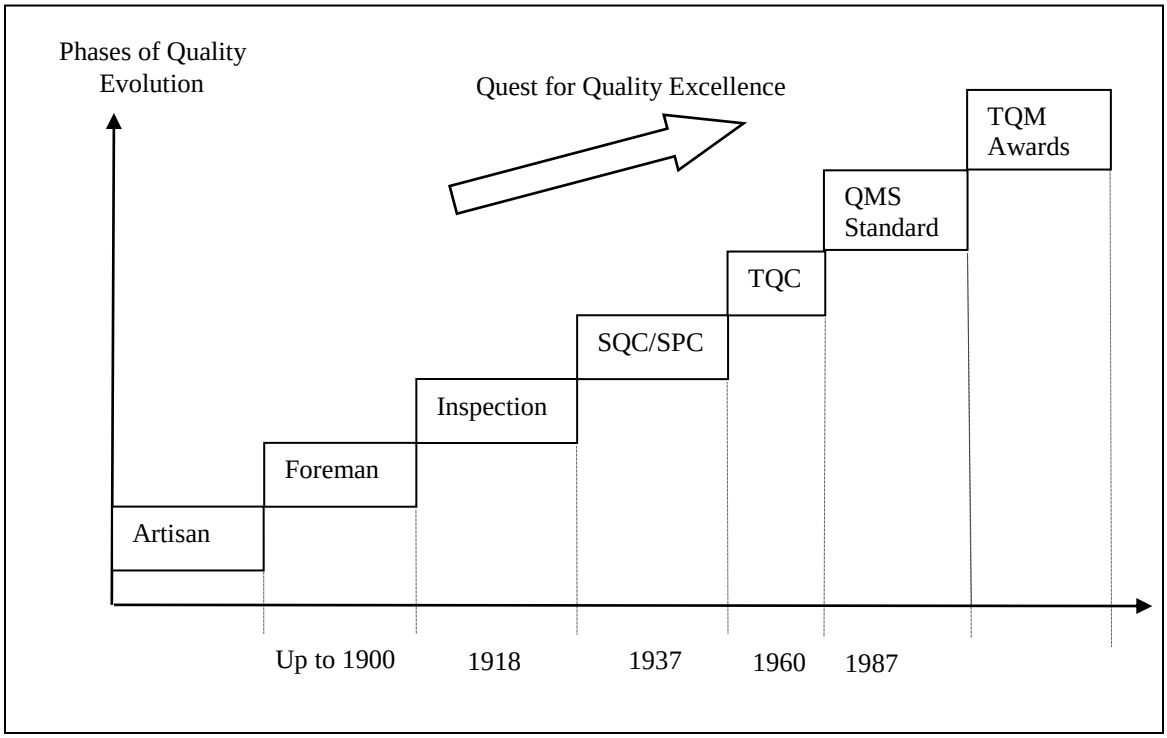


**Figure 0.1:** Quality Evolution Spectrums *(Evan and Lindsay, 2005)*

## 2.3 Researchers Contribution to Quality Philosophies

Various researchers, scholars and proponents have contributed to the philosophy of quality in their thoughts and concepts (Khan 2008). Crosby's (1979) stated the fourteen steps of quality improvement program as Management Commitment, Quality Improvement Team, Quality Measurement, Cost of Quality Evaluation, Quality Awareness, Corrective Action, Establish an Ad Hoc Committee for the Zero Defects Program, Supervisor Training, Zero Defects Day, Goal Setting, Error Cause Removal, Recognition, Quality Councils, Do it over again.

Deming's famous fourteen points for quality, its improvement and management as stated by (March 1996) are Create constancy of purpose for improvement of product and service, Adopt the new philosophy, Cease dependence on mass production, End the practice of awarding business on price tag alone, Constantly and forever improve the system of production and service, Institute modern methods of training on the job, Institute modern methods of supervising, Drive out fear, Break down barriers between departments, Eliminate numerical goals for the work force, Eliminate work standards and

numerical goals, Remove barriers that hinder the hourly workers, Institute a vigorous program of education and training, Create a structure in top management that will push every day on the above thirteen points thoughts and concepts (Khan 2008).

The ten steps in the quality improvement process as perceived by Juran (1989) are; Set goals for improvement, Build awareness of the need and opportunity for improvement, Provide training, Organize so as to reach the goals, Carry out projects to solve problems, Report progress, Keep score, Give recognition, Communicate results, Maintain momentum by making annual improvement part of the regular systems and procedures of the company.

Dr Kaoru Ishikawa's influenced the participative and bottom up view of quality, which became the landmark of the Japanese approach to the quality and its management. Kaoru's (1986) elements of quality philosophy are out lined below:

a. Quality begins with education and ends with education.
b. The first step in quality is to know the requirements of customers.
c. The ideal state of quality control occurs when inspection is no longer necessary.
d. Remove the root cause, not the symptoms.
e. Quality control is the responsibility of all workers and all divisions.
f. Do not confuse the means with the objectives.
g. Put quality first and set your sights on long-term profits.
h. Marketing is the entrance and exit of quality.
i. Top management must not show anger when facts are presented by subordinates.
j. Ninety-five percent of problems in a company can be solved with simple tools for analysis and problem solving.
k. Data without dispersion information are false data.

## 2.4 Quality Management

Quality Management (QM) importance in any firm or organization is obvious from the importance given by Crosby, Deming, Juran and Ishikawa and cannot be more

stressed. In 1979, Crosby stated "Quality Management is a systematic way of guaranteeing that organized activities happen the way they are planned. It is a management discipline concerned with preventing problems from occurring by creating the attitudes and controls that make prevention possible". Insisting on an assurance of quality has got to save money in the long run. It ensures that manufacturing design features are more dependable, efficient, and built-in quality at every stage will obviously reduce wastage and increase customer satisfaction as shown in Figure 2.2.

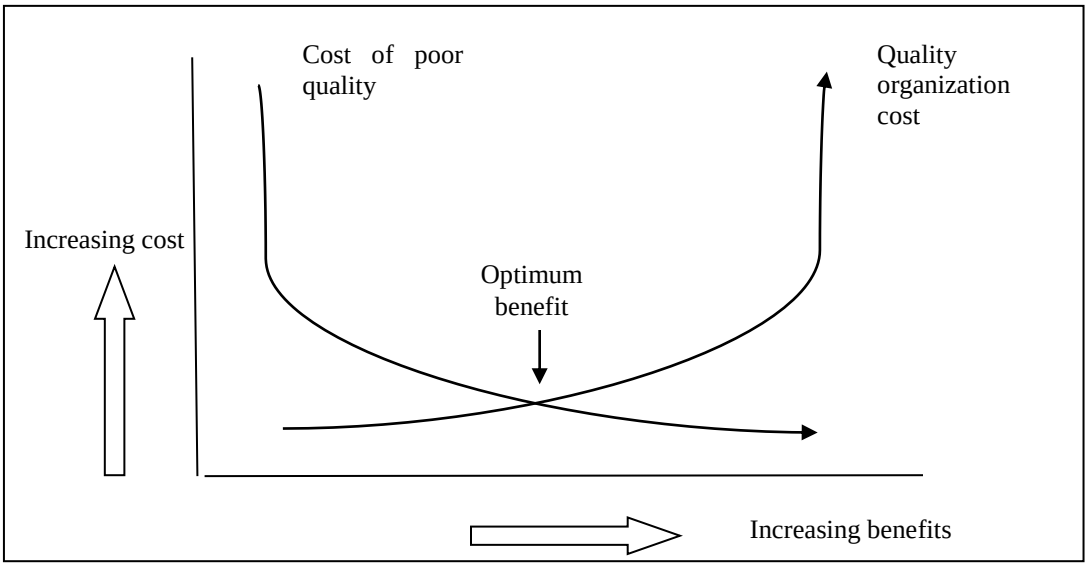


**Figure 0.2**: Quality Management System Cost (*Tricker, 2009*)

Lascelles and Dale (1988) suggested that the basic core of the philosophies of Crosby, Deming, Feigenbaum, Juran, and other quality advocated the concept of adopting quality as a fundamental business strategy permeating the culture of the entire organization. Lakhe and Mohanty (1994) stated that the efforts to adopt QM would succeed only if a cultural change was brought about. They also suggested four points as an approach for adopting the QM philosophy:

a. Develop a vision
b. Promote a policy on quality
c. Create a total quality-oriented culture
d. Training and education

Ebrahimpour (1988) in his study of quality management approaches in ten Japanese and American organizations in the United States recognized that top management commitment to quality and emphasis by employees on improving quality were the hallmarks of a successful quality management approach. Longenecker and Scazzero (1993) in a case study identified the causes for the failure of a QM program in a medium sized manufacturing organization in the United States as:

a. Failure of management to create a climate for quality by adjusting its style and ongoing management principles.
b. Management failure to create a work environment which was conducive to quality improvement from the workers perspective.

Glover (1993) pointed out that a successful QM system became the way of life for the organization and its people. Therefore management should stress to reinforce the management and employee's behaviors that reflect QM values. Harber et al (1993) stated: "Thus when an organization adopts QM, as with other major organizational change programs, a cultural change is also necessary for a successful implementation. In particular, the move to an emphasis on quality of products and services usually requires a significant change in organizational values and leadership styles".

Johnson (1993) stated following ten features that determine the extent of quality culture in an organization which are equally vital for any QM implementation program:

a. Top-down leadership. Leaders know where they are going, and they are taking their people with them.
b. Vision. A clear image is provided depicting exactly where the organization is going, what plans, objectives, and goals are required to get there, and the benefits employees can expect when goals are achieved.
c. Customer focus. Satisfying both internal and external customers is a primary part of all mission considerations.
d. Employee well-being. Employee well-being is considered in the decision making processes and efforts are made to strike a positive balance between this and other important factors.
e. Performance management system. Employees are selected for quality, trained, appraised against a standard, and recognized for their achievements.

f. Reward system. Employees are rewarded based on accomplishments rather than seniority, longevity, or a subjective standard.

g. Communications system. Communications are open and employees know what is occurring and why.

h. Roles and relationships. Roles are supportive rather than directive, where possible, and relationships up and down the chain are designed to encourage teamwork rather than conflict.

i. Structure. The structure is discretionary allowing more employee input into operations and process input.

j. Teamwork. Lone Rangers are out and teams are in. The rewards system supports team efforts.

Kaoru's Ishikawa (1976) defined following components of a manufacturing system:

a. Marketing and Sales – personnel are responsible for determining the needs and expectations of consumers.

b. Product Design and Engineering – develop technical specifications for products and production processes to meet the requirements determined by the marketing function.

c. Purchasing and Receiving – the quality of purchased parts and services and the timeliness of their delivery are critical.

d. Production Planning and Scheduling- a production plan specifies long-term and short-term production requirements for filling customer orders and meeting anticipated demand.

e. Manufacturing and Assembly – the role of this component in producing quality is to ensure that the product is made correctly.

f. Tool Engineering – responsible for designing and maintaining the tools used in manufacturing and inspection.

g. Industrial Engineering and Process Design – manufacturing processes must be capable of producing items that meet specifications consistently. Industrial engineers and process designers work with product design engineers to develop realistic specifications.

h. Finished Goods Inspection and Testing – judges the quality of manufacturing, to discover and help to resolve production problems that may arise, and to ensure that no defective items reach the customer.

i. Packaging, Shipping, and Warehousing – the functions that protect quality after goods are produced.

j. Installation and Service – if any problems occur with the product after installation, customer satisfaction depends on good after-the-sale service.

