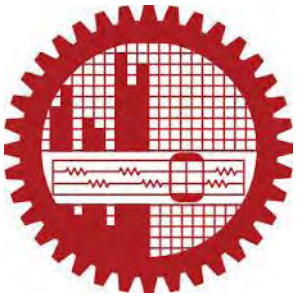
MASTERS OF ENGINEERING

TOTAL QUALITY MANAGEMENT (TQM) IN CONSTRUCTION FIRM: A CASE STUDY

MOHAMMAD SHAHINUR FERDOUSH



DEPARTMENT OF INDUSTRIAL AND PRODUCTION ENGINEERING

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY (BUET), DHAKA-1000, BANGLADESH

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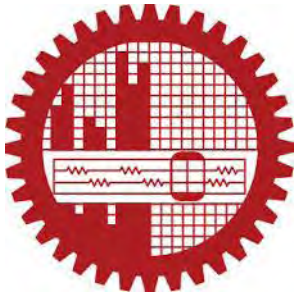
TOTAL QUALITY MANAGEMENT (TQM) IN CONSTRUCTION FIRM: A CASE STUDY

A thesis work submitted to the Department of Industrial and Production Engineering, Bangladesh University of Engineering and Technology (BUET), in partial fulfillment of the requirements for the degree Master of Engineering in Advanced Engineering Management (AEM).



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DHAKA-1000, BANGLADESH

CERTIFICATE OF APPROVAL

The thesis titled "TOTAL QUALITY MANAGEMENT (TQM) IN CONSTRUCTION FIRM: A CASE STUDY" submitted by Mohammad Shahinur Ferdoush, Roll No. 0409082124, Session- April, 2009 has been accepted as satisfactory in partial fulfillment of the requirements for the degree of Master of Engineering in Advanced Engineering Management (AEM) on April 22, 2014.

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1. Dr. Sultana Parveen — Chairman
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2. Dr. M. Ahsan Akhtar Hasin — Member
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Mohammad Shahinur Ferdoush

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Mohammad Shahinur Ferdoush

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Abstract

The construction industry is being viewed as one with poor quality emphasis compared to other sectors like the manufacturing and service sectors. At present 28% of the population of Bangladesh live in urban areas, which will be 34% in 2015. Real estate business started in Dhaka in late seventies. Now in 2013 there are about 1300 companies with REHAB membership engaged in this business. So Quality Management is very important to control the loss & defects of the construction business and to achieve stakeholders‟ satisfaction. For this reason it is the time to implement TQM in construction firms of Bangladesh.

Very few construction firms are practicing TQM in this country and the top-down approach is commonly used here. To implement TQM in the firms‟ top management must be committed to practice "bottom-up" approach by forming "Quality Circle" like Japan. In this research it is identified clearly that the first and foremost condition for implementing TQM in construction firms is top management commitment. Some other barriers those have to face by the firms are lack of education, lack of motivation, lack of mutual trust, lack of trained workers, competitive markets, poor plans and specifications, bad attitudes, lack of competent field managers etc.

In this paper one case study is reviewed how Total Quality Management (TQM) is successfully implemented by following Japanese "bottom-up" approach and making quality circles in a construction firm of Bangladesh. Experience is implemented into another company to implement TQM after some analysis of Pareto chart, Cause Effect diagram, Process analysis and finally identified root causes by using Root Cause analysis. Then a framework for implementing TQM in construction firm is recommended.

Chapter 1
Introduction

1.1 INTRODUCTION

Attainment of acceptable levels of quality in the construction industry has long been a problem. Great expenditures of time, money and resources, both human and material, are wasted each year because of inefficient or nonexistent quality management procedures. The manufacturing industry has developed Total Quality Management (TQM) concepts, first applied in Japan and in recent years used in the United States which have increased productivity, decreased product cost and improved product reliability. These concepts are also applicable to the construction industry [1].

TQM involves everyone in the construction industry. It is achieved through an integrated effort in the different phases of the project including planning and design, construction, operation and maintenance to increase customer satisfaction by continuously improving performance. TQM focuses on management commitment and leadership, statistical methods, supplier involvement and customer service, teamwork, training, and cost of quality in an effort to achieve customer satisfaction, cost effectiveness, and defect free work, TQM provides the culture and climate essential for innovation and for technology advancement. Many people have contributed to the development of the TQM approach but there are three names that stand out above the others as the best known original thinkers. These are W. E. Deming, J. Juran and P. Crosby [1].

The construction industry is being viewed as one with poor quality emphasis compared to other sectors like the manufacturing and service sectors [2]. Bangladesh is poor country and urbanization process is also is a slow process here. But due to increasing demand of people and dramatic change of modern science and technology the people of Bangladesh also want to keep pace with the developed countries of the world in many sectors. Construction industries are one of the exploring sectors here. During the last 40 years, after liberation war, many large and famous building projects have been established. At present 28% of the population of Bangladesh live in urban areas, which will be 34% in 2015 [3]. Real estate business started in Dhaka in late seventies. Now in 2013 there are about 1300 companies with REHAB membership engaged in this business [4].

Nowadays Real Estate business is one of the top listed profitable businesses. The land owners who are not able to build their house themselves transferred the authority to the developers by certain percentage of share to build their houses. Initially land owners get some signing money and monthly compensation to stay in other rental houses by the time the developer build their houses. On the other hand some people build their houses after retirement with their big savings. Some rural people sell their rural land and capital to buy land in city area or to buy flat in city. So ownership of a city house is an ultimate dream of many moderate and rich people of Bangladesh.

According to provisional data from the Bangladesh Bureau of Statistics, the construction sector accounted for a record 9.1 per cent of GDP (Gross Domestic Product) in fiscal year (FY) 2012/13 (July-June) [5].

Before 20 years, concept of quality development in building construction and housing projects was far behind. Then population was less and land was also sufficient to them for living. They did not even think about high rise or multistoried building like nowadays. But in present, due to increasing pressure of population, city centric business, education and employment there has been created the need to better utilization of land [and capital. Many men have to live within a small land. So they created demand for multistoried apartment. Multistoried apartment requires high quality concern and lots of sensitive issues. And thus like many other developed countries; Bangladesh also needs to implement Total Quality Management (TQM) in construction industries to successfully achieve the goal.

There are seven basic tools of Total Quality Management (TQM) which can be used to analyze and subsequently intervene to eliminate the problems from the production system. Based on long experience in quality issues, a renowned quality expert Dr. Kaoru Ishikawa stated: “As much as 95% of quality related problems can be solved with seven fundamental quantitative tools” [6].

1.2 BACKGROUND OF THE STUDY

The concept of Real Estate is developed to resolve the residential facility which is a big problem in a densely populated country like Bangladesh. Especially the cities where unavailability of land tends to raise the tendency of high rise apartments rather than private

dwellings. At present 28% of the population of Bangladesh live in urban areas, which will be 34% in 2015 [3].

Like any other country in the world, the housing sector plays vital roles both in the context of the economy of Bangladesh and serving the fundamental human right of shelter. Apart from providing physical shelter, housing may have significant impact on the lives of the dwellers in terms of skills enhancement, income generation, increased security, health, self-confidence and human dignity. Bangladesh, like many other developing countries, faces an acute shortage of affordable housing both in the urban and rural areas. Moreover, housing affordability is being eroded by poor land administration policies, which have resulted in very high land prices that make urban housing prohibitive for lower-income groups. Also, there is no active secondary market for real estate, mainly because of the high transfer taxes and an uninterrupted long-term increase in land prices. In spite of all these, this sector has experienced considerable growth in past few decades [21].

With a rising population and increasing housing demand, apartment culture has grown up in Dhaka sharply. Apartments were first introduced by the formal private developers in early 80s to the housing history of Dhaka. It first appeared in Dhaka near Central Road and subsequently the city experienced a boom in apartment development in all residential areas including Paribagh, Maghbazar, Siddeshwari, Shantinagar, Dhanmondi, Mirpur, Banani, old DOHS, new DOHS, Gulshan and Baridhara, to name just a few. In line with this, house rent in Dhaka increased by 250 percent between 1990 and 2007 [21].

1.3 OBJECTIVES

The specific objectives of the present research work are as follows:

a. To identify the requirement of customers & employees and the barriers to TQM in construction firms.
b. To identify the possible causes of problems by Check Sheet, Pareto Chart, Cause Effect diagram (Fish Bone Method), Root Cause Analysis and other Tools of TQM.
c. To examine possible steps for restructuring an organization for TQM and to develop a Total Quality Management (TQM) approach for practicing in construction firms as per identified performance parameter.

Chapter 2
Literature Review

2.1 INTRODUCTION

In general, quality refers to the characteristics of a product or service that defines its ability to consistently meet or exceeds customer expectations. The characteristics are added to the product or service through out its value chain, right from materials procurement up to customer use. As such, all the departments of an organization have some roles to play in determining quality of the product or service [7].

Crosby defines quality as “Quality is conformance to requirements or specification” [8].
Juran defines quality as “Quality is fitness for use” [8]. Which typically means its performance, conformance, safety, durability and reliability?

Quality emerged as a major factor in business success after World Was II, when Japanese opted for fighting in two fronts- quality and price. Prior to this, the US business organizations tended to focus on only price, quality being a distant second factor. The success of Japanese changes the whole complexion of business in the world. In fact, the Japanese injected a revolutionary idea that increased quality means decreased cost, a completely opposite idea commonly prevailing those days, even partly now-a-days. A balance between the price and performance of the product is the focal point of „quality“ [7].

2.2 EVOLUTION OF QUALITY

Quality management is a recent phenomenon. Advanced civilizations that supported the arts and crafts allowed clients to choose goods meeting higher quality standards than normal goods. In societies where arts and crafts are the responsibility of a master craftsman or artist, they would lead their studio and train and supervise others. The importance of craftsmen diminished as mass production and repetitive work practices were instituted. The aim was to produce large numbers of the same goods. The first proponent in the US for this approach was Eli Whitney who proposed (interchangeable) parts manufacture for muskets, hence producing the identical components and creating a musket assembly line. The next step forward was promoted by several people including Frederick Winslow Taylor a mechanical engineer who sought to improve industrial efficiency. He is sometimes called "the father of

scientific management." He was one of the intellectual leaders of the Efficiency Movement and part of his approach laid a further foundation for quality management, including aspects like standardization and adopting improved practices. Henry Ford was also important in bringing process and quality management practices into operation in his assembly lines. In Germany, Karl Friedrich Benz, often called the inventor of the motor car, was pursuing similar assembly and production practices, although real mass production was properly initiated in Volkswagen after World War II. From this period onwards, North American companies focused predominantly upon production against lower cost with increased efficiency.

Walter A. Shewhart made a major step in the evolution towards quality management by creating a method for quality control for production, using statistical methods, first proposed in 1924. This became the foundation for his ongoing work on statistical quality control. W. Edwards Deming later applied statistical process control methods in the United States during World War II, thereby successfully improving quality in the manufacture of munitions and other strategically important products.

Quality leadership from a national perspective has changed over the past five to six decades. After the Second World War, Japan decided to make quality improvement a national imperative as part of rebuilding their economy, and sought the help of Shewhart, Deming and Juran, amongst others. W. Edwards Deming championed Shewhart's ideas in Japan from 1950 onwards. He is probably best known for his management philosophy establishing quality, productivity, and competitive position. He has formulated 14 points of attention for managers, which are a high level abstraction of many of his deep insights. They should be interpreted by learning and understanding the deeper insights. These 14 points include key concepts such as:

- Break down barriers between departments
- Management should learn their responsibilities, and take on leadership
- Supervision should be to help people and machines and gadgets to do a better job
- Improve constantly and forever the system of production and service
- Institute a vigorous program of education and self-improvement

In the 1950s and 1960s, Japanese goods were synonymous with cheapness and low quality, but over time their quality initiatives began to be successful, with Japan achieving very high

levels of quality in products from the 1970s onward. For example, Japanese cars regularly top the J.D. Power customer satisfaction ratings. In the 1980s Deming was asked by Ford Motor Company to start a quality initiative after they realized that they were falling behind Japanese manufacturers. A number of highly successful quality initiatives have been invented by the Japanese (see for example on this page: Genichi Taguchi, QFD, and Toyota Production System. Many of the methods not only provide techniques but also have associated quality culture (i.e. people factors). These methods are now adopted by the same western countries that decades earlier derided Japanese methods.

Customers recognize that quality is an important attribute in products and services. Suppliers recognize that quality can be an important differentiator between their own offerings and those of competitors (quality differentiation is also called the quality gap). In the past two decades this quality gap has been greatly reduced between competitive products and services. This is partly due to the contracting (also called outsourcing) of manufacture to countries like India and China, as well internationalization of trade and competition. These countries amongst many others have raised their own standards of quality in order to meet International standards and customer demands. The ISO 9000 series of standards are probably the best known International standards for quality management.

There are a huge number of books available on quality management. In recent times some themes have become more significant including quality culture, the importance of knowledge management, and the role of leadership in promoting and achieving high quality. Disciplines like systems thinking are bringing more holistic approaches to quality so that people, process and products are considered together rather than independent factors in quality management.
The influence of quality thinking has spread to non-traditional applications outside of walls of manufacturing, extending into service sectors and into areas such as sales, marketing and customer service [9].

Early stage: Inspection based quality
In this stage, the corrective action took place at the end of the production line, when wastes were already created, and corrective action was impossible.

The next stage: Statistical Quality Control (SQC)
This idea was sampling based, where random samples used to be taken for further statistical

analysis to evaluate the ability of the process. But still then, involvement of all in the organization was not though of. The idea was still limited to quality and production department.

The third stage: Quality Assurance (QA)

A new idea evolved which says – one can give early assurance if a **process** is diagnosed as being **capable**. Quality assurance (QA) phase, in which stress was on providing some advance assurance of quality of the service/products that it would fulfill the requirements of customers, received acceptance.

Last and current stage: Total Quality Management (TQM)

The most modern idea of quality says- quality is not the responsibility of two departments only, rather as responsibility of all in the organization. When the philosophy of „Customer satisfaction" became the definition of quality, the organization-wide quality management got establishment. This is Total Quality Management (TQM), which advocates for end-less continuous improvement [10].

2.3 CONCEPT FROM QUALITY GURUS

An extensive review of literature was carried out to identify the concept of TQM from quality gurus such as Deming, Juran, Crosby, Feigenbaum, and Ishikawa. Their propositions are the foundation for understanding the concept of TQM. The following subsections present the main principles and practices of TQM proposed by these quality gurus.

2.3.1 DEMING'S APPROACH TO TQM

2.3.1.1 ROLE OF W. E. DEMING

- Deming was an American who worked in the 1930s with Walter A. Shewhart at Bell Telephone Company.
- Deming developed a process, based on Shewhart's, using statistical control techniques that alerted managers of the need to intervene in the production process.
- Although, Deming"s principal of quality management were not received well in the USA. There were no takers for Deming"s preaching.
- However when General Mal Arthur brought Deming to Japan as a management consultant for the Japanese, they were very attentive to Deming"s philosophy

- In 1947 Douglas MacArthur and the U.S. State Department sent Deming to Japan to help the war-devastated Japanese manufacturing plants. He introduced these "statistical process control" methods in a series of lectures on statistical methods to Japanese businessmen and engineers.
- His concept of employees working toward quality fit well into their personal ideas.
- Deming developed the chain reaction: as quality improves, costs go down and productivity goes up; this leads to more jobs, greater market share, and long-term survival.
- **Quality circles**, a central Deming theme, are based on the importance of employees meeting regularly in groups to comprehensively discuss product quality.
- The GDP in Japan rose steadily from 1960s by more than 10 percent per year.
- He stressed worker pride and satisfaction and considered it management's job to improve the process, not the worker.
- By 1951 the Japanese had named their quality prize in his honour. Deming's book, Out of the Crisis, emphasized improving quality of the product as more important than short-term financial goals.
- He believed that "statistical process control" was an invaluable instrument in the quest for quality [11].

2.3.1.2 DEMING'S FOURTEEN POINTS OF MANAGEMENT

1. Create a plan; publish the aims and purposes of the organization.
2. Learn and adopt the new philosophy of quality.
3. Understand the purpose of inspection; stop depending on inspection.
4. Stop awarding business based on price alone.
5. Improve the system constantly.
6. Institute training.
7. Teach and institute leadership.
8. Drive out fear, create trust, and create a climate for innovation.
9. Optimize the efforts of teams, groups and staff areas.
10. Eliminate exhortations, and targets for the work force; provide methods of achievement.
11. Eliminate numerical quotas for the work force.
12. Remove barriers that rob people of pride for workmanship.
13. Encourage education and self improvement for everyone.