According to Deming, quality comes not from inspection, but from improvement of the process (Walton 1986). Predpall (1994) states: "It is particularly important to provide specific tools that can be applied directly to employee work processes. ... Otherwise, employees may not see the difference between quality-improvement principles and their own work". The identification and validation of critical factors of quality management have been given by international researchers such as Saraph, Benson and Shroeder (1989), Ahire, Golhar and Waller (1996), Zeitz, Johannesson and Ritchie Jr. (1997) and Rao, Solis and Raghunathan (1999).

Saraph et al. (1989) developed a quality management instrument, listing 8 critical factors of quality management. The factors are top management support, quality reporting, employee training, employee involvement, product design, supplier quality, process management and role of quality department. 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 an significant contribution by developing and validating a measurement instrument for international quality management research which consisted of 13 critical factors of quality management.

Seven groups of recognized researchers have introduced and utilized total of 27 different critical factors of quality management in their study. Out of the 27 different critical factors developed by the researchers, 8 were found to be the most popular critical factors. These 8 critical factors, ranked from the highest level of popularity to the lowest level of popularity are as following:

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

Quality monitoring in construction is continuous. It extends throughout the organization and certainly beyond "inspection". Figure 2.3 shows the quality process for materials.


**Figure 0.3**: Quality Processes of Construction Materials *(Stukhart, 1989)*

The Steel Re-rolling milling comprises of various processes. The quality product is outcome of uninterrupted processes monitored by QA/QC procedures and practices as shown in flow chart given in Figure 2.4 (Courtesy: Pak Steel Mill Islamabad):

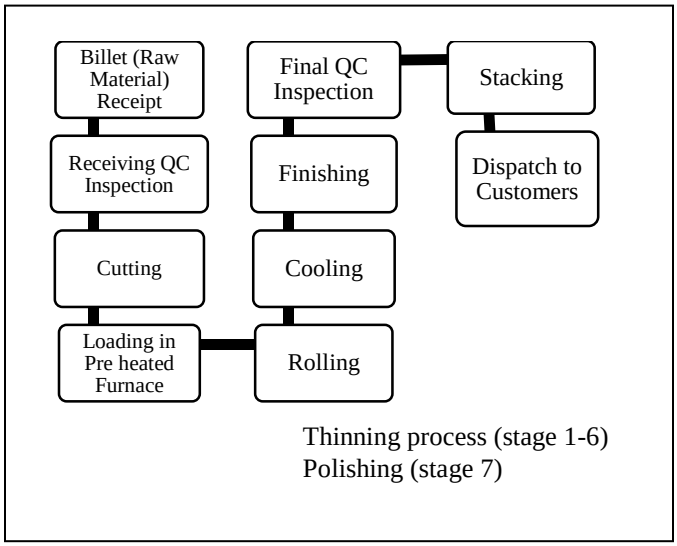


**Figure 0.4:** Steel Re-rolling Milling Process Flow Chart

In a study by Khan (2008), quality assurance and control was focused on Taunsa Barrage rehabilitation using the concept of quality, quality management system and quality management system standards in civil construction works. Farouqi et al. (2008) in his studies identified the lack of standardization and employee training a major obstacle in implementation of quality management from contractor's perspective. From the above literature, it is ascertained that any successful implementation of a QM practice consists of two aspects the people and the process. The proper implementation of quality principles in the process, besides being easier to practice, will also bolster the morale and confidence of the organization thus allowing for an easier follow-up implementation of QM in the people aspect.

## 2.5 Quality Assurance and Control

The Quality Assurance (QA) is a set of activities whose purpose is to demonstrate that an entity meets all quality requirements (ISO, 2007). QA gives the stakeholder an adequate confidence that a structure, component, material or system meets pre-stated quality standards and will perform satisfactory during its entire service life.

Quality Control (QC) is the set of activities or techniques whose purpose is to ensure that all quality requirements are being met. In order to achieve QC, processes are monitored and performance problems are solved (ISO, 2007).

Quality Control (QC) deals with actual measurement, testing or supervision of manufacturer's own final product control, either by inspection of each unit or by sample testing.

International standards of Quality Management System (QMS) emerged in 1987 as ISO 9000:1987. This QMS was based on the British Standard BS 5750(Khan 2008). The eight principles of ISO 9001-2008 are Customer focus, Leadership, Involvement of people, Process approach, System approach to management, Continual improvement, Financial approach to decision making, Mutually beneficial supplier relationships (Tricker 2008).

## 2.6 Identified Quality Assurance and Control Standards

During literature review fourteen quality management standards were identified by the researcher as having bearing on quality of steel bars produced locally. These are as following:

a. Quality Plan and Management Procedures (Quality Planning)
b. Specification Followed (Quality Planning)
c. Monitoring, inspection and testing (Quality Control)
d. Test equipment (Quality Control)
e. Control of non conforming products (Quality Control)
f. Statistical techniques (Quality Control)
g. Document control (Quality Assurance)
h. Handling, Storage, Packing and Delivery (Quality Assurance)
i. Suppliers quality assurance (Quality Assurance)
j. Internal quality audits (Quality Assurance)
k. Involvement of workers (Quality Improvement)
l. Continual improvement (Quality Improvement)
m. Customers focus (Quality Improvement)
n. Personnel training (Quality Improvement)

### 2.6.1 Quality Plan and Management Procedures

This variable is concerned with the management commitment and the organizational policy for defining a quality program, establishing organizational objectives and individual responsibilities. The first requirement is for the organization to nominate an individual who will be solely responsible to top management for the implementation and maintenance of the QMS. This person is called the "Quality Manager".

This quality aspect is also concerned with the existence and the updating process of the quality manual. The quality manual provides information about all of the quality policies, processes, and their associated quality procedures and work Instructions. Depending on the size of the organization, the quality manual will also, probably, include standard formats for data collection, data reporting and quality records. Organizational procedures regarding quality are also addressed in the quality manual and it is openly available to the employees (McLaughlin 1995). According to policy, the organization also needs to indicate the methodology it intends to follow to achieve quality of the product. The organization also needs to depute a quality in-charge who is overall responsible for assurance of quality product.

### 2.6.2 Supplier Quality Assurance

When an organization has to purchase products, materials and/or services from suppliers who have not been previously specified in a contract or by a customer, they are normally selected on their ability to meet the organization's requirements given due consideration to statutory obligations, quality, scale, cost and time. Organization must maintain a list of approved suppliers and subcontractors.

### 2.6.3 Customer Focus

Organizations depend on their customers. To satisfy customer requirements, organizations must fully understand the customer's current and future needs and expectations. To ensure that the customer expectations are met, the organization should carry out the evaluation by the stake holders and strive to exceed customer expectations. The organization also needs to carry out the study of significant product characteristics for future reference and better use of organization's resources.

### 2.6.4 Specification Followed

The manufacturer's main responsibility must always be to ensure that anything leaving their factory conforms to the specific requirements of the purchaser particularly with regard to quality. The best way of doing this is for the manufacturer to ensure that their production facility or manufacturing outlet fully complies with the requirements of the quality standards adopted by the country in which they are manufacturing and the country to whom they intend supplying the component, product or system. To do this they must of course first be aware of the standards applicable to that country, know how to obtain copies of these standards, how to adapt them to their own particular environment and how to get them accepted by the relevant authorities. Although an organization can set out to abide by accepted standards, unless they achieve this aim they will fail in their attempt to become a recognized manufacturer of quality goods.

The quality conscious company ensures that the product specifications are current according to the market change and the standard is always kept current, accurate and applicable. To meet the high standard of quality product, the design and specifications are revised after some time besides during occurrence of errors and inconsistencies.

### 2.6.5 Monitoring, Inspection and Testing

The quality product is output of regular inspections, clear definition of inspection levels, test notifications and hold points. This quality management area identifies the occurrence of errors or inconsistencies in an early stage of production and helps avoid the high cost of redo or rejected product.

### 2.6.6 Test Equipment

The availability of physical or chemical testing laboratories equipped with modern testing equipment, well maintained and regularly calibrated against a known working standard held by the manufacturer helps to ensure the quality specifications and standard.

### 2.6.7 Control of Non Conforming Products

In Crosby's view (1979, 1984), there is no room for nonconformance. The performance standard is "zero defects", and this standard is achieved by "doing it right

the first time". Normally inspection and testing is carried out on completion of installation with results being documented. If items fail to fulfill the agreed contract criteria or specified standard and specifications, then they should be repaired, replaced or identified for future evaluation and production. All repaired items need to be re-inspected to ensure their acceptability prior to being used.

### 2.6.8 Document Control

The organization shall set off a documented procedure for the quality control of documents. This procedure shall include processes for controlled access and distribution of documents, approval of documents before issue, review, updating, identifying the recent revision status of documents, ensuring that only concerned versions of applicable documents are available at points of use, ensuring that documents remain readable, readily identifiable and retrievable.

### 2.6.9 Handling, Storage, Packaging and Delivery

This area investigates that adequate lift capabilities and equipments are held by the company e.g. lifter, crane and spreader. The storage areas for critical items are clean, humidity controlled and well ventilated. A separate section shall deal with verification, packing, marking and dispatching.

### 2.6.10 Personnel Training

Employees training and awareness is one of the most widely recognized by quality experts. Employees should be given on job training and provided with latest facilities to improve their skills. Short and long term courses be offered to enable them to handle special tasks.

### 2.6.11 Involvement of Workers

The combination of empowered and trained employees, well structured teams that also perform well, and adequate communication of the organization's quality strategy, will create the right sort of culture for quality and also make the employees commitment to the TQM efforts of the organization (Oakland 2003).

### 2.6.12 Continual Improvement

Even when customers are satisfied, the firm must keep looking for ways to use customer needs change and the competition may be improving too (Nelton 1986). Continual improvement is an integral part of a QMS. No industry can survive without continual improvement of its product quality according to the market change. Earmarking of a certain amount annually for quality improvement and setting of goal to achieve certain quality standard provides a clear vision of quality improvement. Continual improvement is assured by utilization of the PDCA model developed by ISO (Tricker 2009) is shown in Figure 2.4.

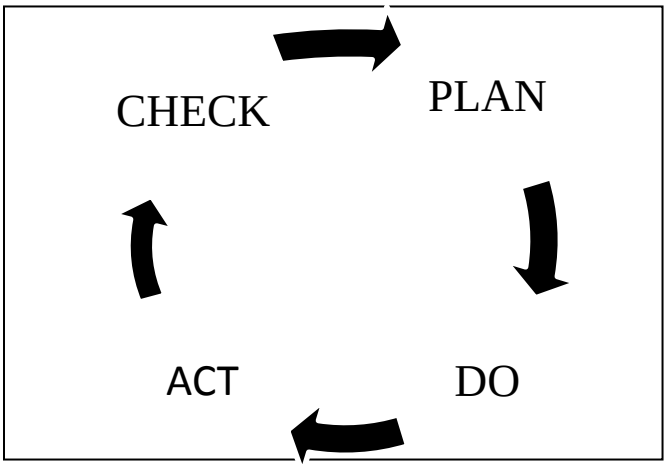


**Figure 0.5**: Continual Improvement (*Tricker, 2009*)

### 2.6.13 Statistical Techniques

The purchaser may often require confirmation that the organization is capable of continuing to produce a quality product. Statistical analysis is one of the methods frequently used to provide this sort of confirmation. Nowadays there are many methods of statistically analyzing with the use of statistical methodologies. The organization should analyze data in order to assess, control, and improve the performance of processes and products and to identify areas for improvement. Problems can be identified by analysis of data and the results of this analysis can be used to determine the accuracy of procedures and processes. Histograms, control charts, check sheets and pareto charts can effectively record variations in the samples collected for testing.

### 2.6.14 Internal Audits

Auditing can be defined as a methodical study and review of one or more quality practices, and the checking for compliance and effectiveness; for the purpose of verification and improvement (Hutchins 1993, Mirams and McElheron 1995). Quality assurance audit ensures that the systems are in place and being followed religiously to provide good quality to the users. The audits are also performed to make sure that the organization is following the legal and regulatory requirements. Organizations should set up an internal audit process to evaluate the strengths and weaknesses of its QMS. The internal audit process should also be used to review the effectiveness of other organizational activities and processes.

## 2.7 Summary

In this chapter, quality and evolution of QMS is discussed in detail. Different factors and components of quality management system developed and validated by various researchers have been highlighted. Fourteen quality management standards are identified by the researcher as having bearing on quality of steel bars which can be used to assess the implementation level of quality management system in re-rolling steel mills in Pakistan.

*Chapter 3*

# RESEARCH METHODOLOGY

## 3.1 Introduction

The research methodology adopted for this study is mentioned in this chapter. Research strategy shows how the researchers are going to carry out their study to achieve and answer research objectives (Saunders *et al*., 2007). It is an exploratory study which reports the findings of the questionnaire survey being conducted at the manufacturing stage of the deformed steel bars. Development, validation and finalization of questionnaire along with selection of sample size are discussed. The selection of geographic areas for data collection and statistical techniques being used for analysis are included in this chapter.

## 3.2 Research Design

Key variables of quality management system were identified from literature review. A questionnaire was developed with few relevant indicators being able to give strong indication about the variable. Questionnaire was developed with the aim to figure out the indicators with set of questions for elaboration (Powell 1998). Pilot survey was conducted to check the applicability of questionnaire in local environment. Before using the questionnaire to collect data in the field, it is necessary to conduct few pilot studies for testing the questionnaire for its reliability, consistency and validity (Thompson 2010). Four questionnaire surveys were conducted in personnel in Islamabad and surroundings to check the apprehension, response and validity. The respondents were from leading industries with an experience of more than five years in quality management. From their feedback, the questionnaire was amended and redistributed to same individuals, and a final questionnaire was developed from the feedback of these experts to suit the local environment. Final questionnaire, as shown in “Appendix II” has four sections. First section includes an introduction of the respondent covering their name, qualification, experience and position held with the organization. Second section deals with the registration held with organizations of standardization, standards & specifications followed during manufacturing, annual product turn over, product prices

and products portfolio. Third section perceives the importance rating given to Quality in the organization on five- point Likert scale. The final section consists of fourteen variables of quality management system with few indicators each. Five-point Likert scale has been used for each indicator to provide flexibility to the respondents to choose one option that best aligns with their view. The five-point scale used is "1= Never, 2 = Rarely, 3 = Sometimes, 4= Mostly, 5 = Always".

## 3.3 Research Geographical Zones

Upper Punjab (Lahore, Gujranwala, Rawalpindi, Rawat, Hattar), Islamabad and Peshawar were selected to conduct survey. Lahore is a provincial capital and a financial hub of Punjab province with second highest population of 7.2 million. Rawalpindi and Islamabad are twin cities with combine population of 2.98 million and form third largest concentration of population in Pakistan, besides Islamabad is a capital city. Gujranwala with population of 1.57 million is seventh largest city of Pakistan and emerging hub of manufacturing and agriculture industry. Hattar industrial estate is famous for re-rolling steel mills and main supplier of steel bars to Hasanabdal, Taxila and Abbottabad district surroundings. Peshawar is a provincial capital of Khyber Pukhtunkhuwa with population of 1.44 million and is an industrial hub of the province.

## 3.4 Research Response

Total 68 questionnaires were distributed out of which 64 (94 percent) valid responses were received. The area wise distribution is: 15 (Lahore), 30 (Rawalpindi/Islamabad), 2 Rawat), 13 (Hattar), 2, (Peshawar), 2, (Gujranwala). All respondents were approached personally or through telephone to brief about the purpose of study. The questionnaire was handed over to respondents for their opinions. Twenty two (22) percent of the respondents had 10 or more years of experience and forty one (41) percent had 6-10 years of experience and rest thirty seven percent had thirty seven (37) percent in their respective fields in quality management. Keeping in view the geographical locations of these areas, their population size, industrial development contribution, extensive experience and position of respondents in the industry, the data

collected was extensive and is categorized to be representative of the steel re-rolling mills.

## 3.5 Sample Size

It will be difficult to obtain a significant statistic test if the sample size is smaller than 30 (Saunders et al. 2009). Sample size that represents the targeted population can be determined by equation (Shash and Abdul-Hadi 1993):

$$n=n' / (1+n'/N) \quad \textbf{(3.1)}$$

Where;

- n' = Sample size from infinite population which can be calculated from formula ($n'= S^2/V^2$).
- n = Sample size from finite population.
- N = Total Population.
- V = Standard error of sample population equal 0.05 for confidence interval level of 95%.
- $S^2$ = Standard error variance of population elements, $S^2=P(1-P)$; max P = 0.5.

The choice of sample size depends on:

- The confidence required to have the data, i.e., the level of certainty that the characteristics of the data collected will represent the characteristics of the total population.
- The margin of error that can be tolerated, i.e., the accuracy required for the estimates made from the sample.

Therefore considering the above arguments, at least sample size of 61 was to be considered appropriate to study the prevalence of QMS for 158 steel re-rolling mills being registered with Pakistan Steel Re-rolling Mills Association (PSRMA).

## 3.6 Data Acquisition

The first objective of this research was to evaluate the implementation level of identified variables of quality management system in Pakistan re-rolling steel industry.

Data collected was based on the interviews by industry owners / executives, quality assurance/control managers, laboratory in-charge and foremen. These personnel were approached to get their willingness for participation in this research. The response on telephone was very poor. However on visit of the office/industry and briefing about the purpose of study, the respondents agreed to provide the information/data. Each visit took about 90-120 minutes. The data was compiled on regular basis.

The identities of the respondent were kept anonymous and the related information was treated with the confidentiality. The principle of anonymous, which means that the participants will remain anonymous through the study even to the researchers themselves (Smith 2003; Trochim 2006).

All 68 firms were accessed and got the responses of 64 Firms (94%). The valid interviews accounted for the survey were 64 (94%). Figure 3.1 shows the statistics of the responses.

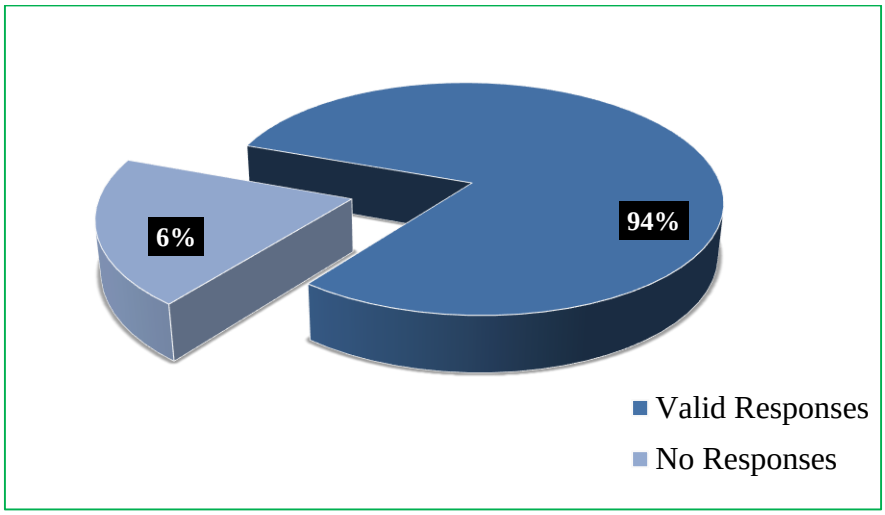


**Figure 0.1:** Percentages of Interview Responses

A covering letter (Appendix I) about the purpose and brief of the survey objectives was attached with each questionnaire to assist the respondent to have a summary view of this survey based research.

## 3.7 Data Analysis Methodology

Statistical Package for Social Science (SPSS-18) was used to analyze the collected data. Hypothesis testing was used for statistical inference. Level of significance i.e. 0.05 with, 0.01 being highly significant was followed in the study. To check the significance, Hypothesis testing is the most common method used (Chaudhry and Kamal 1999; Pallant 2007). The Null hypothesis (Ho) is accepted as being true, when it is supported by the sample data and is rejected when the sample data fail to support it and Alternate hypothesis (H1) is accepted. Following statistical techniques were used to analyze the data:-

### 3.7.1 Test for Normality

The normality tests are very sensitive to the sample size of the variable concerned. The numerical methods like, Shapiro-Wilk and Kolmogorov-Smirnov tests are objective in nature and have been used in this research. The null hypothesis (Ho) for the test is that the data follows the normal distribution and is rejected if the result is significant. The results are tested against the hurdle of significance of 0.05 with 0.01 being highly significant. In case the data fails the test for normality nonparametric testing is to be adopted. The statistical tests conducted with the assumption that the data is not normally distributed, are known as Non-Parametric tests (Kanji 2006). The mathematical transformation creates doubts about authenticity of data unless proper judgment is applied, therefore, nonparametric testing was adopted in the analysis while keeping in mind their major limitations i.e. less flexible and less powerful hence can draw fewer conclusions.

### 3.7.2 Test for Outliers

An outlying observation, or outlier, is one that appears to deviate markedly from other members of the sample in which it. Outliers have intense influence on the slope of the regression line and consequently on the value of the correlation coefficient. New mean i.e. 5% Trimmed Mean is attained after removing the top 5 and bottom of the data value. If there is not much difference between the 5% Trimmed Mean and Original Mean values, then it means that Outliers are not affecting the means of the

data, therefore the outliers are not necessary to be removed and retained (Pallant 2007). The standard error is the standard deviation of a mean.

### 3.7.3 Friedman One-way ANOVA

Friedman one-way ANOVA should be used if the distributions deviate too far from normality (George and Mallery 2009). The comparison in the Friedman procedure is based on mean rank of variables rather than on means and standard deviations. Moreover Friedman compares ranked values with expected values in chi-square analysis. The assumption for the test is that all the variables have the same mean, which would be the Null Hypothesis or Ho. Alternate Hypothesis or H1 would be that the variables under consideration have different means. Friedman's test provides Ranked Mean and Friedman's Statistics. Null Hypothesis may be rejected or accepted on the significance value achieved. Mean Ranking is used to obtain the descending ranking for various variables being considered/prevailing.