14. Make action to accomplish the transformation, make it everyone's job [11].

2.3.1.3 SEVEN DEADLY DISEASES

1. Lack of constancy of purpose to plan products and services.
2. Emphasis on short-term profits.
3. Personal review systems for managers and management by objectives.
4. Job hopping by managers.
5. Using only visible data in decision making.
6. Excessive medial costs.
7. Excessive costs of liability driven up by lawyers that works on contingency [11].

2.3.2 JURAN'S APPROACH TO TQM

Joseph M. Juran, like Deming, went to Japan in 1954 and assisted the Japanese in their quest to achieve quality [10].

TQM is the system of activities directed at achieving delighted customers, empowered employees, higher revenues, and lower costs (Juran and Gryna, 1993). Juran believed that main quality problems are due to management rather than workers. The attainment of quality requires activities in all functions of a firm. Firm-wide assessment of quality, supplier quality management, using statistical methods, quality information system, and competitive benchmarking are essential to quality improvement. Juran‟s approach is emphasis on team (QC circles and self-managing teams) and project work, which can promote quality improvement, improve communication between management and employees coordination, and improve coordination between employees. He also emphasized the importance of top management commitment and empowerment, participation, recognition and rewards.

According to Juran, it is very important to understand customer needs. This requirement applies to all involved in marketing, design, manufacture, and services. Identifying customer needs requires more vigorous analysis and understanding to ensure the product meets customers‟ needs and is fit for its intended use, not just meeting product specifications. Thus, market research is essential for identifying customers‟ needs. In order to ensure design quality, he proposed the use of techniques including quality function deployment, experimental design, reliability engineering and concurrent engineering.

Juran considered quality management as three basic processes (**Juran Trilogy**), such as

- **Quality planning** (determine customer needs, develop product in response to needs).
- **Quality control** (assesses performance, compare performance with goals, act on differences between performance and goals).
- **Quality improvement** (develop infrastructure, identify areas of improvement and implement projects, establish project team, provide teams with what they need).

In his view, the approach to managing for quality consists of: The sporadic problem is detected and acted upon by the process of quality control; The chronic problem requires a different process, namely, quality improvement; Such chronic problems are traceable to an inadequate quality planning process. Juran defined a universal sequence of activities for the **three quality processes**, which is listed in **Table 2.1.**

Juran defined four broad categories of quality costs, which can be used to evaluate the firm‟s costs related to quality. Such information is valuable to quality improvement. The **four quality costs** are listed as follows:

1. **Internal failure costs** (scrap, rework, failure analysis, etc.), associated with defects found prior to transfer of the product to the customer;
2. **External failure costs** (warranty charges, complaint adjustment, returned material, allowances, etc.), associated with defects found after product is shipped to the customer;
3. **Appraisal costs** (incoming, in-process, and final inspection and testing, product quality audits, maintaining accuracy of testing equipment, etc.), incurred in determining the degree of conformance to quality requirements;
4. **Prevention costs** (quality planning, new product review, quality audits, supplier quality evaluation, training, etc.), incurred in keeping failure and appraisal costs to a minimum [12].

Table 2.1: Universal Processes for Managing Quality [12]

Quality planning	Quality control	Quality improvement
Establish quality goals	Choose control subjects	Prove the need
Identify customers	Choose units of measure	Identify projects
Discover customer needs	Set goals	Organize project teams
Develop product features	Create a sensor	Diagnose the causes
Develop process features	Measure actual performance	Provide remedies, prove
Establish process controls transfer to operations	Interpret the difference Take action on the difference	remedies are effective Deal with resistance to change Control to hold the gains

Also Juran describes ten steps of quality improvement.

Juran's Ten Steps to Quality Improvement

1. Build awareness of opportunities to improve.
2. Set goals.
3. Organize to reach goals.
4. Provide training.
5. Carry out projects to solve problems.
6. Report progress.
7. Give recognition.
8. Communicate results.
9. Keep score.
10. Maintain momentum by making annual improvement part of the systems and processes of the company [11].

2.3.3 CROSBY'S (1926 – 2001) APPROACH TO TQM

Crosby identified a number of important principles and practices for a successful quality improvement program, which include, for example, management participation, management responsibility for quality, employee recognition, education, reduction of the cost of quality (prevention costs, appraisal costs, and failure costs), emphasis on prevention rather than after-the-event inspection, doing things right the first time, and zero defects. Crosby claimed that mistakes are caused by two reasons: Lack of knowledge and lack of attention. Education and training can eliminate the first cause and a personal commitment to excellence (zero defects)

and attention to detail will cure the second. Crosby also stressed the importance of management style to successful quality improvement. The key to quality improvement is to change the thinking of top managers-to get them not to accept mistakes and defects, as this would in turn reduce work expectations and standards in their jobs. Understanding, commitment, and communication are all essential. Crosby presented the quality management maturity grid, which can be used by firms to evaluate their quality management maturity. The five stages are: Uncertainty, awakening, enlightenment, wisdom and certainty. These stages can be used to assess progress in a number of measurement categories such as management understanding and attitude, quality organization status, problem handling, cost of quality as percentage of sales, and summation of firm quality posture. The quality management maturity grid and cost of quality measures are the main tools for managers to evaluate their quality status. Crosby offered a 14-step program that can guide firms in pursuing quality improvement. These steps are listed as follows:

1. Management commitment: To make it clear where management stands on quality.
2. Quality improvement team: To run the quality improvement program.
3. Quality measurement: To provide a display of current and potential nonconformance problems in a manner that permits objective evaluation and corrective action.
4. Cost of quality: To define the ingredients of the cost of quality, and explain its use as a management tool.
5. Quality awareness: To provide a method of raising the personal concern felt by all personnel in the company toward the conformance of the product or service and the quality reputation of the company.
6. Corrective action: To provide a systematic method of resolving forever the problems that is identical through previous action steps.
7. Zero defects planning: To investigate the various activities that must be conducted in preparation for formally launching the Zero Defects program.
8. Supervisor training: To define the type of training that supervisors need in order to actively carry out their part of the quality improvement program.
9. Zero defects day: To create an event that will make all employees realize, through a personal experience, that there has been a change.
10. Goal setting: To turn pledges and commitment into actions by encouraging individuals to establish improvement goals for themselves and their groups.

11. Error causal removal: To give the individual employee a method of communicating to management the situation that makes it difficult for the employee to meet the pledge to improve.
12. Recognition: To appreciate those who participate.
13. Quality councils: To bring together the professional quality people for planned communication on a regular basis.
14. Do it over again: To emphasize that the quality improvement program never ends [13].

2.3.4 FEIGENBAUM'S APPROACH TO TQM

Feigenbaum defined TQM as: An effective system for integrating the quality- development, quality-maintenance, and quality-improvement efforts of the various groups in a firm so as to enable marketing, engineering, production, and service at the most economical levels which allow for full customer satisfaction. He claimed that effective quality management consists of four main stages, described as follows:

- Setting quality standards;
- Appraising conformance to these standards;
- Acting when standards are not met;
- Planning for improvement in these standards.

The quality chain, he argued, starts with the identification of all customers" requirements and ends only when the product or service is delivered to the customer, who remains satisfied. Thus, all functional activities, such as marketing, design, purchasing, manufacturing, inspection, shipping, installation and service, etc., are involved in and influence the attainment of quality. Identifying customers" requirements is a fundamental initial point for achieving quality. He claimed that effective TQM requires a high degree of effective functional integration among people, machines, and information, stressing a system approach to quality. A clearly defined total quality system is a powerful foundation for TQM. Total quality system is defined as follows:

The agreed firm-wide operating work structure, documented in effective, integrated technical and managerial procedures, for guiding the coordinated actions of the people, the machines, and the information of the firm in the best and most practical ways to assure customer quality satisfaction and economical costs of quality.

Feigenbaum emphasized that efforts should be made toward the prevention of poor quality rather than detecting it after the event. He argued that quality is an integral part of the day-to-day work of the line, staff, and operatives of a firm. There are two factors affecting product quality: The technological-that is, machines, materials, and processes; and the human-that is, operators, foremen, and other firm personnel. Of these two factors, the human is of greater importance by far. Feigenbaum considered top management commitment, employee participation, supplier quality management, information system, evaluation, communication, use of quality costs, and use of statistical technology to be an essential component of TQM. He argued that employees should be rewarded for their quality improvement suggestions, quality is everybody‟s job. He stated that effective employee training and education should focus on the following three main aspects: Quality attitudes, quality knowledge, and quality skills [14].

2.3.5 ISHIKAWA'S APPROACH TO TQM

Ishikawa argued that quality management extends beyond the product and encompasses after-sales service, the quality of management, the quality of individuals and the firm itself. He claimed that the success of a firm is highly dependent on treating quality improvement as a never-ending quest. A commitment to continuous improvement can ensure that people will never stop learning. He advocated employee participation as the key to the successful implementation of TQM. **Quality circles,** he believed, are an important vehicle to achieve this. Like all other gurus he emphasized the importance of education, stating that quality begins and ends with it. He has been associated with the development and advocacy of universal education in the **seven QC tools** (Ishikawa, 1985). These tools are listed below:

- Pareto chart;
- Cause and effect diagram (Ishikawa diagram);
- Stratification chart;
- Scatter diagram;
- Check sheet;
- Histogram;
- Control chart.

Ishikawa suggested that the assessment of customer requirements serves as a tool to foster cross-functional cooperation; selecting suppliers should be on the basis of quality rather than solely on price; cross-functional teams are effective ways for identifying and solving quality problems. Ishikawa‟s concept of TQM contains the following **six fundamental principles**:

- Quality first-not short-term profits first;
- Customer orientation-not producer orientation;
- The next step is your customer-breaking down the barrier of sectionalism;
- Using facts and data to make presentations-utilization of statistical methods;
- Respect for humanity as a management philosophy, full participatory management;
- Cross-functional management [15].

2.4 RESULTS FROM QUALITY GURUS

After the approaches to TQM of the five quality gurus have been reviewed, it has become evident that each has his own distinctive approach. Nevertheless, the principles and practices of TQM proposed by these quality gurus do provide the author with a better understanding of the concept of TQM. Their insights offer a solid foundation for conducting this study. Although their approaches to TQM are not totally the same, they do share some common points which are summarized as follows:

(1) It is management‟s responsibility to provide commitment, leadership, empowerment, encouragement, and the appropriate support to technical and human processes. It is top management‟s responsibility to determine the environment and framework of operations within a firm. It is imperative that management foster the participation of the employees in quality improvement, and develops a quality culture by changing perception and attitudes toward quality.

(2) The strategy, policy, and firm-wide evaluation activities are emphasized.

(3) The importance of employee education and training is emphasized in changing employees‟ beliefs, behavior, and attitudes; enhancing employees‟ abilities in carrying out their duties.

(4) Employees should be recognized and rewarded for their quality improvement efforts.

(5) It is very important to control the processes and improve quality system and product design. The emphasis is on prevention of product defects, not inspection after the event.

(6) Quality is a systematic firm-wide activity from suppliers to customers. All functional activities, such as marketing, design, engineering, purchasing, manufacturing, inspection, shipping, accounting, installation and service, should be involved in quality improvement efforts [15].

2.5 TQM CONCEPT IN THIS STUDY

2.5.1 TOTAL QUALITY MANAGEMENT (TQM)

The fourth and highest level of quality management is TQM. TQM is a management philosophy, a paradigm, a continuous improvement approach to doing business through a new management model. TQM expands beyond statistical process control to embrace a wider scope of management activities of how to manage people and organizations by focusing on the entire process, not just simple measurements. This involves the application of quality managements principles, these are; continuous improvement, customer focus, honesty, sincerity and care to all aspects of the business, including customers and suppliers. TQM is composed of three paradigms:

Total: Involving the entire organization

Quality: Conformance to requirements (meeting customer requirements)

Management: Science and art or manner of planning, controlling, directing and the like

2.5.2 QUALITY TOOLS

There are seven basic tools of Quality which can be used to analyze and subsequently intervene to eliminate the problems from the production system. Despite a lofty title, such as Statistical Quality Control or Statistical Process Control (SQC/ SPC), understanding and using does not require advanced knowledge of statistics. Rather, the seven basic tolls of quality and formalized body of techniques involve tabulating, depicting, and describing data sets. Once the system is visible, the describing and identifying appropriate actions to improve the processes and systems are generally self-evident.

The seven basic tools are listed below:

1. Check sheet
2. Histogram
3. Pareto analysis
4. Process flow chart
5. Cause-Effect diagram
6. Scatter diagram
7. Control chart

In this research we will use only four basic tools of these seven and two other tools. These four basic tools are as below:

1. Check sheet

2. Pareto analysis
3. Process flow chart
4. Cause-Effect diagram

Other two tools are as below:

1. Quality Circle (QC)
2. Root Cause Analysis

2.5.2.1 CHECK SHEET

The check sheet, also called a „Defect Concentration Diagram", is basically a data collection sheet. It is a simple tool used to record data for further processing. The data collection sheet should be pre-printed and highly systematic and structured, such that identification of problem becomes easier.

This is a generic tool that can be adapted for a wide variety of purposes, although mainly for identifying frequency or patterns of events, problems, defects, defect location, defect causes, etc. this is a widely used tool for statistical quality control purpose to analyze productive process.

Procedure of preparing a check sheet

1. Decide what event or problem will be observed. Develop operational definitions.
2. Decide when data will be collected and for how long.
3. Design the form. Set it up so that data can be recorded simply by making check marks or Xs or similar symbols and so that data so not have to be recopied for analysis.
4. Label all spaces on the form.
5. Test the check sheet for a short trial period to be sure it collects the appropriate data and easy to use.
6. Each time the targeted event or problem occurs, record data on the check sheet in tally format.

Success from a data collection sheet largely depends on classification of problem types. A wrongly designed and inappropriately classified data sheet may not carry any significant information for further analysis. The following (table 2.2) is an example of a structured check sheet, which gathers data in a shop producing cylindrical components in a Lathe machine.

Table 2.2: An example of check sheet for data collection.

Check Sheet			
Product Name:		Product ID:	
Dept.		Shift In-Charge:	
Inspector Name:		Lot No.	
Approved by:		Date:	
Type of Defects	**Checks**		**Frequency**
Wrong Specification	~~///~~ ~~///~~ ~~///~~ //		17
Cracks	~~///~~ ~~///~~ /		11
Surface scars	~~///~~ //		7
Broken	////		4
Others	//		2
Total defects	~~///~~ ~~///~~ ~~///~~ ~~///~~ ~~///~~ ~~///~~ ~~///~~ ~~///~~ /		41

Data can be collected randomly, on different days, at different times, in different shops or work places, of different workers or processes or machines, etc. in order to clearly point out the exact location or source of and reasons for defects. Thus, it can be and extensive data collection form, which must be standardized.

Information from this data collection sheet is generally used for further analysis in Histogram, another important tool of TQM [16].

2.5.2.2 PARETO CHART

This is a simple statistical chart, also known as Pareto diagram or Pareto analysis, but very useful in quality control.

In the early nineteenth century, the famous Italian Economist Vilfredo Pareto observed and stated that about 80% of the country‟s wealth is occupied by about 20% of the population. This famous observations was later on named as "80-20" rule. Although the observation was concentrated on only wealth distribution in the society. Later on it was found by the researchers in other fields that this is equally applicable to other knowledge areas too. This is now applied to materials managements, more specifically to materials grading, or

classification, which is popularly known as ABC analysis.

This is also applied to quality control, to mean many things, one being: about 20 percent causes/ reasons are responsible for 80% defects in a shop. Although, initially this was classified as 80-20 distribution, it is not that strict in numerical values. It can well be 15-85 distribution, or something else. It can be generalized as – only a few causes are responsible for majority of the problems. These „few" (say, 20% causes) as known as „vital few", whereas the rest „many" (say, 80% causes) are known as „Trivial Many". While vital few occurs frequently, trivial many occurs infrequently. Thus, one should concentrate on vital few, not on trivial many.

Description of Pareto Chart

A Pareto chart looks like a cumulative bar graph. The lengths of the bars represent frequency or cost (time or money), and are arranged with longest bars on the left and the shortest to the right. The longest bar represents the most vial causes.

This is graphical tool for ranking causes from most significant to least significant. It depicts a series of vertical bars lined up in a descending order- from high to low – to reflect frequency, importance, or priority. The following is an example (Table 2.3 and Figure 2.1) of a Pareto analysis of concrete failure causes that occurred in Ready Mix concrete of a plant [17].