### 3.7.4 Descriptive Statistics

Measures from central tendency (Mean, Median, Mode), measures of variability around the mean (Standard deviation, variance) and measures of deviation from normality (Skewness and Kurtosis) are calculated. Descriptive statistics are designed to give information about the distribution of variable (George and Mallery 2009). The frequency and percentage response based on five-point Likert scale for each indicator of the variable was used to study the prevalence of quality assurance and control procedures. The perception and inferences are drawn for conclusion and recommendations.

## 3.8 Summary

This research uses multiple research methods. Interview based pilot study was conducted for development and validation of questionnaire. Questionnaire survey was adopted as the main research instrument. In this chapter, the research methodology, sampling techniques and design of the survey are discussed. Above discussion provides a lucid understanding of the research methodology used.

*Chapter 4*

# RESULTS AND ANALYSIS

## 4.1 Introduction

Research survey was conducted with one dependent variable i.e. Quality Standards implemented and fourteen independent variables, which were Quality Plan and Management Procedures, Suppliers quality assurance, Customers focus, Specification followed, Monitoring, Inspection & testing, Test equipment, Control of non conforming products, Document control, Handling, Storage, Packing & Delivery, Personnel training, Involvement of workers, Continual improvement, Statistical techniques and Internal quality audits.

## 4.2 Statistical Analysis

Table 4.1 shows the descriptive statistics of data collected on five point Likert scale where "1= Never, 2 = Rarely, 3 = Sometimes, 4= Mostly, 5 = Always". There were no missing values. Skewness and Kurtosis showed the shape of the curve formed. Here skewness did not indicate any symmetry in the data, whereas Kurtosis showed the peakedness of the data. The values of skewness and kurtosis were not equal to zero indicating the lack of normality in the data (Kanji 2006; Pallant 2007). This had been further confirmed in the test of normality.

**Table 0.1:** Descriptive Statistics

| Variables | N | Mean | Std dev | Variance | Skewness | Kurtosis |
|---|---|---|---|---|---|---|
| Quality standards implemented | 64 | 4.5156 | .56322 | .317 | -.613 | -.652 |
| Quality Plan and Management Procedures | 64 | 3.8500 | .84403 | .712 | -.345 | -.940 |
| Suppliers quality assurance | 64 | 3.8250 | .66428 | .441 | .284 | -1.120 |
| Customers focus | 64 | 3.1719 | .67975 | .462 | .126 | -.378 |
| Specification Followed | 64 | 4.1297 | .60440 | .365 | -.046 | -1.249 |
| Monitoring, inspection & testing | 64 | 3.8086 | .67339 | .453 | .467 | -1.138 |

| Variables | N | Mean | Std dev | Variance | Skewness | Kurtosis |
|---|---|---|---|---|---|---|
| Test equipment | 64 | 3.8922 | 1.33456 | 1.781 | -.602 | -1.543 |
| Control of non conforming products | 64 | 4.0438 | .48888 | .239 | -.603 | 3.720 |
| Document control | 64 | 2.8203 | .55182 | .305 | .837 | 2.397 |
| Handling, Storage, Packing & Delivery | 64 | 3.7703 | .44210 | .195 | -.571 | -.116 |
| Personnel training | 64 | 1.6344 | .50402 | .254 | .469 | -.674 |
| Involvement of workers | 64 | 3.4094 | .74444 | .554 | .653 | -.424 |
| Continual Improvement | 64 | 2.7813 | 1.25949 | 1.586 | .422 | -1.062 |
| Statistical Techniques | 64 | 1.7266 | .83538 | .698 | 1.665 | 3.597 |
| Internal Quality Audit | 64 | 3.7422 | 1.09831 | 1.206 | -.331 | -.654 |

### 4.2.1 Test of Normality

SPSS presents results of normality in “Kolomogorov-Smirnov” and “Shapiro-Wilk” tests. Since N<2000, results of Shapiro-Wilk test was considered (Park 2008). The assumption about the population here was that the data is normally distributed. The significance value selected is 0.05 for two tailed test. The hypothesis for the test of normality was as following:

$H_0$ = Data is following the normally distribution

$H_1$ = Data is not following the Normal Distribution

The Null Hypothesis or $H_0$ would not be rejected, if significance (sig.) value of “Shapiro-Wilk” is greater than 0.025 (level of significance). If significance (sig.) value of “Shapiro-Wilk” is less than 0.025 (level of significance), Null Hypothesis or $H_0$ would have to be rejected and Alternate Hypothesis or $H_1$ have to be accepted. Result of the test of Normality was as per Table 4.2. As significance (sig.) value of “Shapiro-Wilk” was less than 0.05 (level of significance), hence the Null hypothesis (Ho) was rejected and Alternate hypothesis or $H_1$ was accepted. Therefore the data was not normally distributed.

**Table 0.2:** Shapiro-Wilk Normality Test

| **Variables** | **Significance Value** | **Remarks** |
|---|---|---|
| Quality Plan and Management Procedures | 0.002 | Significant(0.002< 0.025), Ho is failed to be accepted |
| Suppliers quality assurance | 0.002 | Significant |
| Customers focus | 0.003 | Significant |
| Specification Followed | 0.000 | Significant |
| Monitoring, inspection and testing | 0.000 | Significant |
| Test equipment | 0.000 | Significant |
| Control of non conforming products | 0.000 | Significant |
| Document control | 0.000 | Significant |
| Handling, Storage, Packing and Delivery | 0.000 | Significant |
| Personnel training | 0.000 | Significant |
| Involvement of workers | 0.000 | Significant |
| Continual improvement | 0.000 | Significant |
| Statistical techniques | 0.000 | Significant |
| Internal quality audits | 0.000 | Significant |

### 4.2.2 Test for Outliers

The result using SPSS 18.0 clearly indicated that there is not much difference in 5% Trimmed mean and the original mean of all the variables, hence Outliers are not affecting the means of the data, therefore the outliers are not necessary to be removed and retained. The results of test for outliers are attached as Appendix “I”.

### 4.2.3 ANOVA

The Friedman One-way ANOVA test was performed to compare the variables based on Mean Rank with the level of significance ($p$= 0.05). The Null Hypothesis (Ho) was that all variables had the same mean. The results are shown in Table 4.3 for Ranked Mean and Friedman's Statistics respectively. Very high value of chi-square (i.e. 467) and significance value less than 0.05 as shown in Table 4.4 concluded that the Null Hypothesis was rejected and the Alternate Hypothesis was accepted, which was that the variables did not have the same mean. The result revealed that Specification had the highest Mean Rank among the fourteen variables where as Personnel training had the lowest Rank Mean. It reveals that current specification is given the maximum weightage for compliance followed by use and maintenance of test equipment. The least attention is given to use of statistical techniques and personnel training in the steel re-rolling industry.

**Table 0.3:** Friedman Mean Rank

| **Variable** | **Mean Rank** |
|---|---|
| Specification Followed | 11.68 |
| Test equipment | 10.96 |
| Control of non conforming products | 10.54 |
| Internal quality audits | 10.01 |
| Suppliers quality assurance | 9.98 |
| Quality Plan and Management Procedures | 9.95 |
| Monitoring, inspection and testing | 9.92 |
| Handling, Storage, Packing and Delivery | 9.7 |
| Involvement of workers | 7.64 |
| Customers focus | 6.28 |
| Continual improvement | 5.29 |
| Document control | 5.06 |
| Statistical techniques | 1.87 |
| Personnel training | 1.71 |

**Table 0.4:** Friedman Test Statistics[a]

| | |
|---|---|
| N | 64 |
| Chi-square | 476.062 |
| df | 14 |
| Asymp. Sig. | .000 |

a. Friedman Test

## 4.2.4 Descriptive Statistics

The trends and traditions of the population would be deducted basing on their descriptive analysis. The percentage response for each indicator is discussed to study the prevalence in the deformed steel bar industry.

### 4.2.4.1 Quality Plan and Management Procedures

This quality procedure has five indicators, which include quality program, responsibilities for quality, quality manual, design & production methodology and quality manager appointment in organization. Interviewees were asked for rating for its significance on five point Likert scale, which was mostly on the higher side except for presence of Quality manual which had response of 0% as "Never" and 14.5% as "Always". The response for other four indicators was around 50% for "Always" except quality manual which has response of only 14.5%. It revealed that most of the steel re-rolling mills did not possess the quality manual. 13.9 % respondents thought that quality manager was not required where as 52.8 % had appointed a full time quality manger to monitor the quality aspect in the company. Detail of the responses is as per Table 4.5.

**Table 0.5:** Quality Plan and Management Procedures

| **Response** | **Quality program** | **Responsibilities for quality** | **Quality manual** | **Design & production methodology** | **Quality Manager** |
|---|---|---|---|---|---|
| Never | 4.7 | 0 | 0 | 0 | 13.9 |
| Rarely | 1.6 | 1.6 | 0 | 0 | 5.6 |
| Some times | 21.9 | 0 | 12.5 | 12.5 | 8.3 |
| Mostly | 27 | 40.6 | 14.1 | 42.2 | 19.4 |
| Always | 45.3 | 57.8 | 14.5 | 45.3 | 52.8 |

#### 4.2.4.2 Suppliers Quality Assurance

This quality variable had five indicators, which included performance of raw material supplier, quality history of material supplier for prequalification, supplier contact through buyers, supplier awareness of acceptance procedure and replacement of damaged items. Interviewees rating for its significance on five point Likert scale is shown in Table 4.6, which was mostly on the higher side i.e more than 50% for *Followed Always* except for Supplier contact through buyers and prequalification of suppliers which had very weak response of 23.4% and 39.1% respectively for *Always* which indicated that there were very less occasions when supplier of the raw material contact manufacturer of steel bars through the buyer of the product. Mostly mills have specified supplier of raw material. The other four indicators had stronger implementation in the re-rolling industry.

**Table 0.6:** Supplier Quality Assurance

| Response | Performance of raw material supplier | Quality history of material supplier for prequalification | Supplier contact through buyers | Supplier awareness of acceptance procedure | Replacement of damaged items |
|---|---|---|---|---|---|
| Never | 14.1 | 0 | 50 | 0 | 0 |
| Rarely | 4.7 | 0 | 3.1 | 1.6 | 0 |
| Some times | 7.8 | 6.3 | 9.4 | 0 | 6.3 |
| Mostly | 23.4 | 54.7 | 14.1 | 46.9 | 18.8 |
| Always | 50 | 39.1 | 23.4 | 51.6 | 75 |

#### 4.2.4.3 Customers Focus

This variable had two indicators, which included evaluation by customer and study of product specification for future reference. Interviewees' rating for its significance on five- point Likert scale is shown in Table 4.7, which was mostly towards lower side. 60.9% respondents suggested it was *Some times* that customer evaluation is being carried out for product feed back and suggestions were asked 42.2% for *Study of Product for future* improvement. Very few firms had a proper system of customer evaluation or response to customer complaints on reach out pattern. Maximum rating

received was 61% for “Some times” in customers evaluation asked by mills for the product, which showed serious absence of this aspect of quality.