Table 2.3: Pareto Chart data for Complaints regarding Failure of Concrete Strength.

Areas of Complaints	Count	Cumulative Count	Cumulative %
Tech. Supervision	300	300	20.5
Under grade 1/2" stone chips	300	600	41.0
Aggregate washing	300	900	61.4
Unskilled labour	150	1050	71.7
Wrong mix design	150	1200	81.9
Over grade 3/4" stone chips	90	1290	88.1
Water Cement ratio	40	1330	90.8
Transport duration	30	1360	92.8
Late water addition	30	1390	94.9
Aggregate quality	30	1420	96.9
Casting method	30	1450	99.0
Admixture dose	5	1455	99.3
Cement Quality	5	1460	99.7
Others	5	1465	100.0

10 days observation @ 30 trucks each day =Total 300 trucks

Based on this table, a Pareto chart is prepared, as given in **Figure 2.1**.

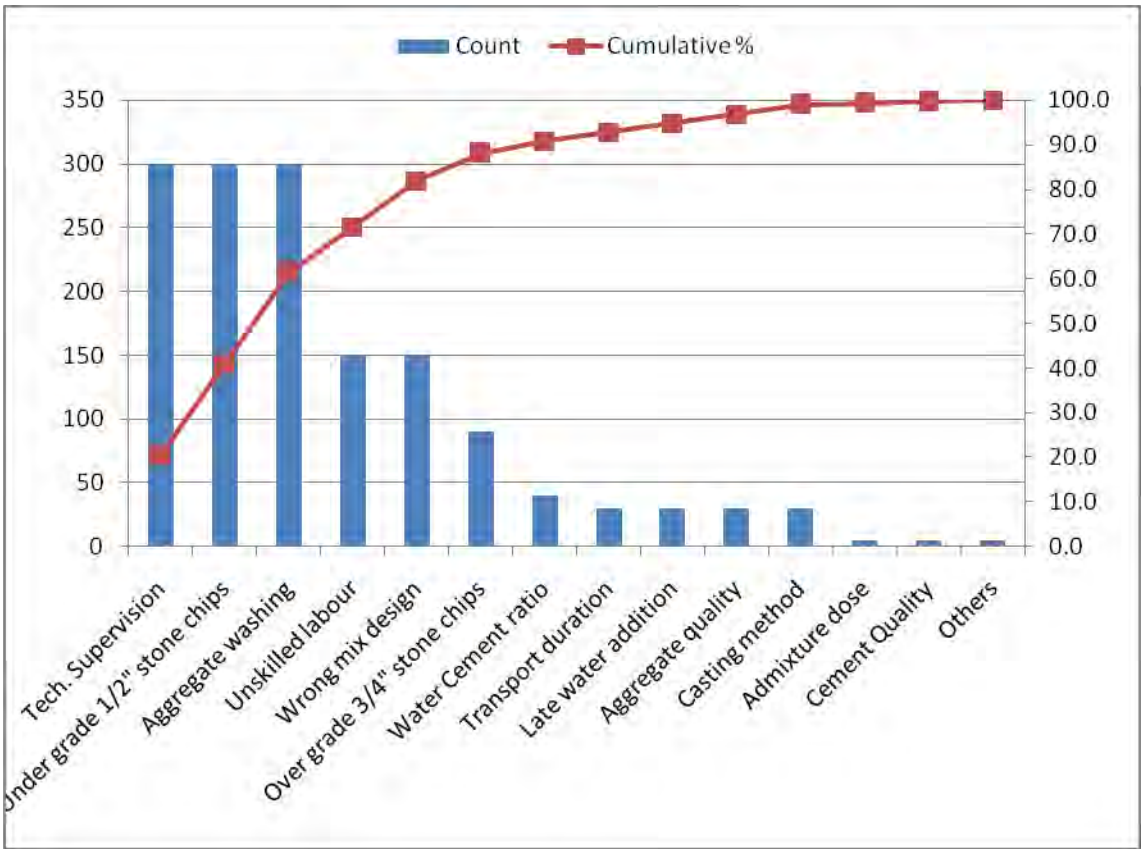

Figure 2.1: Pareto Chart for Complaints regarding Failure of Concrete Strength.

Application of Pareto chart

1. When analyzing data about the frequency of problems or causes in a process.
2. When there are many problems or causes and the quality analyst wants to focus on the most significant.
3. When analyzing broad causes by looking at their specific components.
4. When analyzing the characteristics of the shop, or production process.

Procedure of preparing Pareto chart

1. Decide what categories you will use to group items.
2. Decide what measurement is appropriate. Common measurements are frequency, quantity, cost and time.
3. Decide what period of time the chart will cover: One work cycle? One full day? A week?
4. Collect the data, recording the category each time. (Or assemble data that already exist).
5. Subtotal the measurements for each category.
6. Determine the appropriate scale for the measurements you have collected. The maximum value will be the largest subtotal from step 5. (If you will do optional steps 8 and 9 below, the maximum value will be the sum of all subtotals from step 5). Mark the scale on the left side of the chart.
7. Construct and label bars for each category. Place the tallest at the far left, then the next tallest to its right and so on. If there are many categories with small measurements, they can be grouped as “other”.
8. Calculate the percentage for each category: the subtotal for that category divided by the total for all categories. Draw a right vertical axis and label it with percentages. Be sure that the two scales match: For example, the left measurement that corresponds to one-half should be exactly opposite 50% on right scale.
9. Calculate and draw cumulative sums: Add the subtotals for the first and second categories, and place a dot above the second bar indicating that sum. To that sum add the subtotal for the third category, and place a dot above the third bar for that new sum. Continue the process for all the bars. Connect the dots, starting at the top of the first bar. The last dot should reach 100 percent on the right scale.

2.5.2.3 PROCESS FLOW CHART

Process flow chart is a graphical tool and shows the major steps in a process. This is alternatively known as Run chart, or Route Sheet, Process Map. Flowcharts are useful tool for examining how various steps are related to each other. By studying these charts individuals and teams can often uncover potential sources of trouble and/or identify steps to be taken to improve or error-proof a process.

Process flow chart focuses on the specific processes that raw materials, parts and sub-assemblies follow as they move through the plant. This chart is a useful diagnosis tool and can be used to improve the performances at each step in the operations. Indeed the standard first step in analyzing any production is to map the flows.

This is equally applicable to service organization as well. The flow of papers and information, flow of service may well require a flow chart as an aid to diagnosis.

A complete diagnosis of a sub system certainly requires information on its input side and output side, because, the sub-system may interact with or may be affected by the preceding part of operations and requirements/constraints in the succeeding operations. Thus, a complete view of a process flow helps an analyst to pin point the exact location, or source of disturbance. The following figure (Figure 2.2) shows a brief schematic view of a process flow chart.

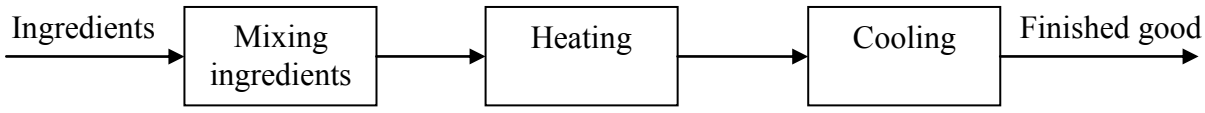

Figure 2.2: A process flow chart.

The American Production and Inventory Control Society (APICS) have suggested using pre-defined standard symbols for depicting such process flow chart. However, this is not mandatory. A company may define its own symbols, or a normal graphical schematic graph, like in Figure 2.2, may also be used. But in any case, symbols must be standardized in a company, even though it is their own. Different analyst in a company must not use different symbols of his/her own.

This tool, though highly useful, has not been suggested by large majority of the quality experts as the eight tool of TQM. This is widely prescribed for use as a good analysis tool, not exactly a TQM tool. Thus, a large cross section of quality related papers do not cover this topic in their TQM chapter, rather it is most commonly found in the literature of operations management. However, a small cross section of papers does suggest this as a tool of TQM.

2.5.2.4 CAUSE-EFFECT DIAGRAM

There are must be many potential reasons, or "Causes", which ultimately lead to create an advance "Effect". Here, the „Effect" is the quality problem. Cause-Effect (CE) analysis is a tool for analyzing and illustrating a process by showing the main causes and sub-causes leading to an effect (symptom). It is sometimes referred to as the "Ishikawa diagram", because Kaoru Ishikawa developed it, and the "fishbone diagram", because eh complete diagram resembles a fish skeleton. The fishbone is easy to construct and invites interactive participation.

Procedure of Constructing CE Diagram:

The following materials are needed, for gathering information from a brainstorming session: a flipchart or whiteboard, marking pens.

The following step by step procedure may be followed to construct a CE diagram:

1. Agree on a problem statement (effect). Write it at the centre right of the flipchart or whiteboard. Draw a box around it and draw a horizontal arrow running to it.
2. Brainstorm the major categories of causes of the problem. If this is difficult use generic headings:
    a. Methods
    b. Machines (equipments)
    c. People (manpower)
    d. Materials
    e. Measurement
    f. Management
    g. Environment
3. Write the categories of causes as branches from the main arrow. These branches as known as Twigs.
4. Brainstorm all the possible causes of the problem. Ask: "Why does this happen?"

As each idea is given, the facilitator writes it as a branch from the appropriate category. Causes can be written in several places if they relate to several categories.

5. Again ask "why does this happen?" about each cause. Write sub-causes branching off the causes. The sub-branches are known as Twiglets. Continue to ask "Why?" and generate deeper levels of causes. Layers of branches indicate causal relationships.
6. When the group runs out of ideas, focus attention to places on the chart where ideas are few.

Types of CE analysis

There are many different types of CE diagrams, of which the following two are more widely used:

1. Cause Enumeration
2. Process Analysis

Cause Enumeration

This is the most commonly used CE diagrams in industries. This identifies one-by-one all possible causes from brainstorming sessions and then classifies into groups. Specialists from concerned departments, like engineering and desing, procurement, quality assurance, maintenance, production, etc. form the group. Participants in the brainstorming session are encouraged to think freely suggest from experience, judgment, anticipation, etc. the following (figure 2.3) is an example of a general form of cause enumeration diagram.

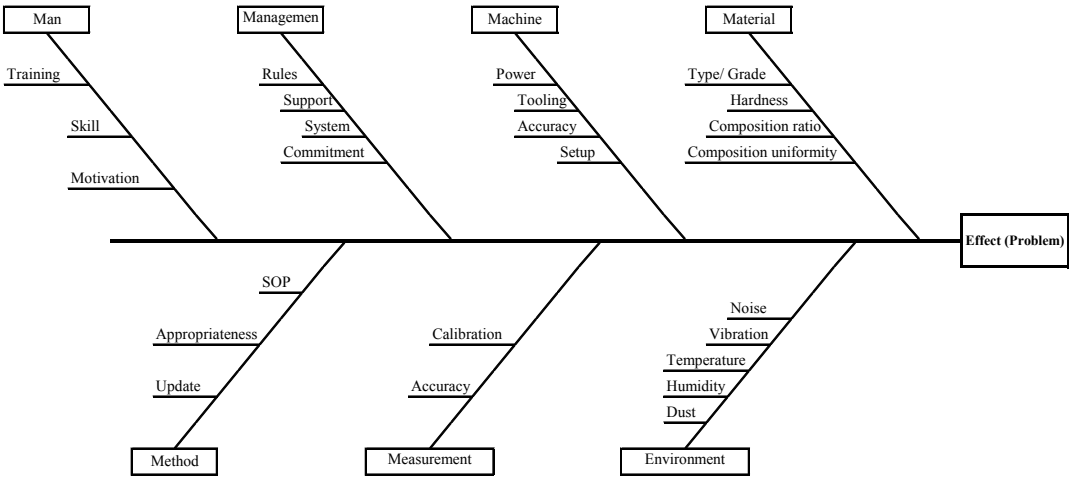

Figure 2.3: Cause enumeration.

Process Analysis:

A simple cause enumeration may not identify exact location of occurrence in the complete process. A process analysis type CE diagram can do that.

Its structure is totally different from the earlier type of CE analysis. It follows the process step by step and causes are listed as per process step. Thus, prior to developing a CE diagram, process flow chart is a must. Additionally, participation of the process owners is also a must in the brainstorming session. The main advantage of creating this type of CE diagram is its ability in pinpointing the exact location of occurrence.

The following figure (Figure 2.4) shows a process type CE diagram for production of bread in a bakery shop.

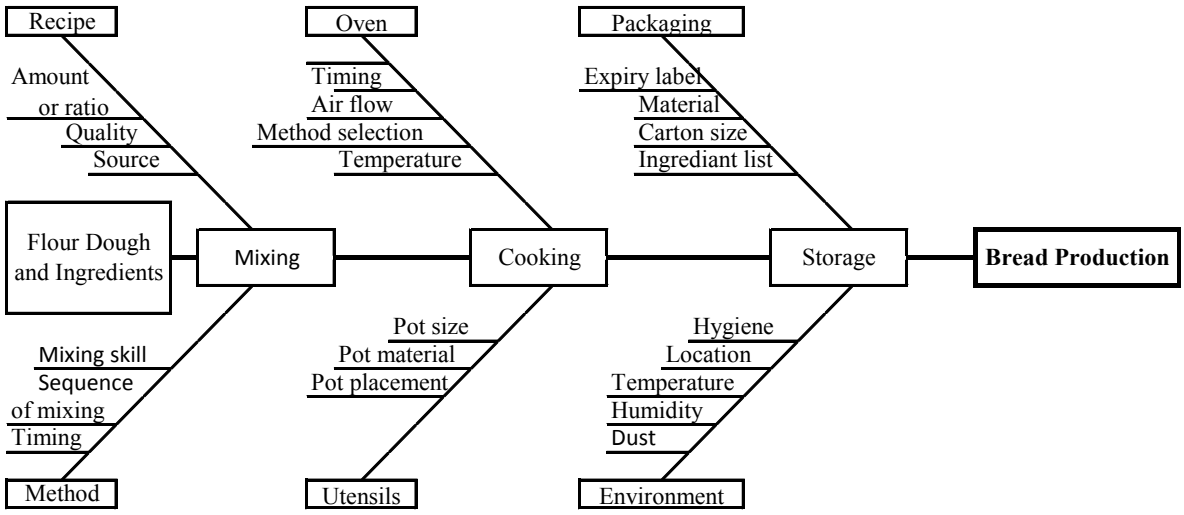

Figure 2.4: Process type CE diagram.

It is not a question as to which CE diagram should be used; rather the main strategic issue in quality control is to combine the ideas of both types. Finding out a cause and pinpointing its location may require use of both CE diagrams at a time [17].

2.5.2.5 QUALITY CIRCLE (QC)

A quality circle is a volunteer group composed of workers (or even students), who do the same or similar work, usually under the leadership of their own supervisor (or an elected team leader), who meet regularly in paid time who are trained to identify, analyze and solve work-related problems and present their solutions to management and where possible

implement the solutions themselves in order to improve the performance of the organization, and motivate and enrich the work of employees. When matured, true quality circles become self-managing, having gained the confidence of management.

Quality circles are an alternative to the rigid concept of division of labor, where workers operate in a more narrow scope and compartmentalized functions. Typical topics are improving occupational safety and health, improving product design, and improvement in the workplace and manufacturing processes. The term quality circles was defined by Professor Kaoru Ishikawa in a journal and circulated throughout Japanese industry by JUSE in 1960. The first company in Japan to introduce Quality Circles was the Nippon Wireless and Telegraph Company in 1962. By the end of that year there were 36 companies registered with JUSE by 1978 the movement had grown to an estimated 1 million Circles involving some 10 million Japanese workers. Contrary to some people's opinion this movement had nothing whatever to do with Dr. Edwards Deming or indeed Dr Juran and both were skeptical as to whether it could be made to work in the USA or the West generally.

Quality circles are typically more formal groups. They meet regularly on company time and are trained by competent persons (usually designated as facilitators) who may be personnel and industrial relations specialists trained in human factors and the basic skills of problem identification, information gathering and analysis, basic statistics, and solution generation. Quality circles are generally free to select any topic they wish (other than those related to salary and terms and conditions of work, as there are other channels through which these issues are usually considered).
Quality circles have the advantage of continuity; the circle remains intact from project to project. (For a comparison to Quality Improvement Teams, see Juran's Quality by Design.

History

Quality circles were first established in Japan in 1962; Kaoru Ishikawa has been credited with their creation. The movement in Japan was coordinated by the Japanese Union of Scientists and Engineers (JUSE). The first circles were established at the Nippon Wireless and Telegraph Company but then spread to more than 35 other companies in the first year. By 1978 it was claimed that there were more than one million quality circles involving some 10 million Japanese workers. They are now in most East Asian countries; it was recently claimed that there were more than 20 million quality circles in China.

Quality circles have been implemented even in educational sectors in India, and QCFI (Quality Circle Forum of India) is promoting such activities. However this was not successful in the United States, as it (was not properly understood and) turned out to be a fault-finding exercise although some circles do still exist. ref Don Dewar who together with Wayne Ryker and Jeff Beardsley first established them in 1972 at the Lockheed Space Missile Factory in California.

Empirical studies of quality circles

In a structures-fabrication and assembly plant in the south-eastern US, some quality circles (QCs)were established by the management (management-initiated); whereas others were formed based on requests of employees (self-initiated). Based on 47 QCs over a three-year period, research showed that management-initiated QCs have fewer members, solve more work-related QC problems, and solve their problems much faster than self-initiated QCS. However, the effect of QC initiation (management- vs. self-initiated) on problem-solving performance disappears after controlling QC size. A high attendance of QC meetings is related to lower number of projects completed and slow speed of performance in management-initiated QCS QCs with high upper-management support (high attendance of QC meetings) solve significantly more problems than those without. Active QCs had lower rate of problem-solving failure, higher attendance rate at QC meetings, and higher net savings of QC projects than inactive QCs. QC membership tends to decrease over the three-year period. Larger QCs have a better chance of survival than smaller QCs. A significant drop in QC membership is a precursor of QC failure. The sudden decline in QC membership represents the final and irreversible stage of the QC's demise. Attributions of quality circles' problem-solving failure vary across participants of QCs: Management, supporting staff, and QC members.

There are 7 basic quality improvement tools but as a Circle matures it can use others namely:

- The Ishikawa or fishbone diagram - which shows hierarchies of causes contributing to a problem.
- The Pareto Chart - which analyses different causes by frequency to illustrate the vital cause,
- Process Mapping, Data gathering tools such as Check Sheets
- Graphical tools such as histograms, frequency diagrams, spot charts and pie charts

- Run Charts and Control Charts
- Scatter plots and Correlation Analysis
- Flowcharts [18]

2.5.2.6 ROOT CAUSE ANALYSIS

If there is and unwanted recurring harmful situation which consumes resources and tends to happen in a repeated fashion the there is a possibility that it might be beneficial to figure out what is really causing this situation to occur ad remove it so the situation does not occur again. This is generally referred to as Root Cause Analysis, finding the real cause of the problem and dealing with it rather than simply continuing to deal with the symptoms.

This arises several questions:

- How does on determine which situations are candidates for root cause analysis?
- How does one figure out what the root cause is?
- Does the removal of the cause entail less resource expenditure than it takes to continue to deal with the symptom?

Determining candidates

In normal chaotic organizational environments is often quite difficult to find candidates for root cause analysis because the situations which repeat are either distributed over time so one doesn‟t realize they are actually of recurring nature. When an organization really observes events carefully, it is very easy to determine which situations are recurring with what frequency. Those situations which are recurring with greatest frequency and consume greatest amount of resources to rectify are the candidates for root cause analysis.

Pareto analysis can certainly play a role in sorting out the potential root cause candidates.

Finding the root cause

Consider the specific example of expediting customer order in an order fulfillment process. The organization has a well defined process for accepting, processing, and shipping customer orders. When a customer calls and complaints about not getting their order, the most normal response is to expedite. This means that someone personally tracks down this customer‟s order, assigns it no. 1 priority, and ensures it gets shipped ahead of everything else. What

isn‟t realized, until someone later on, if at all, is that in expediting this order one or more other orders were delayed because the process was disrupted down this customer‟s order out of the door. What is all comes down to is that expediting orders simply ensures that more orders will have to be expedited later. In systems terms this is a typical “fixes that fail” structure which evolves into an “Addiction” structure where the organization becomes addicted to expediting to deal with customer order complaints.

The appropriate response to this situation is to figure out why the order was in need of expediting in the first place. Yet this is seldom done because the task assigned to the expediter was, “get the order shipped!” and that‟s as far as the thought processes and investigations are apt to go.

To find the root causes there is really only one question that‟s relevant, “what can be learn from these situation which are about 95% related to process problem and only 5% related to personal problem?” *Yet, most organizations spend far more time looking for culprits than causes.*

Let‟s consider the following two scenarios.

Scenario No. 1

The plant manager walked into the plant and found oil in the floor. He called the foreman over and told him to have maintenance clean up the oil. The next day while the Plant Manager was in the same area of the plant, he found oil in the floor again and he subsequently raked the foreman over the coals for not following his direction from the day before. His parting works were to either get the oil cleaned up or he‟d find someone else to doe that.

Scenario No. 2

The Plant Manager walked into the plant and found oil in the floor. He called the Foreman over and asked him why there was oil on the floor. The Foreman indicated that it was due to leaky gasket in the pipe joint above. The Plant manager then asked when the gasket had been replaced and the Foreman responded that Maintenance had installed 4 gaskets over the past few weeks and they each one seem to leak. The Foreman also indicated that Maintenance had been talking to Purchasing about the gaskets because it seemed they were all bad.

The Plant Manager then went to talk with Purchasing about the situation with the gaskets. The Purchasing Manager indicated that they had in fact received a bad batch of gaskets from the supplier. The Plant Manager then asked the Purchasing Manager why they had purchased from the supplier if they were so disreputable and the Purchasing Manager said because they were the lowest bidder when quotes were received from various suppliers. They Plant Manager then asked the Purchasing Manager why they went with the lowest bidder and he indicated that was the direction he had received from the VP of the Finance.

The Plant Manager then went to talk to VP of the Finance about the situation. When the Plant Manager asked the VP of Finance why Purchasing had been directed to always take the lowest bidder the VP of Finance said, "Because you indicated that we had to be as cost conscious as possible!" And purchasing from the lowest bidder saves us lots of money. The Plant Manager horrified when he realized that he was the reason there were oil on the plant floor. Boomerang!

One may find scenario no. 2 somewhat funny, and laugh at the situation. But this scenario practically provides a good example of how one should proceed to do root cause analysis. It is like – "Everyone in the organization doing their best to do the right things, and everything ends up with wrong things". The root cause of this whole situation is local optimization with no global thought involved. Once simply has to continue ask "why?" until the pattern completes and cause of the difficulty in the situation becomes rather obvious.

To resolve or not to resolve

Once the root cause determined then it has to be determined whether it costs more to remove the root cause or simply continue to treat the symptoms. This is often not an easy determination. Even though it may be relatively easy to estimate the cost to remove the root cause it is generally very difficult to assess the cost of treating the symptom. This difficulty arises because the cost of the symptom is generally wrapped up in some number of customers and employee satisfaction factors in addition to the resource cost associated with just treating the symptom.

Let"s consider a situation where it is determined that it will cost $100,000 to remove the root cause of a problem and only 5 minutes for someone to resolve the situation when the

customer calls with the problem. Initially one might perceive that the cost of removing the root cause is far larger than the cost treating the symptom. Yet suppose that this symptom is such that when it arises it so infuriates the customer that they swear they will never buy another product from this seller, and will go out of there way for the next year to tell everyone they meet what a terrible company this is to do business with. How does this company estimate lost business cost associated with this situation? And if one thinks this is a bizarre case, it is not.

In a world of high competition, this continuous improvement endeavor is truly endless. Because once a root cause is found and removed, another one should be looked into. This search and consequent improvement continues as long as business continues! That is the essence of TQM [19].

2.6 IMPLEMENTING TQM IN A CONSTRUCTION FIRM – A CASE STUDY [20]

2.6.1 THE CASE OF THE STRUCTURAL ENGINEERS LTD.

The Structural Engineers Ltd. (SEL) is a Private Limited company formed in 1983. After inception the company started making significant contributions in construction and allied field of civil engineering. In 1995 the company entered into real estate business to make contributions to the housing needs of the residents of Dhaka city. About 450 people are working together in SEL for excellence. Of these, about 50 are management staff including 25 engineers and architects and the rest are workmen and non management staff. The company being in existence over 17 years, the average length of service of the staff is as high as over 12 years. The top management team is made up of heads of the functions like Personnel, Finance, Purchase, Marketing etc., the Directors and the Managing Director.

2.6.2 WORKING PRACTICES

Like other companies in Bangladesh, The Structural Engineers Ltd. engages one Contractor (usually called Sub-contractor) for each of the trades like Civil, Sanitary, Electrical, Wood work, Mosaic, Painting etc. at each Project. The sub-contractor engages skilled and unskilled workers known as Head Mistri, Mistri, Helper and Labor on daily wage basis. The Sub-contractor gets the work done by his people under the supervision of company people like Supervisors, Site Engineers and Project Engineers etc. The subcontractor gets part-payment for daily fooding & other expenses of his people. This part payment called „Khoraki" is paid

at a fixed rate per day per person, usually 50% of his daily wage (fixed by the sub-contractor) called „Hajira". At the end of each month the subcontractor submits his bill for work done by his group on item of work basis as per the rate agreed earlier between himself and the Company. An agreement is signed between him and the Company in this regard before commencement of actual work.

2.6.3 THE BEGINNING

In 1994 The Managing Director of the company went to Japan to participate in a 3 (three) week management program organized by AOTS, Japan. Participating in the course, he came to know about the Japanese style of management including the concept of Quality Control Circles. The basic philosophy of TQM, participation at all levels, impressed him tremendously. Returning back home he started sharing his experience with the top management. Immediately after, all the Project Engineers were called into a meeting to discuss the existing problems of their construction sites. The meeting was conducted at the style of QC Circle meeting. More than 25 (Twenty five) problems were identified out of which at least 5(five) were major. Out of them 2 (two) problems were selected for immediate solution. One problem was the migration of the workers. After joining work at a site, sometimes a worker was found sitting idle within a few days. The reason behind that was the non-payment of his due payments by the sub-contractor. The sub-contractor did not like to clear his dues to bar him from leaving the site. So it was a mis-trust between the sub-contractor and his workers. At the end, the worker used to leave the work site even without getting the payments cleared. Another major problem was the over payment to the Sub-contractors in the form of „khoraki". It was really a big question how it could be? As mentioned above „khoraki" is paid only at the rate of half the daily wages to meet the fooding and other incidental expenses. After a threadbare discussion it was logically identified that the average output of the workers were below 50% of the expected performance. The reason behind it could be the poor nutrition of the workers. They used to take low protein food of low calorie. Besides, the workers were used to work even on weekly holidays (Fridays) to earn more money. So, taking poor food and working for days and weeks-together one used to become physically weak resulting in poor performance. So, it was proposed to declare Friday a full day holiday so that no one could do any work on Fridays. But the Project Engineers opined that the workers won't accept it because in such case they would lose 4(four) day's wages per month. Finally it was decided that there will be a half day work on Friday and to compensate the wages of the remaining half day, the company will provide them dinner with

enough beef and rice. The decision was implemented at all the work sites and it was accepted by the workers with enthusiasm. It was also declared that if the workers liked to play any traditional games like football etc., the company will arrange the logistics and the winning team would get some prizes. This also created sensation among the workers. But unfortunately the initial enthusiasm started to fade away gradually. Within a couple of months a surprising proposal came from the sub-contractors. They asked the company to give them the money being spent on account of the dinner on Fridays, because workers were more interested to get the money not the improved food. In this way the whole program finally came to an end.

2.6.4 PARTICIPATION IN QUALITY CONVENTIONS

At the middle of 1996, the management of the company decided to participate in quality conventions at home and abroad. Accordingly, the Managing Director attended the 5th convention of AOTS Alumni Societies held in Nagoya, Japan during 01-05 Sept ‟96. He also participated in ICQCC „1998 held in Colombo, Sri Lanka during 26-31 October „1998; the Regional Convention on TQM held in Kathmandu, Nepal during 11-12 April „1999 and the Regional Convention of Japanese style Management held in Colombo, Sri Lanka during 15-17 July, 1999. The Managing Director and one of the Directors participated in a 4-day Asia Pacific Quality and Service conference (APQS) held during 26-29 September ‟99 at Singapore. The Company participated in all the four National Conventions on Quality, organized by Bangladesh Society for Total Quality Management (BSTQM) with a large number of participants.

2.6.5 TRAINING AND EDUCATION

One of the Directors of the company, Engr. A. H. M. Zahirul Haque went to Japan in December „1998 to participate in a three week training program (SFQM) organized by AOTS, Japan. Besides, one Senior Executive (Marketing & Finance) participated in a two week training program organized by AOTS, Japan in 1999. This year the Managing Director went to Japan once again to participate in a two week training program on Corporate Management held in Yokohama, Japan during 10-23 July „2000. The company has also set up a library for its staff. A good number of books on Quality Circles, 5‟S techniques, Kaizen, 7-QC Tools etc. have been collected so that any one can go through these books and enrich his knowledge in modern management techniques. The company has provided official accommodation for its staff. Staying together, the junior staffs learn many things by sharing

the experience of the senior staff. This is a form of living education which helped us to develop a number of capable personnel.

2.6.6 LAUNCHING OF TQM SEMINAR AND INTRODUCTION OF QUALITY CIRCLES

Finally the Management decided to implement TQM within the company. An agreement was signed with the Center for Management Development (CMD), a Management Consultant. Accordingly, a week long seminar and training program was launched which was participated by the Engineers, Supervisors and Sub-contractors. At the end of the program, ten Quality Circles were formed, one at each site. The Project Engineers were nominated as the Circle Leaders. The Sub-contractor became a member. Other members were recruited by the project Engineer and the Sub-contractor. A steering committee led by the Managing Director was formed. The Directors, the departmental heads and Project Engineers became members of the Steering Committee. The Circles started functioning slowly. Several Steering Committee meetings were held at different sites to create awareness among the workers. But it was observed that very few Circles could hold regular meetings and the attendance were very poor. Inspite of all the efforts, the Circles gradually started to cease away. The Management became concerned and called an emergency meeting of the Steering Committee to discuss and identify the reasons behind it. In the meeting some of the Project Engineers disclosed the fact that some of the Circles identified holding of the „meeting" itself as a problem. The sub-contractor himself considers the time for conducting meeting as a waste. At the end of the meeting it was clear that neither the workers nor the Sub-contractors were motivated enough. Even the Project Engineers were not committed enough to organize such activities. So, the Management had to look for some new strategy. Accordingly it was decided to hold weekly meetings in the Head Office involving the Project Engineers, Sub-Contractors and the Senior Officials. The aim of these meetings was to motivate everybody concerned and educate them on Quality Control Tools. Accordingly meetings were held every week for about 3(three) months. In these meetings the Project Engineers were allowed to preside over the meetings by rotation. The Managing Director and the Director attended the meeting as observers. This helped to develop confidence and leadership among the Project Engineers. After three months, three Quality Circles were formed with the Project Engineers and Sub-Contractors as members of the Circles. The meetings of these circles were held every weak at the Head Office on the same day, same time. After the circle meeting, each circle had to present the meeting"s proceedings in a follow-up meeting in the presence of the Top Management using

„**Cause and Effect'** diagram. It was, observed that the Circles were finding it difficult to construct the „cause and effect" diagram. As an alternative, they were taught the „tree diagram". They found it more easy and convenient and learned it very quickly. In this process it took another three months to build confidence among the circle members.

On the other hand, the circles identified a number of problems at their work places and defined their solutions as well. They also proposed that, circles should not be formed site wise, rather that should be formed trade-wise; because once the project was finished the circle would die automatically. On the other hand, if the circle was formed trade-wise, that would never die because the same members of the circle would continue to work in other projects of the Company. This proposal was highly appreciated and was accepted by all.
Finally, Quality Circles were formed and launched at a grand general meeting inviting all the Engineers, Supervisors, and Sub-contractors & Workers. All participated the meeting with great enthusiasm. The Sub-contractor of the respective trade at each site was declared as the circle leader. The Project Engineers were entrusted with the responsibility of Facilitators. Altogether fifteen Quality circles were formed. A new Steering Committee headed by the Managing Director was also formed. It was also decided to practice 5-„S" & Suggestion System through out the company.

2.6.7 THE PERFORMANCE OF THE NEW QUALITY CIRCLES

The formation of Quality circles this time created a good enthusiasm among the members. The members are attending the circle meetings regularly. Even the nonmembers are attending the meetings as observers. The circles initially started identifying their problems of food and living. Gradually they shifted their eyes into the problem of their workplace.