**Table 0.7:** Customers Focus

| Response | Evaluation by customer | Study of product for future |
|---|---|---|
| Never | 0 | 1.6 |
| Rarely | 20.3 | 20.3 |
| Some times | 60.9 | 42.2 |
| Mostly | 15.6 | 15.6 |
| Always | 3.1 | 20.3 |

#### 4.2.4.4 Specifications Followed

This quality procedure had four indicators, which were review of specification, current specifications, applicable standard and revision of specification. Interviewees rating for its significance on five-point Likert scale is shown in Table 4.8. The response received was quite high for all indicators except Review of specifications that was just 17.2 % for *Always*. The respondents had perception that there was no need of Review of specification for steel bars as specifications are defined for engineers and architects internationally. The current standard and specifications of market were followed and response received was 39.1 % for Always and 54.7 for *Mostly* which is quite satisfactory. However there was provision of diameter adjustment in the re-rolling machines for steel bars. The size of steel bars can be adjusted as required by the customer for load bearing structures.

**Table 0.8:** Specification Followed

| Response | Review of specification | Current Specifications | Applicable Standard | Revision of Specification |
|---|---|---|---|---|
| Never | 3.1 | 0 | 0 | 0 |
| Rarely | 15.6 | 0 | 0 | 3.1 |
| Some times | 39.1 | 6.3 | 0 | 25 |
| Mostly | 25.0 | 54.7 | 45.3 | 37.5 |
| Always | 17.2 | 39.1 | 54.7 | 34.4 |

#### 4.2.4.5 Monitoring, Inspection and Testing

This procedure had four indicators, which included in-plant inspection, inspection levels test notification procedures and defined hold points. Interviewees rating for its significance on five -point Likert scale is shown in Table 4.9. The response received for in-plant inspection was only 17.2% for *Always* i.e. very weak and very few firms followed this quality practice. The point of view of manufacturer was that simple mechanical machines are involved in manufacturing process of steel bars. However inspection levels, test notification procedures were well defined and being followed by re-rolling steel industry. The industry response in case of Defined hold points was 39.1 % for "Sometimes" and represented a weak indicator in this procedure.

**Table 0.9**: Monitoring, Inspection and Testing

| Response | In-plant Inspection | Inspection Levels | Test Notification Procedures | Defined Hold points |
|---|---|---|---|---|
| Never | 28.1 | 0.0 | 0.0 | 3.1 |
| Rarely | 12.5 | 0.0 | 0.0 | 0.0 |
| Some times | 23.4 | 1.6 | 14.1 | 39.1 |
| Mostly | 18.8 | 59.4 | 48.4 | 34.4 |
| Always | 17.2 | 39.1 | 35.9 | 21.9 |

#### 4.2.4.6 Test Equipment

This procedure had three indicators, which included test equipments held, calibration of equipment and maintenance of equipment. Interviewees rating for its significance on five -point Likert scale is shown in Table 4.10. The response was quite encouraging in case of test equipment being held and their regular calibration. The equipment is maintained with due attention by re-rolling mills.

**Table 0.10:** Test Equipment

| Response | Test Equipments | Calibration of Equipment | Maintenance of Equipment |
|---|---|---|---|
| Never | 31.3 | 29.7 | 1.6 |
| Rarely | 0.0 | 0.0 | 0.0 |
| Some times | 3.1 | 4.7 | 0.0 |
| Mostly | 1.6 | 4.7 | 46.9 |
| Always | 62.5 | 59.4 | 50.0 |

#### 4.2.4.7 Control of Non Conforming Products

This procedure had three indicators, which included removal of error causes, material management and segregation of damaged items. Interviewees rating for its significance on five-point Likert scale is shown in Table 4.11. The percentage of prevalence response received was 53.1% and 71.9% *Always* for removal of error causes and segregation of damaged items respectively however material management aspect was lacking in the industry and required due attention.

**Table 0.11:** Control of Non Conforming Products

| Response | Removal of Error Causes | Material Management | Segregation of damaged Items |
|---|---|---|---|
| Never | 0.0 | 21.9 | 0.0 |
| Rarely | 0.0 | 10.9 | 1.6 |
| Some times | 1.6 | 29.7 | 0.0 |
| Mostly | 43.8 | 31.3 | 25.0 |
| Always | 53.1 | 6.3 | 71.9 |

#### 4.2.4.8 Document Control

This procedure had two indicators, which included record of documents, latest computer software. Interviewee rating for its significance on five -point Likert scale is shown in Table 4.12.The response received is very high for filing of documents i.e 60.9%, where as the industry did not uses the computer software for any process or procedures at all and had zero response. The steel re-rolling industry is completely mechanically operated.

**Table 0.12**: Document Control

| Response | Record of documents | Latest Computer software |
|---|---|---|
| Never | 0.0 | 89.1 |
| Rarely | 0.0 | 1.6 |
| Some times | 17.2 | 1.6 |
| Mostly | 20.3 | 6.3 |
| Always | 60.9 | 0.0 |

#### 4.2.4.9 Handling, Storage, Packing and Delivery

This procedure had six indicators, which included lift capabilities, humidity free storage areas, dispatch process, handling responsibilities, packing and marking, defects noting on delivery documents. Interviewees rating for its significance on five-point Likert scale is shown in Table 4.13. The response received was high for "Mostly" or "Always" which was good response for this quality procedure. The response for Lift Capabilities was only 25% and 26.6 for *Mostly* and *Always* implementation respectively which indicates that industry lacks latest lifting equipments like cranes and lifters etc. The trend for noting the defects on delivery documents was found 0% i.e. completely missing in this industry which needs to be addressed.

**Table 0.13:** Handling, Storage, Packing and Delivery

| Response | Lift Capabilities | Humidity free storage areas | Process for dispatch | Responsibilities for handling | Packing and Marking | Defects on Delivery Documents |
|---|---|---|---|---|---|---|
| Never | 3.1 | 0.0 | 0.0 | 0.0 | 0.0 | 95.3 |
| Rarely | 7.8 | 1.6 | 1.6 | 0.0 | 1.6 | 3.1 |
| Some times | 35.9 | 15.6 | 1.6 | 6.3 | 4.7 | 0.0 |
| Mostly | 25.0 | 57.8 | 17.2 | 14.1 | 34.4 | 0.0 |
| Always | 26.6 | 23.4 | 78.1 | 78.1 | 57.8 | 0.0 |

### 4.2.4.10 Personnel Training

This procedure had three indicators, which included engineers / supervisors training, inspector's quality awareness and provisioning of office library facility. Interviewee rating for its significance on five-point Likert scale is shown in Table 4.14. The response received was very weak i.e 0% for *Mostly* and *Always* for training and office library indicator. The industry is completely lacking this aspect of quality and no attention is paid towards personnel training in field of quality awareness and improvement.

**Table 0.14**: Personnel Training

| Response | Engineers/Supervisors Training | Inspectors Quality Awareness | Office Library |
|---|---|---|---|
| Never | 82.8 | 20.3 | 93.8 |
| Rarely | 3.1 | 26.6 | 6.3 |
| Some times | 12.5 | 29.7 | 0.0 |
| Mostly | 0 | 14.1 | 0 |
| Always | 0 | 6.3 | 0 |

### 4.2.4.11 Involvement of Workers

This procedure had three indicators, which included communication of results to workers, encouragement for quality suggestions and recognition of quality performing workers. Interviewee rating for its significance on five-point Likert scale is shown in Table 4.15. The response received from statistics is not very convincing except encouragement of workers to give suggestions that was also only 51.6%. Only 31.3% respondents considered *Mostly* and 14.1% *Always*, this indicator important for implementation in the industry which indicates very less incentive of workers in steel industry.

**Table 0.15**: Involvement of Workers

| Response | Communication of results | Workers Encouragement for Quality suggestions | Recognition of quality performing workers |
|---|---|---|---|
| Never | 0.0 | 0.0 | 3.1 |
| Rarely | 45.3 | 0.0 | 14.1 |
| Some times | 26.6 | 29.7 | 37.5 |
| Mostly | 15.6 | 51.6 | 31.3 |
| Always | 12.5 | 17.2 | 14.1 |

### 4.2.4.12 Continual Improvement

This procedure had two indicators, which included Allocation of particular amount annually and Goal setting technique for quality improvement. Interviewee rating for its significance on five-point Likert scale is shown in Table 4.16. The response received was not convincing and a methodological approach to improve the quality standards were not being followed for quality improvement rather the approach was need based.

**Table 0.16**: Continual Improvement

| Response | Allocation of amount annually | Goal setting for quality improvement |
|---|---|---|
| Never | 6.3 | 29.7 |
| Rarely | 40.6 | 21.9 |
| Some times | 18.8 | 25.0 |
| Mostly | 18.8 | 9.4 |
| Always | 17.2 | 14.1 |

### 4.2.4.13 Statistical Techniques

This procedure had three indicators, which included use of control charts, check sheets and sample testing as quality control statistical techniques. Interviewees rating for its significance on five-point Likert scale is shown in Table 4.17. The response was very weak from the percentage response received for control charts and check sheets as only 6.3% and 0% firms "*Always"* use control charts and check sheets respectively. However

sample testing is followed *Mostly* 21% & and *Always* 18% in steel mills. In most of the mills sample testing is carried out on customers demand or for contractual formality.

**Table 0.17**: Statistical Techniques

| Response | Control charts | Check sheets | Sample testing |
|---|---|---|---|
| Never | 37.5 | 89.1 | 25 |
| Rarely | 17.2 | 6.3 | 16 |
| Some times | 26.6 | 0.0 | 20 |
| Mostly | 12.5 | 7.8 | 21 |
| Always | 6.3 | 0.0 | 18 |

#### 4.2.4.14 Internal Quality Audits

This procedure had two indicators, which included use of periodic audits and effective implementation for quality objective. Interviewees rating for its significance on five-point Likert scale is shown in Table 4.18.The response received was moderate to weak as only 37.5% mills *Always* carried out the Periodic quality audits and 39.1% effectively *(Always)* implemented the management quality plan for attaining quality objectives.

**Table 0.18**: Internal Quality Audits

| Response | Periodic audits | Effective implementation for quality objective |
|---|---|---|
| Never | 3.1 | 3.1 |
| Rarely | 14.1 | 3.1 |
| Some times | 37.5 | 32.8 |
| Mostly | 7.8 | 21.9 |
| Always | 37.5 | 39.1 |

## 4.3 Implementation of Quality Management System

The implementation of Quality Management System was assessed by level of application of three standards, (1) Quality control standards (2) Quality assurance standards and (3) Quality improvement standards. The response received from respondents was grouped in four categories i.e. Rarely, Sometimes, Mostly and Always. Then the weighted average was calculated against each standard.

### 4.3.1 Quality Control Standards

The response received for Quality Control Standards is given in Table 4.19, which indicates that Monitoring, inspection and testing is followed in about 33.78% mills, Test equipment maintenance is in 34.07% and Control of non conforming products is in about 36.42% mills. Application of statistical techniques had very less implementation i.e. only in 19.1% re-rolling steel industry.