2.6.8 5-'S' AND SUGGESTION SYSTEM

Introduction of 5-„S" resulted in significant improvement of work places. Every site has become more organized than before. Actually 3-„S" (Seiri, Seiso, Seiton) are being practiced. A good sense of cleanliness has developed among the workers. Everybody cleans his respective work place for five minutes before the close of the day"s work. But the Suggestion system is not working well. Although a monetary incentive has been declared for each and every suggestion, a very few participated in this program. So far, only five suggestions have been received from two persons.

2.6.9 ACHIEVEMENTS SO FAR AFTER INTRODUCING TQM

Before introducing TQM, one of the main problems of the company was the over running of the cost due to excess consumption of cement in all the projects. So, after three months of introduction of QC Circles, the management forwarded this problem to the circles. Just within a month, one Circle identified that excess thickness of plaster was consuming excess quantity of cement and sand as well. They also identified a number of causes responsible for the excess thickness. The major causes include i) uneven leveling of the slab soffits ii) irregular size of bricks iii) bad workmanship etc. They used Histogram to analyze the distribution pattern of the sizes of the bricks from different sources.

Another Quality Circle found that the use of oversized bricks, particularly in width was also consuming excess quantity of cement and sand. If the average width of the bricks is more than the standard, then every layer of brickwork will require excess width of the mortar bed resulting in additional consumption of cement and sand. They also analyzed the size of the bricks using Histogram.

From their findings, both the circle recommended not to procure bricks from different sources. They also recommended that the bricks should be sorted out according to different range of size before use. The company accepted their recommendations and actions have been taken accordingly. Another circle identified a problem of efflorescence coming out from the surface of brickwork and plaster. After an extensive investigation, they found out that the sand from a particular source had been carrying excessive salt, which was causing this problem.

Accordingly, sand from that particular source is not being used in brick work and plaster. Another Circle identified severe hair cracks on the surface of floor mosaic. The causes for this were as due to 1) Premature drying shrinkage and ii) Use of excess cement in the mixture. They also defined the solutions to spray mist on the premature surface and adjust the proportion of cement and marble chips. Other circles are also making significant contributions to quality improvement activities.

2.6.10 MUTUAL UNDERSTANDING AND DISCIPLINE

After introduction of TQM in the company, the mutual understanding among the staff at different levels has improved substantially. Everybody has developed respect for each other resulting in a strong discipline throughout the company.

2.6.11 RESPONSIBILITY

A good sense of responsibility has developed at all levels of this organization. Before introduction of TQM, everybody had the bad habit of waiting for instruction from the superior. None liked to take a decision by himself and relied heavily on the Managing Director‟s leadership expecting him to put things right whenever a problem emerged. In fact the company lacked to act as an organization and always tried to manage by exhortation rather than by identifying the root causes of the problems.

2.6.12 CONCLUSION

As a result of practicing TQM, The Structural Engineers Ltd. (SEL) has drawn the following benefits:

- Getting edge over other competitors,
- Quality has improved,
- Customer satisfaction is being more & more ensured,
- Internal atmosphere has improved,
- The staffs are satisfied with their jobs,
- Profitability has increased.

Although it is only a couple of years we embarked on this journey but within this short period, almost all our people have become highly motivated and committed to quality [20].

Chapter 3
Research Methodology

3.1 INTRODUCTION

From the beginning of this research a construction company located in Dhaka, Bangladesh has been selected for a case study. Data collection and research work has been carried out at this company from January 2012 to March 2014. The main function of this company is building construction and flat selling business. They develop residential apartment and commercial building and sell to the customers. The reasons behind selecting this company; there are lots of scope for applying quality tools in different directions of the company business and the author of this research is full time attachment to this company. Also the management of this company was trying to improve the quality of works but they did not get the optimum results.

Check sheet is used in collecting data from some external flat buyer and from some internal employees. The gathered data are then analyzed with Pareto analysis to identify the main problems which can give maximum advantages after solving. Cause Effect diagram is used to identify the root causes of some process flow. Some process analysis is also done for finding root causes. Finally some specific root causes is identified for improvement.

3.2 STEPS OF THE RESEARCH (FLOW CHART)

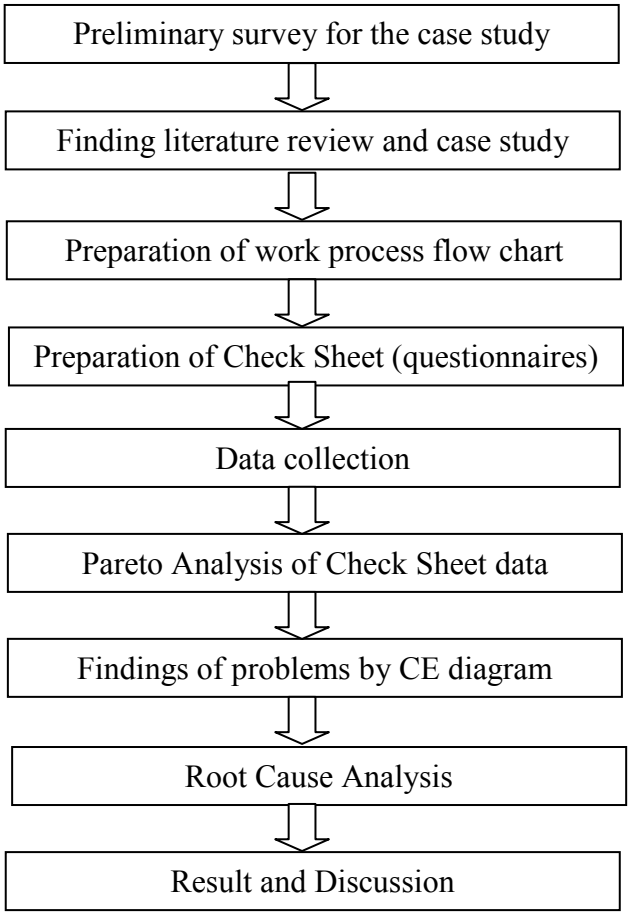

Figure 3.1: Research Flow Chart.

3.2.1 PRELIMINARY SURVEY FOR THE CASE STUDY

A preliminary survey was conducted in different sections of a construction firm such as construction management section, construction sites, ready- mix concrete plant, design section, architect section, quality control section, real estate section, HR section, marketing section etc. to understand the work procedure of those sections. It also helps to find out several points of problem in the work process which are occurring frequently in respective sections.

3.2.2 FINDING LITERATURE REVIEW AND CASE STUDY

Literature and case study is found for the selected topic by searching internet resources, some quality management related books, some papers related to TQM and a construction firm.

3.2.3 PREPARATION OF WORK PROCESS FLOW CHART

After preliminary survey of different sections of the construction firm, a sequence of work process of every section is combined and established a flow chart of work steps which are interconnected. The work process steps are supported by individual department or persons who are also indicated in the process flow chart.

3.2.4 PREPARATION OF CHECK SHEET (QUESTIONNAIRES)

Two questionnaire formats or Check sheet are prepared to collect data from external customers or flat buyers and from company"s internal employees, which includes general information of the company and department and a list of observations on which data to be collected from the external and internal customers.

3.2.5 DATA COLLECTION

Data is collected from 100 external customers (flat buyers) according to their opinion about quality and management related issues. The collected data is then listed on the check sheet. Another check sheet of internal customer (employee) is filled in by collecting data form firm"s internal employees regarding their experience and opinion on quality issues.

3.2.6 PARETO ANALYSIS OF CHECK SHEET DATA

All data collected by check list is then prepared for Pareto analysis. Data is arranged ascending order and cumulative percentages is calculated from the count or frequency of occurrence. As per Vilfredo Pareto"s 80-20 rule „Vital few" and „Trivial many" is identified.

3.2.7 FINDINGS OF PROBLEMS BY CAUSE EFFECT (CE) DIAGRAM

From the firm"s total working process flow some specific points are selected for CE diagram analysis on which problems is occurring frequently. Such as survey team, architectural team, manpower arrangement, soil sub-contractor selection, structural team, site preparation & engineer assignment at site, master plan preparation, approval of drawing, construction in progress, quality control etc.

3.2.8 ROOT CAUSE ANALYSIS

After Pareto analysis and CE diagram and process analysis, some root causes are identified by root cause analysis.

3.3 RESULT AND DISCUSSION

After all analysis and findings of problems from different departments and sections of the construction firm specific results are listed, such as identified major problems, minor problems, specific points to be solved for successful implementation of TQM etc. Finally general issues are briefly discussed.

Chapter 4
Findings and Analysis: A Case Study

4.1 INTRODUCTION

TQM suggests that first identification of problems occurring in a company or organization then searching for the sources of the problems. After finding the sources of occurrence of the problems try to resolve by temporary solution. After evaluation of temporary solution the suggestion is made for practice as permanent system. This improvement is a continuous process in TQM. Through the process some TQM tools can be helpful to identify the problems and their sources. In this chapter analysis has been done by some TQM tools as per methodology as described in chapter 3.

4.2 PRELIMINARY SURVEY FOR THE CASE STUDY

A renowned construction firm of Bangladesh is taken for the case study. General problems which are occurring more frequently in this firm are identified through some investigation process. This construction firm is one of the leading engineering & construction companies in Bangladesh with some of the most prestigious and most technically challenging projects in the country with more than 1000 well known projects to their name. They are the market leader in real estate development. They are involved in all sectors of the market (Premium high and condominiums, medium range apartments, affordable housing, luxury low-rise gated communities etc. They have undertaken many striking commercial projects – from shopping malls to ultra-luxury office blocks and mixed-use products. They have introduced low-cost “pucca” (permanent concrete building instead of temporary tin housing) housing projects.

Recently the construction industry of Bangladesh has increased tremendously and about 1300 developer companies with REHAB membership in this country and mostly in Dhaka and Chittagong city. Simultaneously competition has also increased. So it is very difficult to hold the previous name and fame of the said company. Because many new developer companies are performing very well. They give importance to the customer‟s choice, they are trying to use latest technology in their construction process, and they are recruiting talent engineers and managers even with high remuneration. They try to manage the construction site with proper supervision and timing. They are increasing cost in construction site with

supervision by highly expert managers rather than decreasing project cost with engaging more unskilled employees. Indirectly they are trying to implement Total Quality Management in construction firm.

So, I (the author) have taken this construction firm as a case study to identify the causes of different problems occurring more frequently. Firstly I prepare a working process flow of total construction work of the firm. Then I pay attention to the more specific points in which the problems are coming from. Then I try to find out the causes of occurrence of the problems by Cause Effect diagram. I also identified some major causes by Pareto analysis. Finally I find the root causes of those problems.

During the survey of the firm I collect information form different department and sections of the construction firm. There are several major departments in the firm, such as:

1. Real estate department (CRPL)
2. Lands department
3. Construction department (CECL)
4. Design section
5. Architect section
6. Supply chain management section (SCM) (procurement)
7. Quality control section (CQCT)
8. In-house ready mix concrete plant section (RMC)
9. In-house mechanical tools supplier section (MASD)
10. In-house aluminium and glass sub-contractor (IFL)
11. In-house interior design section (CAIDL)

The total working process flow is described in the next section.

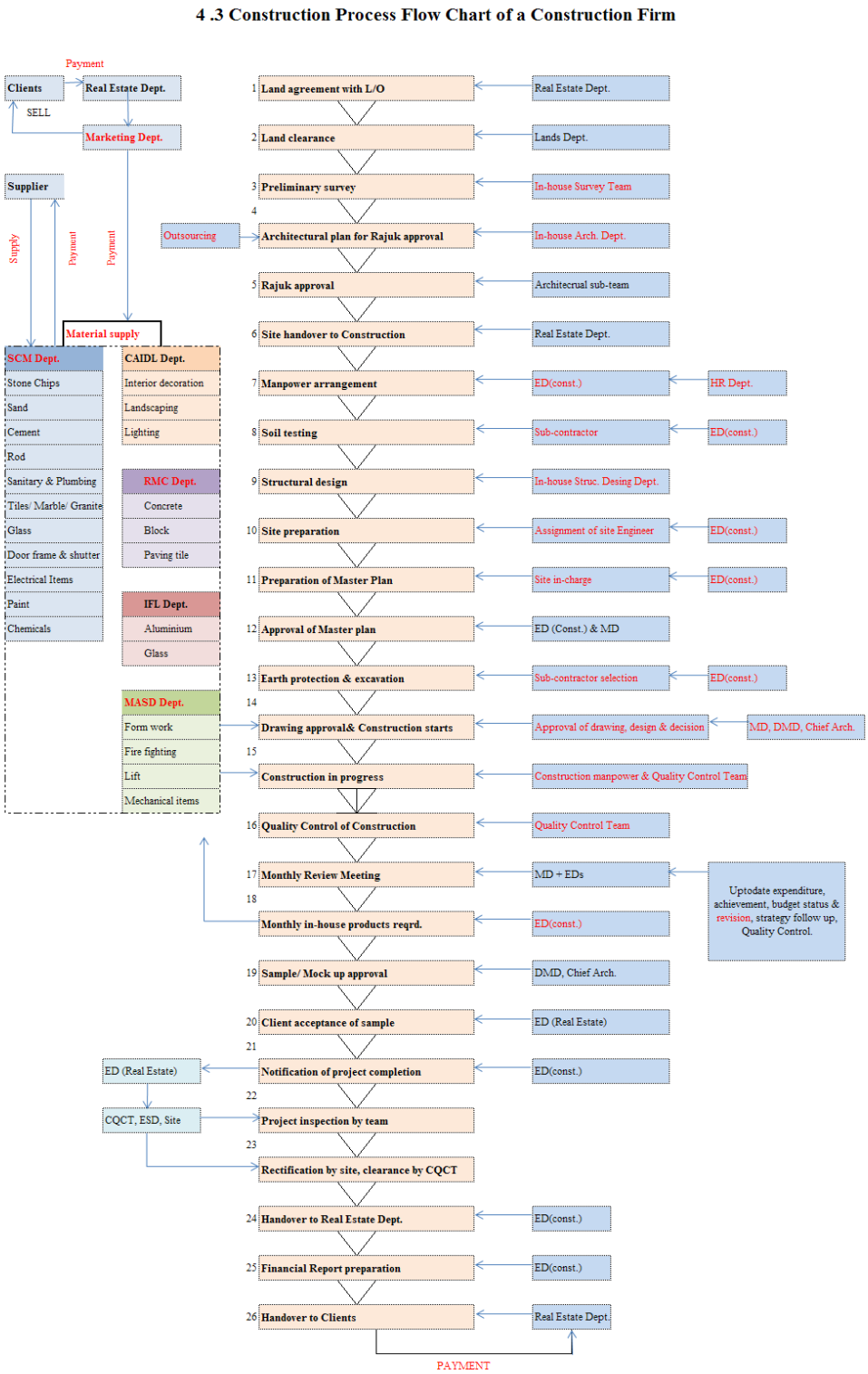

Figure 4.1: Construction process flow chart of a construction firm.

4.4 PREPARATION OF CHECK SHEET & DATA COLLECTION

Table 4.1: Check Sheet of External Customer (Flat buyer) against Complaints on Quality related Problems

Survey is conducted on 100 customers (old & new building)

CHECK SHEET			
Name of Developer		: Concord Engineers & Construction Ltd.	
Inspector Name		: Mohammad Shahinur Ferdoush	
Date		: 1-06-13 to 31-06-13 (from last 2 yrs data)	
Approved by		: Executive Director (Construction)	
Sl No,	**Name of Complaints**	**Checks**	**Nos of Customers**
1	Handover delay	~~/// ///~~	100
2	RCC top floor ceiling leakage	~~/// /// ///~~	15
3	Tile lifting in winter season	////	4
4	Plaster crack	~~/// ///~~	90
5	Block wall crack	~~/// /// /// /// /// /// /// /// /// /// /// /// /// /// /// ///~~	40
6	RCC beam crack	/	1
7	Non standard toilet fitting fixtures	~~/// /// /// ///~~	20
8	Toilet floor slope problem	///	3
9	Non brand material used (Cement)	//	2
10	Door, window related problems	~~/// ///~~	70
11	Slow work progress	~~/// ///~~	95
12	Addition omission mismanagement & delay	~~/// ///~~	80
13	Sanitary & plumbing problem	~~/// ///~~	85
14	Electrical line related problems	~~/// ///~~	10
15	Lift related problem	/	1
16	Sub-station related problem	/	1
17	Generator related problem	~~/// ///~~	5
18	Bad workmanship	~~/// ///~~	90
19	Parking problem	~~/// ///~~	10

Table 4.2: Check Sheet of Internal employee against Complaints on Quality related Problems.