**Table 0.19**: Implementation of Quality Control Standards

| **Sr.** | **Standard** | **Indicator** | **Frequency of Use** | | | | **Weighted Avg (%)** |
|---|---|---|---|---|---|---|---|
| | | | Rarely | Sometimes | Mostly | Always | |
| 1 | Monitoring, inspection and testing | In-plant Inspection | 12.5 | 23.4 | 18.8 | 17.2 | 18.45 |
| | | Defined Inspection Levels | 0 | 1.6 | 59.4 | 39.1 | 33.78 |
| | | Test notification procedures | 0 | 14.1 | 48.4 | 35.9 | 31.7 |
| | | Defined Hold points | 0 | 39.1 | 34.4 | 21.9 | 26.9 |
| 2 | Test equipment | Own Test Equipment | 0 | 3.1 | 1.6 | 62.5 | 26.1 |
| | | Calibration of Equipment | 0 | 4.7 | 4.7 | 59.4 | 26.11 |
| | | Maintenance of Equipment | 0 | 0 | 46.9 | 50 | 34.07 |
| 3 | Control of non conforming products | Removal of Error Causes | 0 | 1.6 | 43.8 | 53.1 | 34.7 |
| | | Material Management | 10.9 | 29.7 | 31.3 | 6.3 | 18.94 |
| | | Segregation of damaged Items | 1.6 | 0 | 25 | 71.9 | 36.42 |
| 4 | Statistical techniques | Control Charts | 17.2 | 26.6 | 12.5 | 6.3 | 13.31 |
| | | Check sheets | 6.3 | 0 | 7.8 | 0 | 2.97 |
| | | Sample Testing | 16 | 20 | 21 | 18 | 19.1 |

### 4.3.2 Quality Assurance Standards

The implementation of Quality Assurance Standards was assessed by four standards i.e. Supplier quality assurance, Internal Quality audits, Document control and Handling, storage, packing & delivery. The response received for Quality Assurance Standards is given in Table 4.20, which indicates that Supplier Quality Assurance is maximum followed in only 36.7% mills whereas internal quality audits in 29.08%, Document control in 33.89% and Handling, storage, packing and delivery had application in 36.88% steel re-rolling mills.

**Table 0.20**: Quality Assurance Standards

| Sr | Standard | Indicators | Frequency of Use | | | | Weigh-ted Avg (%) |
|---|---|---|---|---|---|---|---|
| | | | Rarely = 1 | Sometime = 2 | Mostly =3 | Always =4 | |
| 1 | Supplier Quality Assurance | Performance of raw material supplier | 4.7 | 7.8 | 23.4 | 50 | 29.05 |
| | | Quality history of material supplier for qualification | 0 | 6.3 | 54.7 | 39.1 | 33.31 |
| | | Supplier contact through buyers | 3.1 | 9.4 | 14.1 | 23.4 | 15.78 |
| | | Supplier awareness of acceptance procedure | 1.6 | 0 | 46.9 | 51.6 | 34.87 |
| | | Replacement of damaged items | 0 | 6.3 | 18.8 | 75 | 36.9 |
| 2 | Internal Quality Audits | Periodic audits | 14.1 | 37.5 | 7.8 | 37.5 | 26.25 |
| | | Effective implementation for quality objectives | 3.1 | 32.8 | 21.9 | 39.1 | 29.08 |
| 3 | Document Control | Record of Documents | 0 | 17.2 | 20.3 | 60.9 | 33.89 |
| | | Software Use | 1.6 | 1.6 | 6.3 | 0 | 2.37 |
| 4 | Handling, storage, packing & delivery | Lift Capabilities | 7.8 | 35.9 | 25 | 26.6 | 26.1 |
| | | Humidity free storage areas | 1.6 | 15.6 | 57.8 | 23.4 | 29.98 |
| | | Dispatch Process | 1.6 | 1.6 | 17.2 | 78.1 | 36.88 |
| | | Responsibilities for handling | 0 | 6.3 | 14.1 | 78.1 | 36.73 |
| | | Packing and Marking | 1.6 | 4.7 | 34.4 | 57.8 | 34.54 |
| | | Defects on delivery documents | 3.1 | 0 | 0 | 0 | 0.31 |

### 4.3.3 Quality Improvement Standards

The implementation of Quality Improvement Standards was assessed by four standards i.e. Involvement of workers, Continuous improvement, Customer focus and Personnel training. The response received for Quality improvement standards is given in Table 4.21, which indicates that Involvement of workers is maximum followed in only 28.3% mills whereas Continuous improvement in 20.34%, Customer focus in 23.27% and Personnel training in only 15.35% steel re-rolling mills.

**Table 0.21**: Quality Improvement Standards

| Sr. | Standard | Indicator | Frequency of Use | | | | Weight-ed Avg (%) |
|---|---|---|---|---|---|---|---|
| | | | Rarely | Sometimes | Mostly | Always | |
| 1 | Involvement of workers | Communication of results | 45.3 | 26.6 | 15.6 | 12.5 | 19.53 |
| | | Workers encouragement for quality suggestions | 0 | 29.7 | 51.6 | 17.2 | 28.3 |
| | | Recognition of quality performing workers | 14.1 | 37.5 | 31.3 | 14.1 | 23.94 |
| 2 | Continuous improve-ment | Allocation of amount annually | 40.6 | 18.8 | 18.8 | 17.2 | 20.34 |
| | | Goal setting for quality improvement | 21.9 | 25 | 9.4 | 14.1 | 15.65 |
| 3 | Customer focus | Evaluation by customer | 20.3 | 60.9 | 15.6 | 3.1 | 20.13 |
| | | Study of product for future | 20.3 | 42.2 | 15.6 | 20.3 | 23.27 |
| 4 | Personnel training | Engineers/ Supervisors training | 3.1 | 12.5 | 0 | 0 | 2.81 |
| | | Inspectors quality awareness | 26.6 | 29.7 | 14.1 | 6.3 | 15.35 |
| | | Office library | 6.3 | 0 | 0 | 0 | 0.63 |

## 4.4 Implementation of Eight Critical Factors of Quality Management

Table 4.22 shows the implementation of eight famous factors of Quality Management in Re-rolling Steel industry. The maximum percentage followed is for Supplier quality which is 33%, where as employees training is most neglected with implementation percentage of only 9% in local steel re-rolling industry of Pakistan.

**Table 0.22**: Application of Critical Factors of Quality Management

| Sr. | Factor | Sub Factor | Weighted Avg (%) | Avg of all sub factors |
|---|---|---|---|---|
| 1 | Top management support | Quality commitment (Quality Program / Policy) | 31 | 26 |
| | | Quality investment | 20 | |
| 2 | Employee training | Engineers training | 3 | 9 |
| | | Supervisors training | 15 | |
| 3 | Quality information availability | Record of documents | 34 | 27 |
| | | Internal quality audit | 27 | |
| | | Communication of quality results | 20 | |
| 4 | Quality information usage | Quality Manuals | 13 | 14 |
| | | Control Charts | 14 | |
| 5 | Employee involvement | Employee suggestion encouragement | 24 | 26 |
| | | Recognition for quality performance | 28 | |
| 6 | Process and Product design | Quality Manual | 14 | 24 |
| | | Current specifications and standards | 34 | |
| 7 | Supplier quality | Supplier evaluation | 30 | 33 |
| | | Supplier awareness of acceptance procedures | 35 | |
| 8 | Customer orientation | Customer evaluation | 20 | 22 |
| | | Customers suggestions for product improvement | 24 | |

## 4.5 Affiliation of Re-Rolling Steel Mills with Organizations of Standardization

The second objective of the study was to gain the knowledge of registration of steel re-rolling mills with controlling authorities / Organization of national and International Standardization. The percentage of steel re-rolling mills registration/ certifications with national/ international organizations is shown in Figure 4.1. 94% Steel re-rolling mills were registered with local Chamber of Commerce and Industries, 40% mills had got ISO certification, 31% mills had registration with Pakistan Standard and Quality Control Authority (PSQCA) whereas 70% steel re-rolling mills were registered with Pakistan Steel Re-rolling Mills Association (PSRMA).

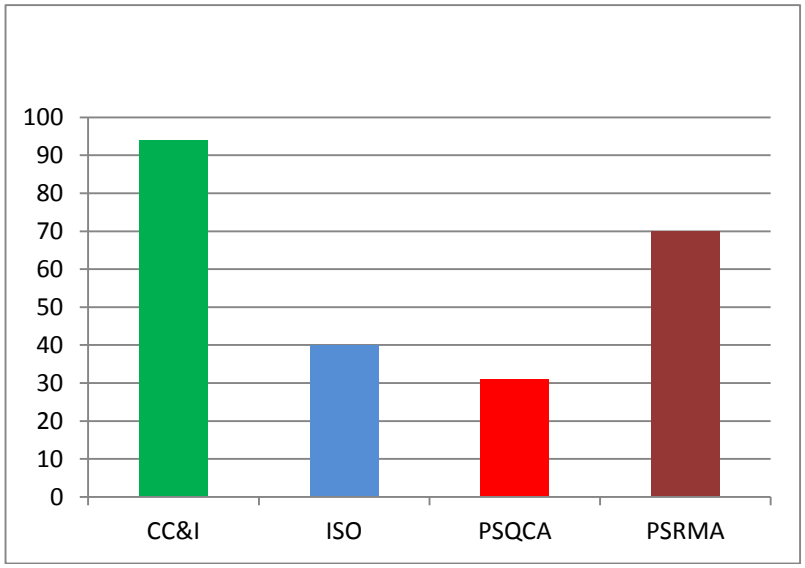


**Figure 0.1**: Percentage of Affiliation with Organizations

## 4.6 Standard and Specifications Being Followed

The third objective of the study was to assess the standards and specifications being followed by steel re-rolling mills in Pakistan. The study revealed that almost 96% mills followed ASTM 615A. However 56% also meet BS-4449 standards for their product beside ASTM A615. The Pakistan Standard is only followed in about 33% steel re-rolling mills. Figure 4.2 shows the graphical representation of percentage of Standards and Specification being followed in steel re-rolling mills.

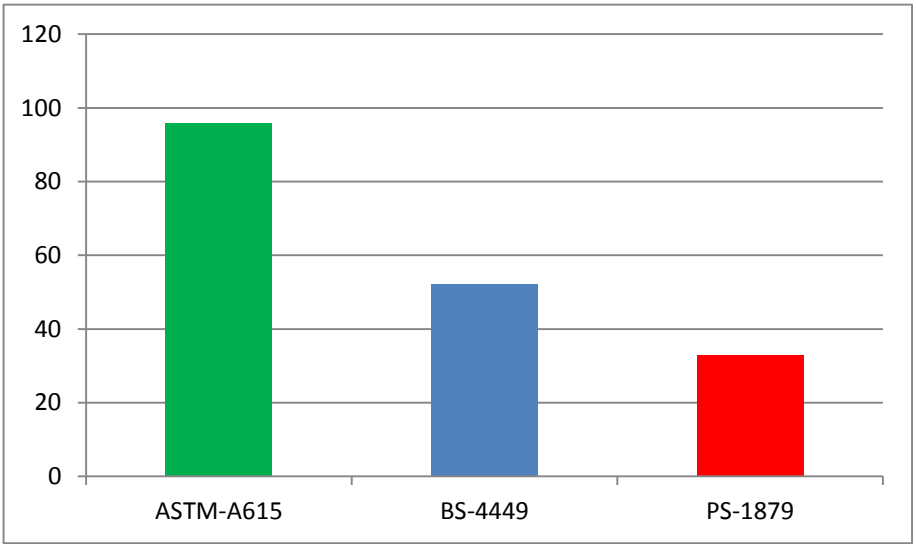


**Figure 0.2**: Standard and Specifications Followed

## 4.7 Summary

In this chapter results of study have been discussed. Forty seven (47) quality management indicators (grouped in 14 variables) were analyzed using SPSS-18 to assess the implementation level of QMS in steel re-rolling mills of Pakistan. Data was collected from steel re-rolling mills located in Rawalpindi, Rawat, Islamabad, Lahore, Peshawar and Gujranwala.