Survey is conducted based on 100 cases (at Site & management at Head Office)

CHECK SHEET

Name of Developer	: Concord Engineers & Construction Ltd.
Inspector Name	: Mohammad Shahinur Ferdoush
Date	: 1-07-13 to 30-07-13 (From last 2 years data)
Approved by	: Executive Director (Construction)

Sl No,	Name of Complaints	Checks	Count (frequency)
1	Unskilled manager	### ### ### ### ### ###	30
2	Unskilled site engineer	### ### ### ### ### ### ### ### ### ### ### ###	60
3	Unskilled supervisor	### ### ### ### ### ### ### ### ### ### ### ### ### ###	70
4	Unskilled labour	### ### ### ### ### ### . . . . ### ### ### ### ### ### ###	90
5	Lack of in time decision	### ### ### ### ### ### . . . . ### ### ### ### ### ### ###	80
6	Lack of material	### ### ### ### ### ### ### ###	40
7	Lack of incentive	### ### ### ### ### ### . . . . ### ### ### ### ### ### ###	95
8	Lack of motivation	### ### ### ### ### ### . . . . ### ### ### ### ### ### ###	95
9	Less salary	### ### ### ### ### ### . . . . ### ### ### ### ### ### ###	100
10	Wrong master budget	### ### ### ### ### ### . . . . ### ### ### ### ### ### ###	100
11	Change of decision	### ### ### ### ### ### ### ### ### ###	50
12	Biased recruitment	### ### ### ### ### ### ### ### ### ### ### ### ### ###	70
13	Improper HR function	### ### ### ### ### ### ### ### ### ### ### ### ### ###	70
14	Lack of manpower	### ### ### ### ###	25
15	Non standard material	### ###	10
16	Lack of finished schedule	### ### ### ### ### ### ### ### ### ### ### ###	60
17	Delay material supply	### ### ### ### ### ### ### ### ### ### ### ###	60
18	Overhead reduction policy	### ### ### ### ### ### ### ### ### ### ### ### ### ### ###	75
19	Wastage	### ### ### ### ###	20
20	Lack of drawing supply	### ### ### ### ###	25
21	Others	###	5

4.5 PARETO ANALYSIS OF CHECK SHEET DATA

Table 4.3: Pareto Chart on External Customer (Flat buyer) against Complaints on Quality related Problems.

Sl No.	Name of Complaints	Nos of Customers	Cumulative	Cumulative %
1	Handover delay	100	100	15.8
2	Slow work progress	95	195	30.9
3	Plaster crack	90	285	45.1
4	Bad workmanship	90	375	59.3
5	Addition omission mismanagement & delay	80	455	72.0
6	Block wall crack	40	495	78.3
7	Door, window related problems	40	535	84.7
8	Non standard toilet fitting fixtures	20	555	87.8
9	Sanitary & plumbing problem	20	575	91.0
10	RCC top floor ceiling leakage	10	585	92.6
11	Electrical line related problems	10	595	94.1
12	Lift related problem	10	605	95.7
13	Parking problem	10	615	97.3
14	Generator related problem	5	620	98.1
15	Tile lifting in winter season	4	624	98.7
16	Toilet floor slope problem	3	627	99.2
17	Non brand material used (Cement)	2	629	99.5
18	RCC beam crack	1	630	99.7
19	Sub-station related problem	1	631	99.8
20	Others	1	632	100.0

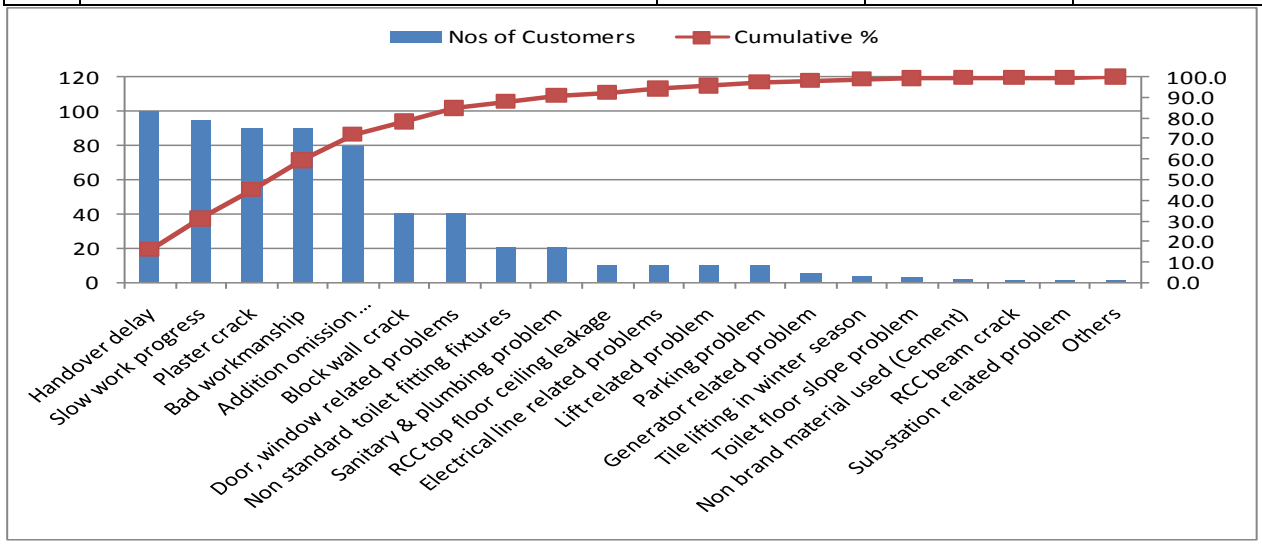

Figure 4.2: Pareto Chart on External Customer (Flat buyer) against Complaints on Quality related Problems.

Table 4.4: Survey on Internal employee against Complaints on Quality related Problems. Survey is conducted based on 100 cases (at Site & management at Head Office)

Sl No.	Areas of Complaints	Count (frequency)	Cumulative	Cumulative %
1	Less salary	100	100	8.1
2	Wrong master budget	100	200	16.3
3	Lack of incentive	95	295	24.0
4	Lack of motivation	95	390	31.7
5	Unskilled labour	90	480	39.0
6	Lack of in time decision	80	560	45.5
7	Overhead reduction policy	75	635	51.6
8	Unskilled supervisor	70	705	57.3
9	Biased recruitment	70	775	63.0
10	Improper HR function	70	845	68.7
11	Unskilled site engineer	60	905	73.6
12	Lack of finished schedule	60	965	78.5
13	Delay material supply	60	1025	83.3
14	Change of decision	50	1075	87.4
15	Lack of material	40	1115	90.7
16	Unskilled manager	30	1145	93.1
17	Lack of manpower	25	1170	95.1
18	Lack of drawing supply	25	1195	97.2
19	Wastage	20	1215	98.8
20	Non standard material	10	1225	99.6
21	Others	5	1230	100.0

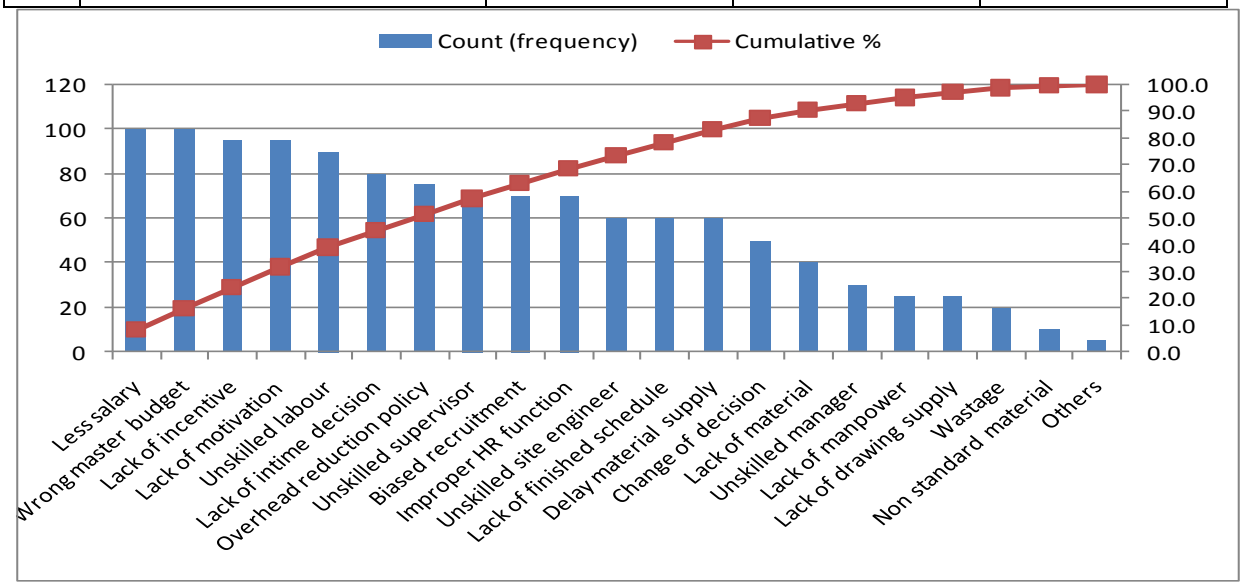

Figure 4.5: Pareto Chart on internal employee against complaints on Quality related Problems.

Table 4.5: Pareto Chart data for Complaints regarding Failure of Concrete Strength.

10 days observation @ 30 trucks each day =Total 300 trucks

Areas of Complaints	Count	Cumulative Count	Cumulative %
Tech. Supervision	300	300	20.5

Under grade 1/2" stone chips	300	600	41.0
Aggregate washing	300	900	61.4
Unskilled labour	150	1050	71.7
Wrong mix design	150	1200	81.9
Over grade 3/4" stone chips	90	1290	88.1
Water Cement ratio	40	1330	90.8
Transport duration	30	1360	92.8
Late water addition	30	1390	94.9
Aggregate quality	30	1420	96.9
Casting method	30	1450	99.0
Admixture dose	5	1455	99.3
Cement Quality	5	1460	99.7
Others	5	1465	100.0

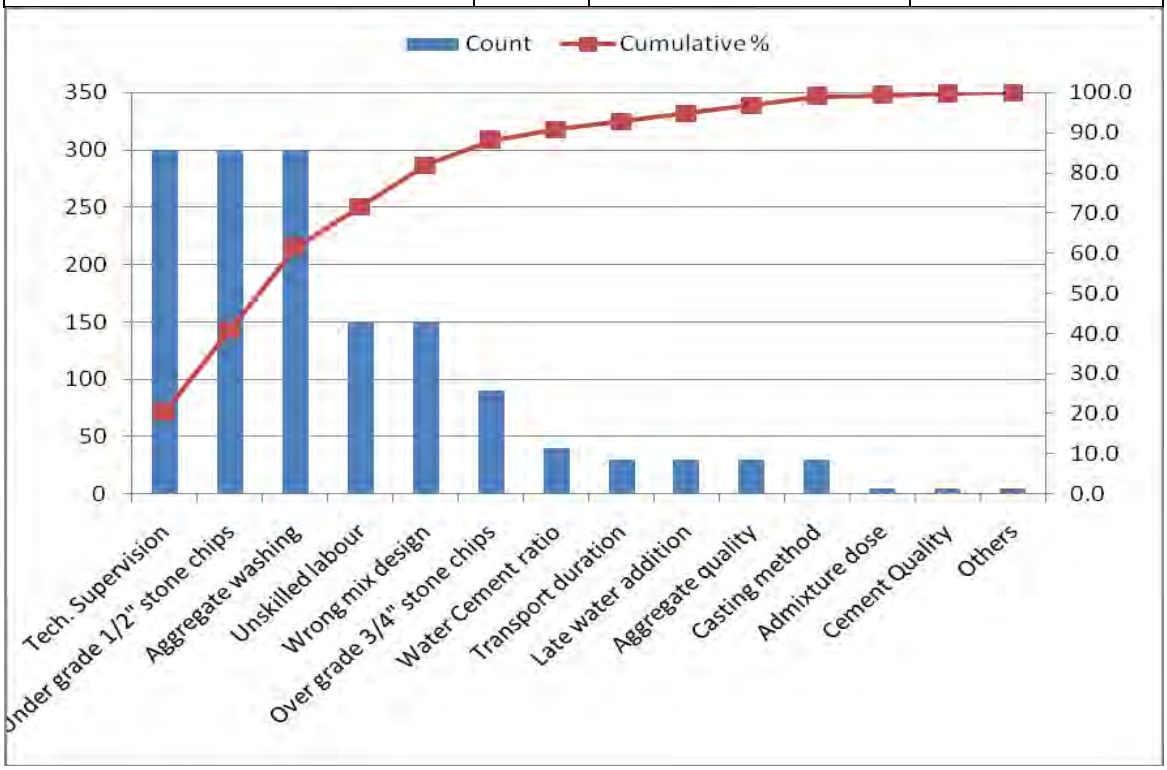

Figure 4.4: Pareto Chart for Complaints regarding Failure of Concrete Strength.

4.6 FINDINGS OF PROBLEMS BY CE DIAGRAM

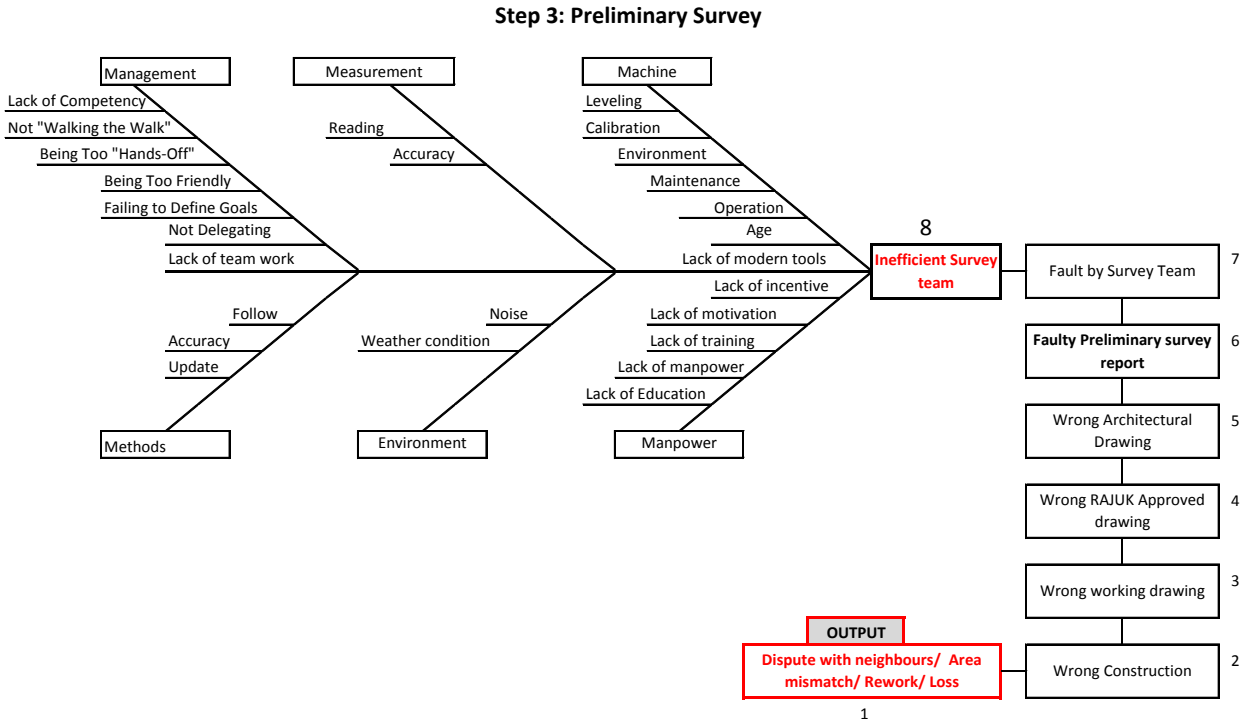

Figure 4.5: Cause Effect diagram on inefficient survey team.

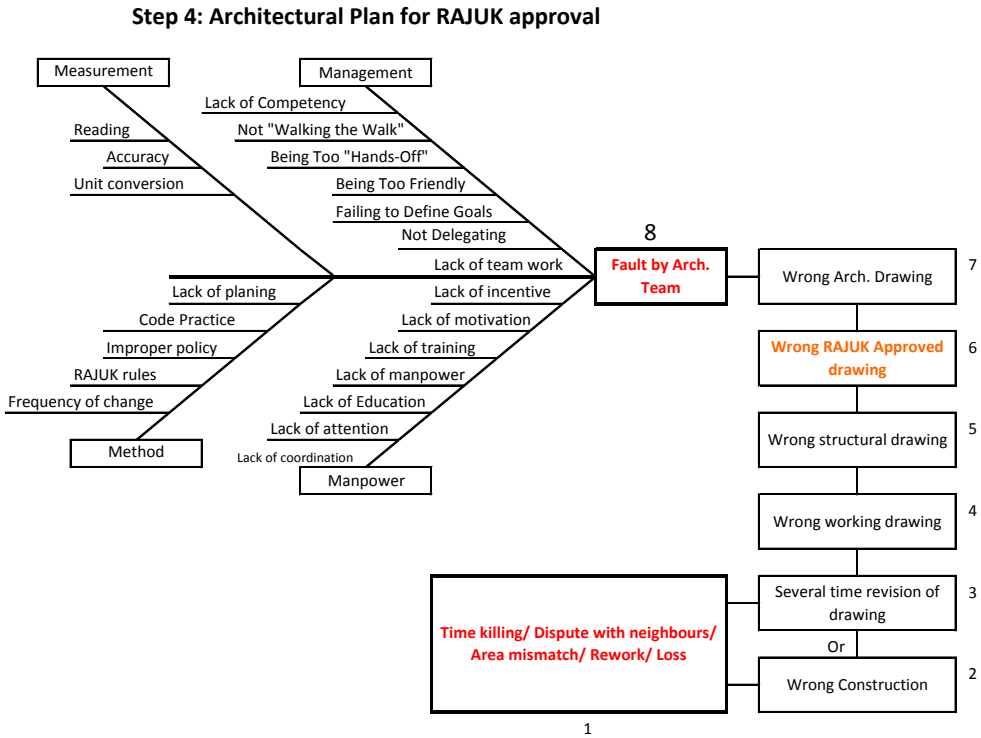

Figure 4.6: Cause Effect diagram on fault by architect team.

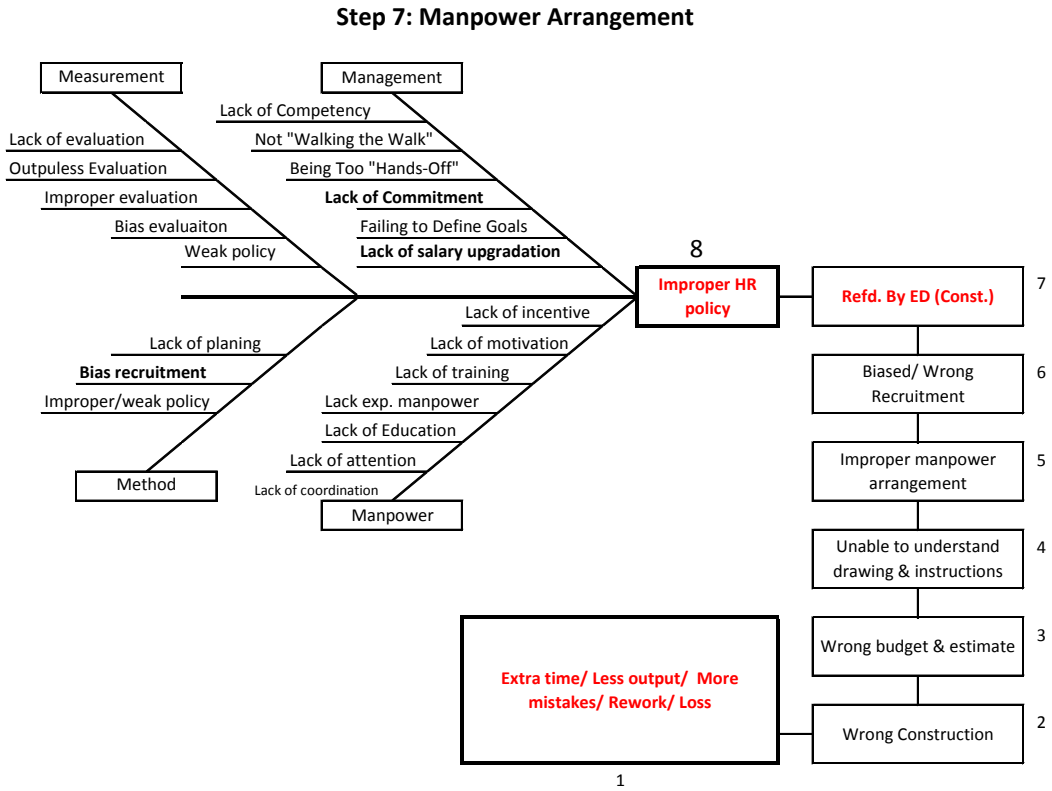

Figure 4.7: Cause Effect diagram on improper HR policy in manpower arrangement.

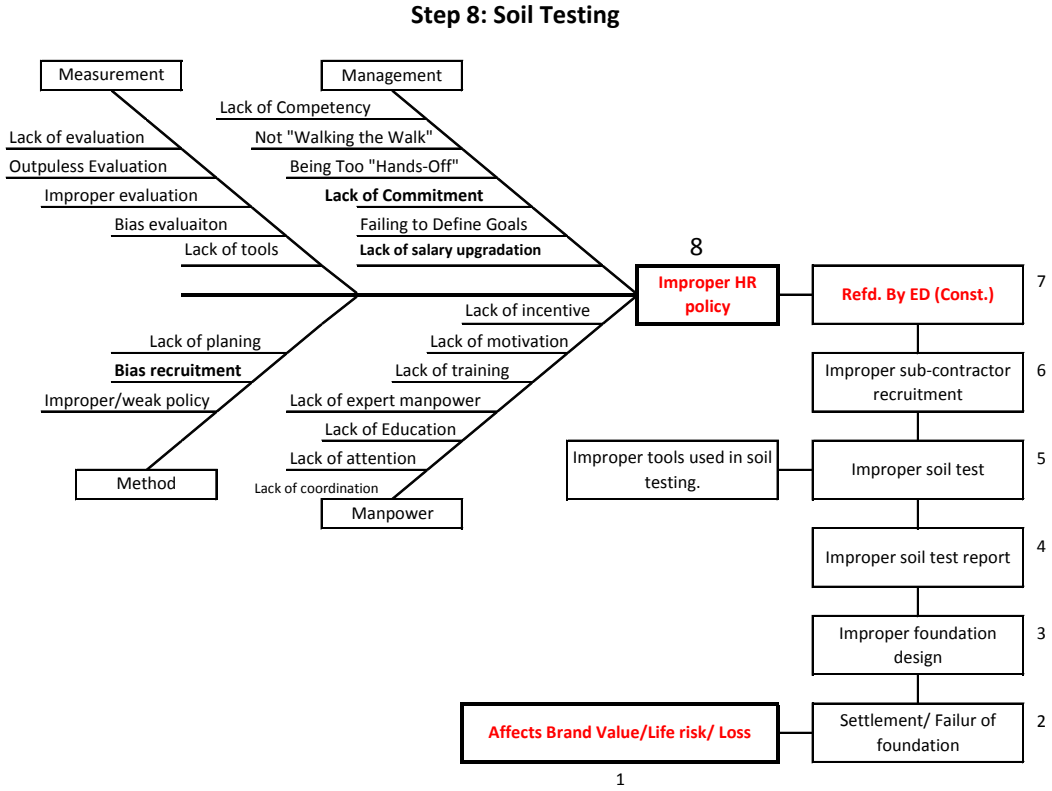

Figure 4.8: Cause Effect diagram on improper HR policy in soil sub-contractor selection.

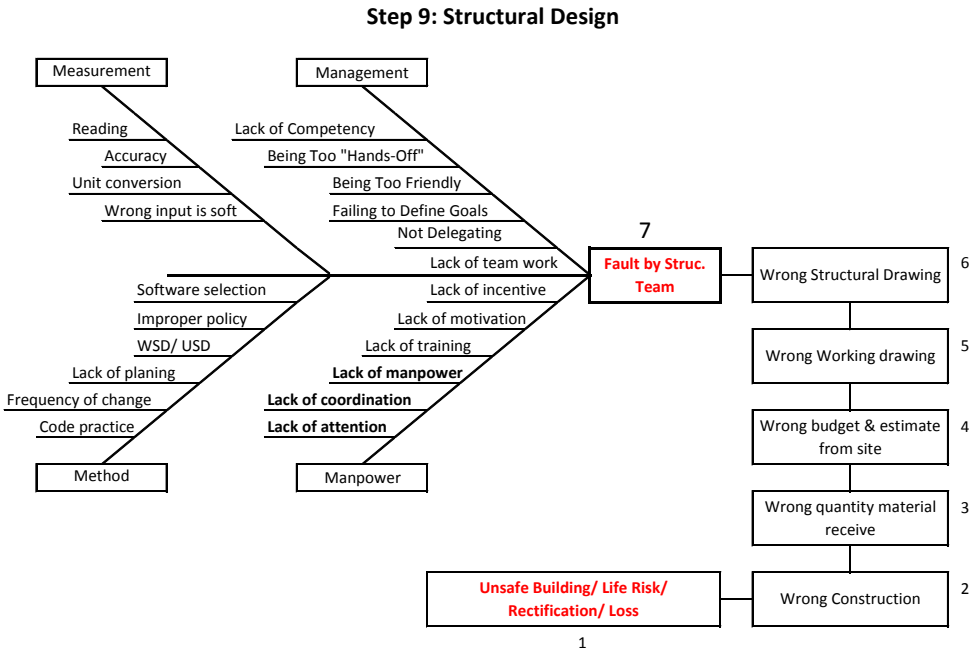

Figure 4.9: Cause Effect diagram on fault by structural design team.

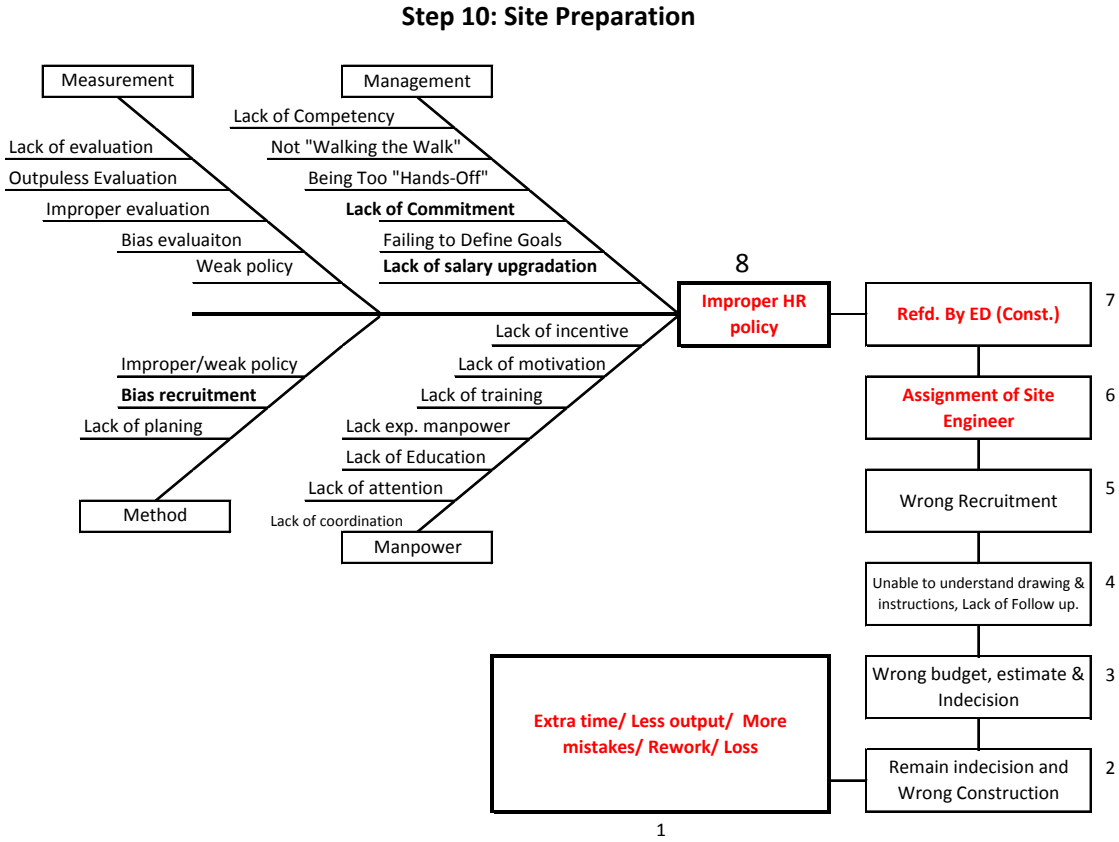

Figure 4.10: Cause Effect diagram on improper HR policy in site engineer recruitment.

Figure 4.11: Cause Effect diagram on inefficient site in-charge.

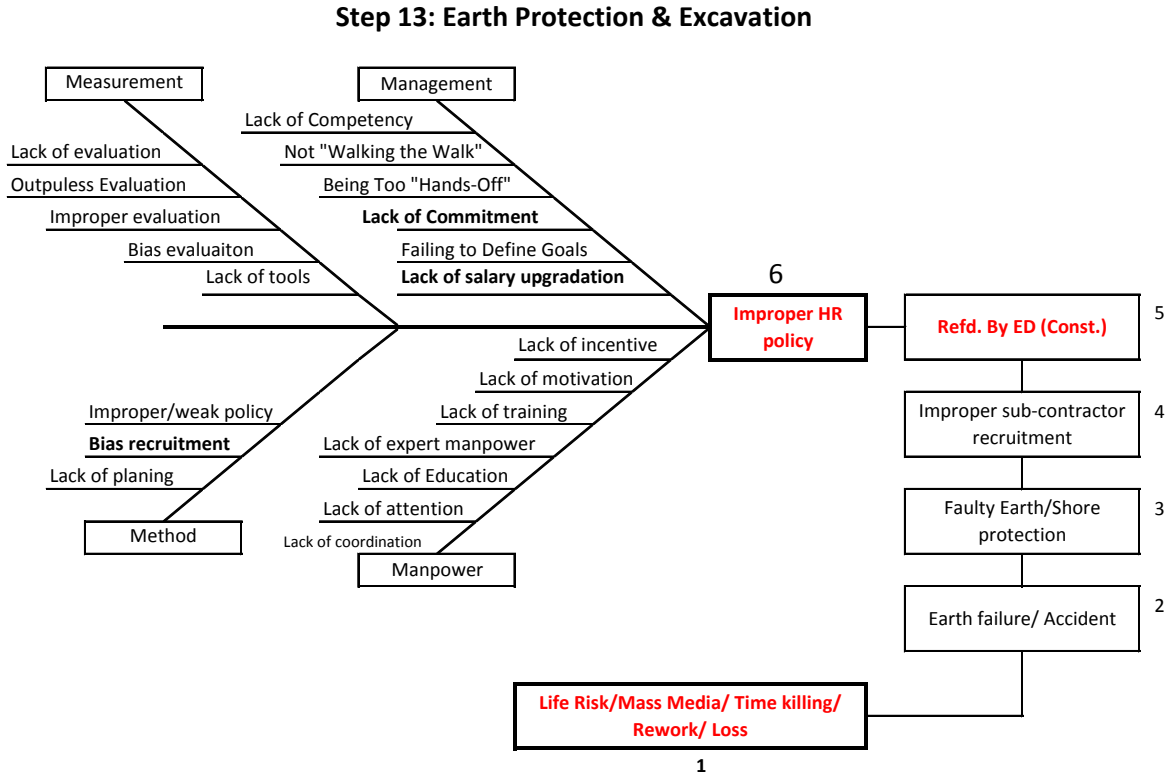

Figure 4.12: Cause Effect diagram on improper HR policy in earth excavation sub-contractor selection.