Descriptive Statistics was carried out to check the type of data available for analysis. Furthermore, Shapiro-Wilk normality test confirmed that the data is not normally distributed so non parametric test (Friedman one way ANOVA) was applied to measure the Mean Rank of fourteen (14) variables. The better implementation is observed for Specifications Followed (11.68) followed by Test Equipment (10.96). The lowest implementation for QMS is observed for training of personnel (1.71) followed by use of statistical analysis (1.87).

The percentage of implementation of quality standards was also assessed in the steel re-rolling industry. The results shows that quality control standards are followed in about 36.4%, quality assurance standards are also followed in about 36.9 % whereas QMS is implemented in only 28 % of the steel re-rolling mills.

The implementation of 8 critical factors of Quality Management was also assessed through this study. The weighted average of sub factors revealed that maximum implementation is for Supplier quality (33%) followed by Quality information available (27%). The lowest implementation is for Employee training (9%) followed by quality information usage (14%).

The registration and certification of steel re-rolling mills was also studied. The results revealed that 94% Steel re-rolling mills were registered with local CC&I, 40% mills had ISO certification, 31% mills had registration with PSQCA, whereas 70% steel re-rolling mills were registered with PSRMA.

The use of type of standards and specification was also part of this research. The results revealed that almost 96% mills followed ASTM 615A. However 56% also meet BS-4449 standards for their product beside ASTM A615. The Pakistan Standard is only followed in about 33% steel re-rolling mills.

*Chapter 5*

# CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Review of Research Objectives

The objectives of this study are:

a. Evaluate the implementation of Quality Management Standards (QMS) for deformed steel bars in local Re-rolling steel industry.
b. Investigate the status of registration with national controlling authorities and international organization of standardization for local re-rolling steel mills.
c. Determine the standards / specifications being followed for deformed steel bars.
d. Recommend the areas to be stressed upon for increase of quality services in steel re-rolling industry.

The first objective was achieved by collecting data for 47 quality indicators (grouped in 14 quality variables) through a questionnaire survey from 64 steel re-rolling mills in 7 different cities of Pakistan and then analyzing the collected data using SPSS-18 and statistical description; second objective was achieved by collecting data for registration and certification of steel re-rolling mills with ISO, PSQCA, PSRMA and CC&I. Third objective was obtained by collecting data form mills for following the standards and specification during manufacturing of steel bars i.e. ASTM A615, BS4449 and PS1469 and finally the fourth objective was obtained by identifying and need to be stressed upon the neglected quality standards for increase of quality services in steel re-rolling industry.

## 5.2 Conclusions

The following conclusions can be drawn from the study:

a. 40 % of steel mills had designated QA / QC managers to ensure the quality of product which is a low indication of dedicated responsibility delegation for quality assurance.

b. 71% of respondents were graduates and 19% were having master's degree which is encouraging percentage of educated personnel present in the industry.

c. Adherence to current, applicable specifications has highest application in the steel industry followed by equipment maintenance. The control of non conforming products has 3rd rank in quality standards being implemented.

d. Personnel's training has last rank in quality standards. Only 23 % employees are given on job training which indicates fewer adaptations to latest techniques and quality awareness. Only 11 % send their quality managers / engineers for training in quality related courses.

e. 21 % "always" and 18 % "mostly "use sample testing as statistical technique for quality control.

f. 8 % "mostly" use check sheets and 12 % "mostly" use control charts as statistical technique for quality control. The less percentage indicates a very less implementation of statistical techniques in re-rolling steel industry.

g. Statistical techniques like Pareto diagrams and scattered charts are rarely used in the steel re-rolling industry.

h. Customer evaluation is practiced "Some times" with the response of 51 % where as 19 % considers it "mostly" important. This standard is not given due importance in the industry.

i. Encouragement of workers is 53 % for "Some times" which is also weak response in quality management.

j. 96% companies follows ASTM-A615, 56 % follows BS-4449 where as PS 1846 is followed in 31 % of the surveyed mills.

k. 40 % mills are ISO 9001 certified whereas the quality management systems implementation is about 26% which indicates the less commitment to the practical implementation of QMS.

l. 31 % of mills are registered with PSQCA. 94 % has registration with concerned CC&I whereas the registration with PSRMA is 70 % for the surveyed mills.

## 5.3 Recommendations

a. Statistical techniques, document control for quality improvement, continual improvement and personnel training needs to be stressed upon for increase in implementation of quality standards.

b. ISO certification should be made compulsory for steel mills with more than 10 years of history / experience.

c. Quality awareness and management institutes be established at the local Chamber of Commerce and Industries level to train the engineers, foremen, inspectors and workers.

d. PSCQA should play a leading role in updating and publicizing PS-1879 and PS-1612 and attract the steel re-rolling mills to get registered.

e. PSQCA registration should be made mandatory for all Steel mills at the local Chamber of Commerce and Industries level to promote and encourage its role for development and enforcement of PS as compatible to ASTM or BS.

## 5.4 Directions for Future Research

a. Study may be extended to clients, contractors and consultants to evaluate the quality of deformed steel bars being used in construction projects.

b. ISO certified steel mills may be evaluated as a case study to gain the extent of adherence to ISO 9001 clauses.

c. Study may be conducted to evaluate the implementation of QA / QC procedures in billet manufacturing (steel melting) mills.

d. Study may also be conducted to evaluate the prevalence of QA/QC procedures in other construction materials.

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# APPENDICES

**APPENDIX "I"**

# Test for Outliers

| Variable | | | Statistic | Std. Error |
|---|---|---|---|---|
| Quality plan and management procedures | Mean | | 3.8500 | .10550 |
| | 95% Confidence Interval for Mean | Lower Bound | 3.6392 | |
| | | Upper Bound | 4.0608 | |
| | 5% Trimmed Mean | | 3.8771 | |
| | Median | | 4.0000 | |
| Suppliers quality assurance | Mean | | 3.8250 | .08304 |
| | 95% Confidence Interval for Mean | Lower Bound | 3.6591 | |
| | | Upper Bound | 3.9909 | |
| | 5% Trimmed Mean | | 3.8160 | |
| | Median | | 3.6000 | |
| Customer focus | Mean | | 3.1719 | .08497 |
| | 95% Confidence Interval for Mean | Lower Bound | 3.0021 | |
| | | Upper Bound | 3.3417 | |
| | 5% Trimmed Mean | | 3.1719 | |
| | Median | | 3.0000 | |
| Specification Followed | Mean | | 4.1297 | .07555 |
| | 95% Confidence Interval for Mean | Lower Bound | 3.9787 | |
| | | Upper Bound | 4.2807 | |
| | 5% Trimmed Mean | | 4.1431 | |
| | Median | | 4.0000 | |
| Monitoring, Inspection &Testing | Mean | | 3.8086 | .08417 |
| | 95% Confidence Interval for Mean | Lower Bound | 3.6404 | |
| | | Upper Bound | 3.9768 | |
| | 5% Trimmed Mean | | 3.7977 | |
| | Median | | 3.5000 | |
| Test Equipment | Mean | | 3.8922 | .16682 |
| | 95% Confidence Interval for Mean | Lower Bound | 3.5588 | |
| | | Upper Bound | 4.2256 | |
| | 5% Trimmed Mean | | 3.9358 | |
| | Median | | 4.7000 | |

| Variable | | | Statistics | Std. Error |
|---|---|---|---|---|
| Control of non-conforming products | Mean | | 4.0438 | .06111 |
| | 95% Confidence Interval for Mean | Lower Bound | 3.9216 | |
| | | Upper Bound | 4.1659 | |
| | 5% Trimmed Mean | | 4.0472 | |
| | Median | | 4.0000 | |
| Document control | Mean | | 2.8203 | .06898 |
| | 95% Confidence Interval for Mean | Lower Bound | 2.6825 | |
| | | Upper Bound | 2.9582 | |
| | 5% Trimmed Mean | | 2.7760 | |
| | Median | | 3.0000 | |
| Handling, storage, packing and delivery | Mean | | 3.7703 | .05526 |
| | 95% Confidence Interval for Mean | Lower Bound | 3.6599 | |
| | | Upper Bound | 3.8807 | |
| | 5% Trimmed Mean | | 3.7896 | |
| | Median | | 3.8000 | |
| Personnel training | Mean | | 1.6344 | .06300 |
| | 95% Confidence Interval for Mean | Lower Bound | 1.5085 | |
| | | Upper Bound | 1.7603 | |
| | 5% Trimmed Mean | | 1.6104 | |
| | Median | | 1.7000 | |
| Involvement of workers | Mean | | 3.4094 | .09306 |
| | 95% Confidence Interval for Mean | Lower Bound | 3.2234 | |
| | | Upper Bound | 3.5953 | |
| | 5% Trimmed Mean | | 3.3826 | |
| | Median | | 3.1500 | |
| Continual improvement | Mean | | 2.7813 | .15744 |
| | 95% Confidence Interval for Mean | Lower Bound | 2.4666 | |
| | | Upper Bound | 3.0959 | |
| | 5% Trimmed Mean | | 2.7569 | |
| | Median | | 2.7500 | |

| Variable | | | Statistics | Std. Error |
|---|---|---|---|---|
| Statistical techniques | Mean | | 1.7266 | .10442 |
| | 95% Confidence Interval for Mean | Lower Bound | 1.5179 | |
| | | Upper Bound | 1.9352 | |
| | 5% Trimmed Mean | | 1.6198 | |
| Internal quality audit | Mean | | 3.7422 | .13729 |
| | 95% Confidence Interval for Mean | Lower Bound | 3.4678 | |
| | | Upper Bound | 4.0165 | |
| | 5% Trimmed Mean | | 3.8038 | |
| | Median | | 3.5000 | |

**APPENDIX "II"**

Department of Construction Engineering and Management
School of Civil and Environment Engineering
National University of Science and Technology, Islamabad

Dear Manager,

1. The purpose of this letter is to kindly invite you to participate in a study survey regarding standard specifications and quality assurance/quality control procedures followed by construction material industry in Pakistan.
2. The objective of this study is to evaluate the standard specifications and quality assurance/control procedures followed by material construction industry of Pakistan by determining the prevalence of the related quality assurance and control procedures in Pakistan.
3. The results of this study can be a great help to your company/organization by providing you the synopsis of the prevalence of quality assurance and quality control procedures among the local construction material industry. The result can give you an idea of the quality of material service provided by your company/organization as compared to the other organizations and thus help you in marketing your strengths and developing the areas of your service in which you feel your company is lagging behind.
4. Please provide the needed information, requested in the enclosed questionnaire as practiced by your company. The information provided by you will be used only for the purpose of the study without mentioning the name of the organization. We realize that there are numerous demands on your time, however your involvement is a vital requisite for this study. We will be highly grateful if you could return the completed questionnaire to us on or before the 15th of January 2011 at any of the addresses below.
5. We highly recommend you to obtain a copy of this study, which will be sent to you upon your request. Please feel free to contact us, if you have questions regarding this study, at the following details:

Dr. Hamza Farooq Gabriel
NIT, SCEE, NUST,
NUST Campus, H-12 Islamabad
Tel:051-90854195
E-mail: hfgabriel2001@yahoo.com

Engr. Muhammad Usman Iqbal
Flat V-2,Iqra Apartments
NUST Campus, H-12 Islamabad
Tel: 0321-3067893
E-mail: musaik36@yahoo.com

Thanking in anticipated cooperation.

Yours Sincerely,

Dr. Hamza Farooq Gabriel
Associate Professor

Muhammad Usman Iqbal
MS student

**APPENDIX "III"**

# QUESTIONNAIRE

**(Quality Assurance/Control procedures of construction materials in Pakistan)**

1. **General Questions Regarding The Company/ Organization**
   **Personnel Information**

   a. Your name: _____
   b. Your designation: _____
   c. Total years of experience with the present company/firm: _____
   d. Highest qualification achieved: _____
   e. Contact No. _____

   **Company's Information**

   a. Company's name: _____
   b. Year of establishment: _____
   c. Registration with some organization: _____
   d. Standards followed ( ASTM, BS, Pakistan standards):_____
   e. Any Pakistan Standards Organization in knowledge: _____
   f. ISO certification held (Yes/No): _____
   g. ISO certification last year of renewal: _____
   h. Production per year: _____
   i. Exports: _____
   j. Rate per Metric Ton: _____

   **Construction material/Product Information:**

   a. Brand name/Logo:_____
   b. Sizes of the materials produced:
      1) _____
      2) _____
      3) _____

**2. Please give your importance rating of adherence of Quality Assurance and Quality Control procedures for your product/material in your company/organization.**

| | 1(Minimum) | 2 | 3 | 4 | 5 (Maximum) |
|---|---|---|---|---|---|
| Importance of Quality Assurance/Quality Control Procedures in your company | | | | | |

**3. Questions Regarding *The Quality Assurance And Quality Control Procedures* Followed in your Company/Organization:**

**SD = Strongly Disagree, D = Disagree, NA/D = neither agree or disagree, A = Agree, SA = Strongly Agree**

| **Quality Assurance/Control Procedures** | | **Never** | **Rarely** | **Sometimes** | **Mostly** | **Always** |
|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** |
| 1. Quality Plan and Management Procedures | | | | | | |
| 1 | The company has an established quality program | | | | | |
| 2. | The company objectives and individual responsibilities for quality are clearly defined | | | | | |
| 3. | Quality manual is present and is updated to reflect current quality policies and procedures | | | | | |
| 4. | The company has a specified design and production methodology. | | | | | |
| 5. | The company has designated a quality manager | | | | | |
| 2. Supplier Quality Assurance | | | | | | |
| 6 | The performance of supplier for raw material is evaluated | | | | | |
| 7 | Quality history of material supplier is included in prequalification | | | | | |
| 8 | The supplier contact through buyers | | | | | |
| 9 | Suppliers are aware of acceptance procedures | | | | | |
| 10 | The supplier is notified to repair or replace the damaged or short items | | | | | |

| | Quality Assurance/Control Procedures | Never | Rarely | Sometimes | Mostly | Always |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| | 3. Customer Focus | | | | | |
| 11 | An evaluation by the client /construction contractors is requested at the end of specific quantity/period. | | | | | |
| 12 | After a specific period ,a study of the significant product characteristics is made for future reference | | | | | |
| | 4. Specification Followed | | | | | |
| 13 | The company reviews design/specifications after some time | | | | | |
| 14 | Specifications are current according to the market change | | | | | |
| 15 | Standard is kept current, accurate and applicable | | | | | |
| 16 | Specifications are revised for errors or inconsistencies | | | | | |
| | 5. Monitoring, inspection and testing | | | | | |
| 17 | In plant inspection is coordinated with supplier | | | | | |
| 18 | The company specifies the inspection levels | | | | | |
| 19 | The test notification procedures are set | | | | | |
| 20 | The company has defined some witness or hold points | | | | | |
| | 6. Test Equipment | | | | | |
| 21 | The company owns test equipment for regular testing | | | | | |
| 22 | Calibration of Equipment is conducted on regular basis | | | | | |
| 23 | The equipment is properly maintained in storage(rotation, mechanical functioning & lubrication, etc) | | | | | |

| | Quality Assurance/Control Procedures | Never | Rarely | Sometimes | Mostly | Always |
|---|---|---|---|---|---|---|
| 7. Control of nonconforming products | | | | | | |
| 24 | Error causes are removed | | | | | |
| 25 | Material management is informed about the non conformances | | | | | |
| 26 | The damaged items are segregated | | | | | |
| 8. Document control | | | | | | |
| 27 | All documents relating to the product are indexed and properly filed | | | | | |
| 28 | Computer software utilized in the design and control process is selected based on their accuracy and checked for any errors | | | | | |
| 9. Handling, storage, packaging, and delivery | | | | | | |
| 29 | Adequate lift capabilities are available. | | | | | |
| 30 | Storage areas for critical items are clean, humidity controlled and well ventilated | | | | | |
| 31 | The process for shipment/dispatch is understood. | | | | | |
| 32 | Responsibilities for verification, handling, storage and acceptance are established. | | | | | |
| 33 | Items are checked for packing and marking. | | | | | |
| 34 | The defects are noted on shipping documents | | | | | |
| 10. Personnel Training | | | | | | |
| 35 | Supervisors/ Engineers are provided with on job training and short courses. | | | | | |
| 36 | Inspectors /crafts men are provided with training and quality awareness. | | | | | |

| Quality Assurance/Control Procedures | | Never | Rarely | Sometimes | Mostly | Always |
|---|---|---|---|---|---|---|
| 37 | The company provides office library facility | | | | | |
| 10. Involvement of workers | | | | | | |
| 38 | The results are communicated and everybody knows what is happening and why. | | | | | |
| 39 | The supervisors and workers are encouraged to suggest for quality improvement. | | | | | |
| 40 | The quality performing supervisors and workers are recognized and rewarded for their achievements | | | | | |
| 11. Continual Improvement | | | | | | |
| 41 | Certain amount is fixed annually for quality improvement | | | | | |
| 42 | Goal setting are introduced for quality improvement | | | | | |
| 12. Statistical Techniques | | | | | | |
| 43 | Control charts are used to keep record of discontinuities | | | | | |
| 44 | Histograms**,** Check Sheets, pareto charts are used for record of discontinuities. | | | | | |
| 45 | Sample testing is carried out regularly | | | | | |
| 13. Internal Quality Audits | | | | | | |
| 46 | Periodic audits are conducted to determine the conformance of QA procedures and related results according to planned arrangements | | | | | |
| 47 | Suitable arrangements are implemented effectively to achieve the quality objectives | | | | | |

4. Others (please specify, your suggestions and comments will be great help in this study).

5. Briefly explain your Quality Assurance and Quality control procedures including the method of sampling for tests and specifications/standard verifications.

**Appendix "IV"**

# LIST OF STEEL RE-ROLLING MILLS VISITED

1. Ittehad Steel Mill – Islamabad
2. Zia Steel Re-rolling Mills – Islamabad
3. Fazal Steel (Pvt) Ltd – Islamabad
4. Ilyas Steel Mill – Gwa
5. Ittefaq Sons (Pvt) Ltd- Lahore
6. Classic Steel Mill-Islamabad
7. Pak Steel Re-rolling Mill- Islamabad
8. R.K Steel Mills –Islamabad
9. Potohar Steel Industries- Islamabad
10. Frontier Foundry (Pvt) Ltd - Peshawar
11. Karachi Steel Re-rolling(KSR)-Islamabad
12. Al-Hilal Steel Mills- Islamabad
13. City Steel UAE Mills(Pvt)Ltd- Lahore
14. Model Steel Mill- Lahore
15. Barkat Steel Re-rolling Mill (Pvt) Ltd –Lahore
16. Malik Steel Re-rolling Mill-Lahore
17. JP Steel Mill - Lahore
18. Ishtiaq Steel Mill- Lahore
19. Eastern Steel Mill (Pvt) Ltd - Lahore
20. Rehmat Steel- Lahore
21. Neelum Steel Industries- -Lahore
22. Adeel Shahbaz Steel Mill – Hattar
23. Islamabad Re-rolling Steel Mill(Pvt) Ltd- Hattar
24. Mujahid Steel Re-rolling Mill-Hattar
25. Farid Steel Casting (Pvt) Ltd- Hattar
26. Mustahkam Ittefaq Steel Industries - Hattar
27. AA Steel Industries - Hattar
28. National Steel Mill - Hattar
29. Nomee Steel Industries - Hattar
30. Modern Steel Mill Islamabad
31. New Millat Steel Mill-Lahore
32. A S Steel Mill-Lahore
33. Chenab Steel Mill –Lahore
34. Jamal Steel Mill-Lahore
35. JR Steel - Islamabad
36. Capital Steel - Islamabad
37. Siddiqi Steel Re-rolling Mill - Islamabad
38. M.I.Z Steel Re-rolling Mill – Islamabad
39. Al Hadid Industries Steel Re-rolling Mill – Islamabad
40. Kohsar Steel Re-rolling Mill- Islamabad

41. RS Steel Re-rolling Mill – Islamabad
42. Noor Re-rolling Steel Mill –Hattar
43. STEELCO Re-rolling & Engg Mill – Islamabad
44. Islamabad Steel Re-rolling Mill –Islamabad
45. Insaaf steel Re-rolling Mill – Rawat
46. New Modern Steel Re-rolling Mill – Rawat
47. BM Steel Re-rolling Mill – Rawalpindi
48. Modern Steel Re-rolling Mill – Islamabad
49. Pak Steel Re-rolling Mill – Islamabad
50. Karachi Steel Re-rolling Mill (KSR) - Islamabad
51. Insaaf Steel Re-rolling Mill- Rawat
52. Ittehad Steel Mill – Islamabad
53. Zia Steel Re-rolling Mills – Islamabad
54. Fazal Steel (Pvt) Ltd – Islamabad
55. Ilyas Steel Mill – Gujranwala
56. Ittefaq Sons (Pvt) Ltd - Islamabad
57. Classic Steel Mill - Islamabad
58. R.K Steel Mills – Islamabad
59. Potohar Steel Industries - Islamabad
60. Frontier Foundry (Pvt) Ltd Peshawar
61. Adeel Shahbaz Steel Mill - Hattar
62. Nomee Steel Industries-Hattar
63. Mujahid Steel Re-rolling Mill -Hattar
64. Farid Steel Casting (Pvt) Ltd- Hattar