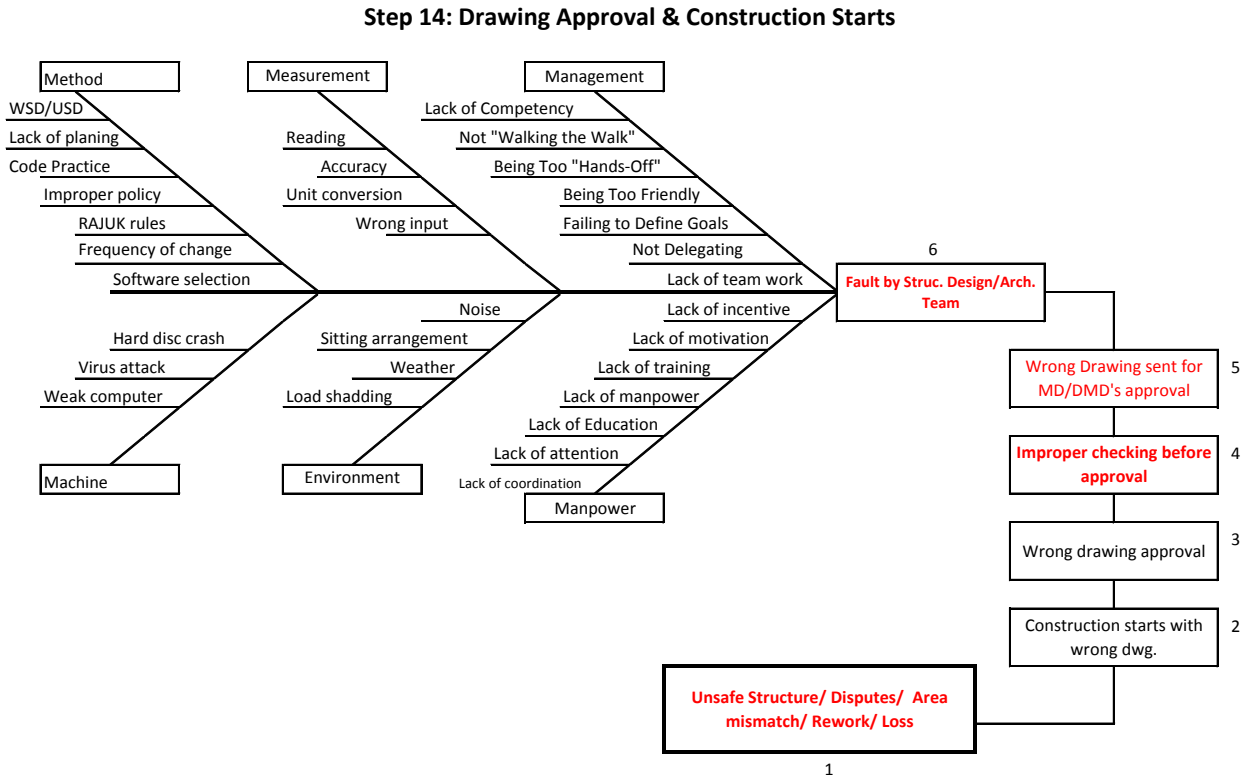

Figure 4.13: Cause Effect diagram on fault by structural design/ architect team.

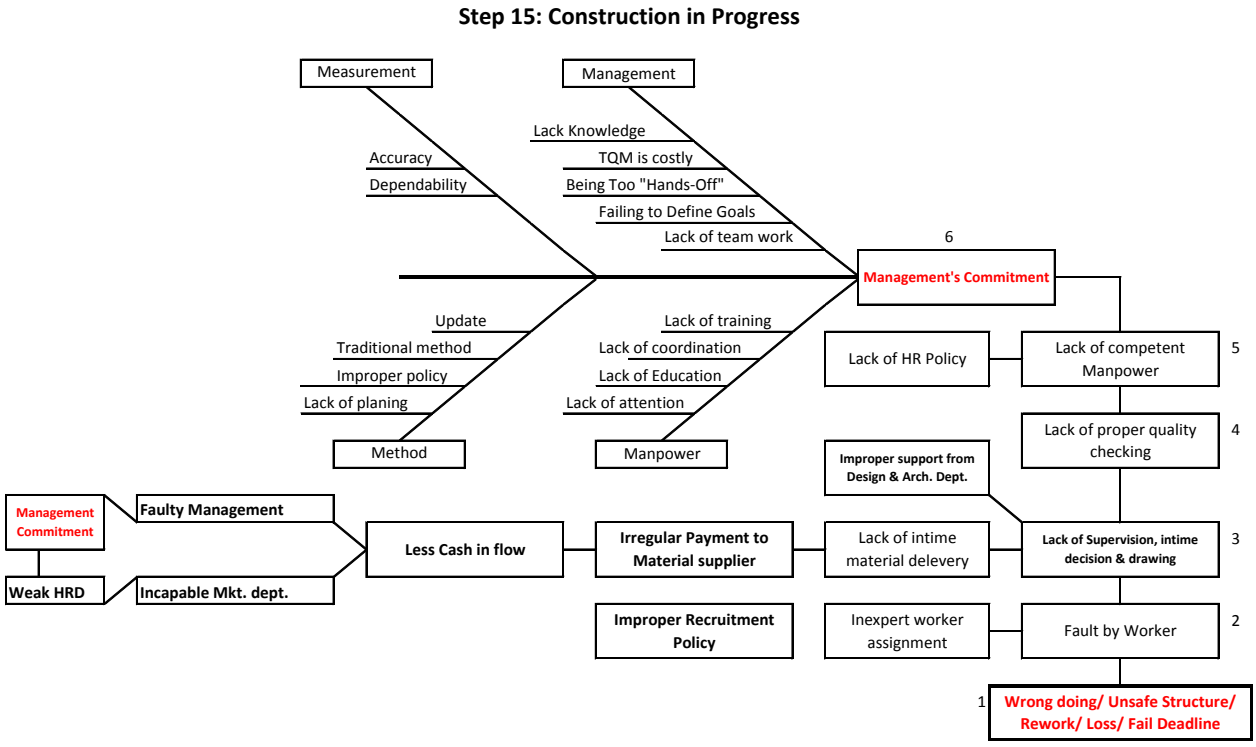

Figure 4.14: Cause Effect diagram on management related problem.

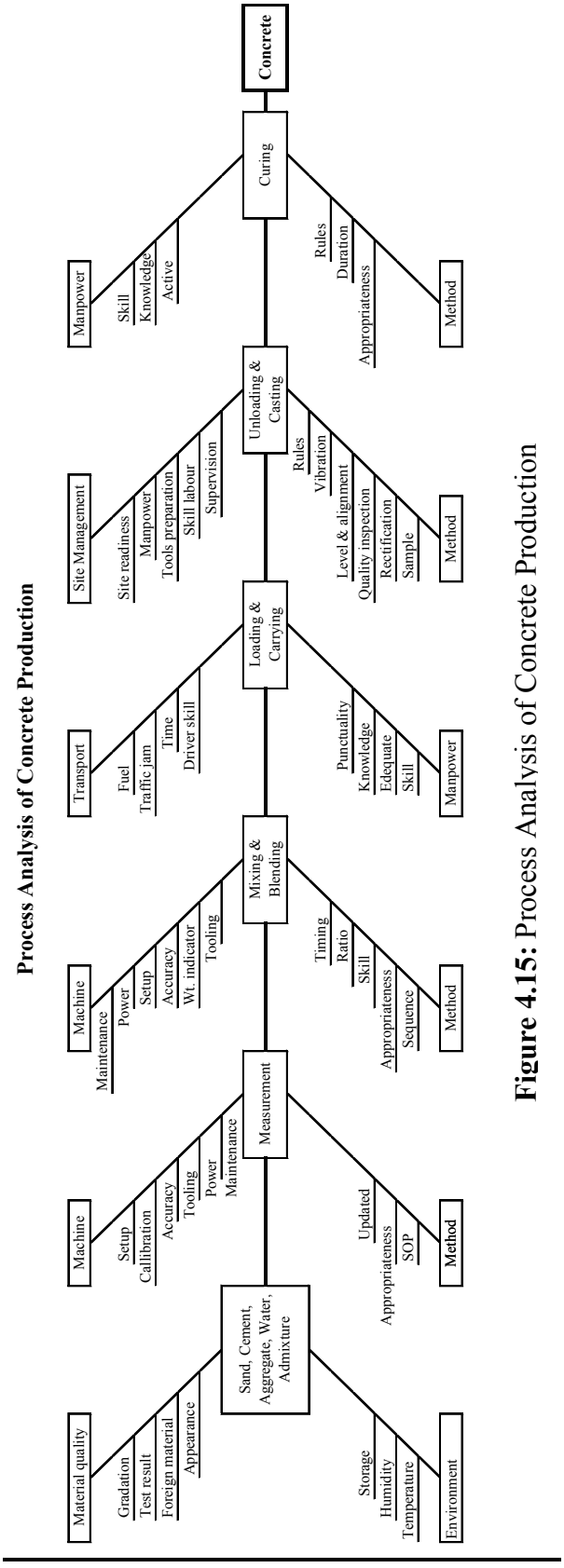

Figure 4.15: Process Analysis of Concrete Production

4.7 IDENTIFIED MAJOR CAUSES AND EFFECTS

After Pareto analysis and Cause Effect diagram analysis the following major causes are

identified:

- Hand over delay
- Slow work progress
- Bad workmanship
- Sanitary and plumbing problem
- Cost reduction policy by management
- Less salary of employees
- Lack of incentive
- Wrong master budget
- Unskilled labour
- Unskilled engineers & site in-charge
- Improper HR policy
- Biased recruitment
- Fault by survey team
- Fault by architect
- Fault by structural designer
- **Lack of management's commitment**

For the above major causes the following effects arises frequently.

- Fail deadline
- Low customer satisfaction
- More rework, material and labor cost
- Extra cost and loss
- Time killing/ extra time
- Area mismatch
- Dispute with neighbor
- Less output (Low productivity)
- Affect brand value
- Unsafe structure
- Life risk
- More rectification
- Mass media

- Fail commitment

4.8 IDENTIFIED BARRIERS FOR IMPLEMENTING TQM

1. Lack of commitment of the top Management
2. Lack of education
3. Lack of motivation
4. Lack of mutual trust
5. Lack of trained workers
6. Competitive markets
7. Poor plans and specifications
8. Bad attitudes
9. Lack of competent field managers

4.9 BRIEF DESCRIPTION OF SOME IDENTIFIED PROBLEMS

4.9.1 MANAGERIAL PROBLEMS

01. Cost reduction policy of management

The said company is still unaware of this kind of management. They are still thinking that **quality is a matter of extra cost**. Rather more activities can be performed with this cost. They are not really increasing expenditure in development of their construction process or not spending on the training of their employees. Management is trying to reduce cost in every steps of construction process. As a result in some cases quality works cannot be achieved. Consequently produces low productivity of business and low quality output.

02. Improper HR Policy

This company generally recruits their employees through a simple interview. The candidates are asked about their previous job and some related questions. But they are not sitting for any written test, computer skill test or analytical ability test those are very important in the practical field of construction project management. Sometimes employees are recruited with recommendation of some high officials although having improper or no experience. This results less productivity and reduction of managerial capacity and skill supervision in construction projects.

03. Lack of Education

Lack of education is another problem in this company. Most of the sub contractors and some employees of this company are not well educated in their respective fields. Most of them become expert by doing on hand without theoretical background. Due to improper supervision and lack of expert management they often mistakes in their works. Also many sub contractors have done same activity in different ways since they have no theoretical knowledge. This issue is very common in Bangladesh.

04. Lack of training

One of the important issues of Total Quality Management is continuous improvement and employees‟ training that is mandatory for achieving continuous improvement. The said company generally is not giving importance in this area. As a result many important activities are being performed by unskilled employees or labours which results many faulty works, extra cost and reworks.

05. Lack of trained worker

A majority identified lack of training as the main barrier to quality in the construction industry. Most of the workers of sub-contractor are not trained properly. They are generally come from villages and learn masonry works from some head mason. They have no educational training and theoretical knowledge. So during inspection it is found that they are working without maintaining rules and standards. As a result quality work cannot be achieved up to the mark and sometimes rework is needed which includes extra cost, material and labor cost.

06. In house sub-contractor

The company is a group of companies which has some in house contractors such as i) mechanical tools and steel form work supplier, ii) interior decoration section, iii) Ready mix concrete supplier, iv) Aluminium and glass work contractor.

The company generally depends upon these in house contractors for respective works in almost all projects. Since this is a group of companies all managerial process is almost similar in these sub groups. So the common problems remain unchanged in those sub groups. As a result work standards of the said activities remain similar. There are a few chances to hire out source contractors in these

activities. Whereas the contractors need to be recruited according to their competitive offers, technically soundness and ability to perform quality works.

07. Bad attitude

The competitive environment, poor management practice, and a general lack of higher expectations have contributed to unproductive and unhealthy attitudes. These attitudes often are expressed in popular sayings, such as *"It's not my job" and "If it isn't broke, don't fix it."* Some may sound uncomfortably familiar. All are clear indicators of trouble. This attitude generally comes from lack of motivation, incentive, less salary, extra pressure and bad management policy.

08. Absence of proper performance evaluation and employees motivation

Employees‟ satisfaction is another measuring tool for evaluation of quality management. This tool works tremendously in improving quality works. Employees motivated greatly if their performance evaluated in proper way and rewarded time to time. In this company there exists a human resources department but they are not performing their real functions such as proper employee‟s performance evaluation and rewarding as per demand, time to time proper employees training, motivating the employees by providing promotional offer etc. They are mostly motivated by the top management. As a result some prospective employees disappointed and decrease their productive activities.

4.9.2 CONSTRUCTION RELATED PROBLEMS

01. Uneven Concrete surface

Uneven concrete surface is a common problem in construction sites. It occurs due to mainly poor quality form work or shuttering materials. Form work materials are supplied by an in house company. Generally old shutters are being used in different projects those have no temper. Project engineers and quality control team suggest for changing or rectifying properly before using in the construction. But fruitful solution does not achieved from the supplier. Sometimes the supplier rectifies the formwork materials manually by hammering and welding but proper evenness cannot achieve ever after their maintenance. Ultimately concrete surface becomes uneven.

02. Shrinkage crack on newly cast concrete

Concrete is a hard combined material made of fine & coarse aggregate, cement and water. The main binding material is cement which reacts with water just after mixing together. Cement generally reacts with water known as hydration reaction that produces heat. For this we need to add estimated amount of water to help this hydration reaction to complete properly without any damage of concrete surface. To help this action the internal water needs to present into the concrete. So we need to spray extra water on all newly cast concrete after its final setting time so that the internal water cannot evaporate easily from it. This adding water on fresh concrete is called curing.

If curing is not done in proper time and proper way hydration reaction produces extra heat and hair crack or shrinkage crack that is observed on the newly cast concrete. This situation is observed in hot weather also. If concreting is done at noon or in very hot weather the internal water tends to evaporate rapidly which results surface crack on the concrete.

So to eliminate this problem the managers and project supervisors or engineers must know these technical stuffs first and they must be aware of the matter. Accordingly they should supervise the worker and instruct them what precaution measure should be taken up. Workers have also to be very careful about this matter.

03. Crack in block wall

This construction firm has been using hollow block as masonry work instead of traditional clay brick. This product is brought to Bangladesh by this company first. The procedure of masonry work by this block is little bit different than that of clay brick. So some special precaution needs to be taken while block masonry work. Such as mortar mixing standards, sand: cement ratio, water: cement ratio, sand fineness modulus (FM), control joint between block wall and RCC member, vertical and horizontal reinforcement requirement etc. the curing procedure of block wall is also different than that of traditional clay brick.

So without proper technical knowledge and strict supervision it is not possible to control this kind of crack in block wall.

04. Crack in construction joint

Generally there are many kinds of construction joints in concrete structure. Such as construction joint in slab, beam, column, shear wall, retaining wall etc. there are another kind of control joint between RCC member and block wall. There are specific standard codes to keep these construction joint in respective members. If the standard codes are not followed properly there is possibility to occur cracks. In the beginning block wall crack was observed near any RCC member. After trial and error method many system was practiced. After a long time by providing 2" gap between RCC and block wall and placing vertical rebar with horizontal tie and filling this gap by concrete this problems have been resolved.

4.9.3 DESIGN RELATED PROBLEMS

01. General dissimilarities among all designers designing process

It is seen that for almost similar type of buildings structural designs have been done in different systematic way by different designer. Some general system such as shore protection system & earth cutting, shore pile bracing system, column-beam framing system, size and thickness of column, beam and slab etc. can be kept more or less similar if the designers consult themselves while performing their design process. There is a consultant to whom the designers consult with and get time to time guideline in their design process. But similarity in design is not being achieved completely. Lack of tendency to consult with them is the reason behind the problem. Another reason is there is no senior coordinator in this section.

02. Design changing/ revision without proper coordination with respective architect

Construction is the work of building, rebuilding, addition and omission or renovation activities. So changing or revision of design is a normal activity in construction firm. The whole concept of a building is first come out from an architect. Planning, modeling & perspective is also created by an architect. The designers only design the requirement of material such as reinforcement, concrete, cement, bricks or blocks etc. He also suggests the architect about the thickness and size of the RCC member. So while changing or revision of design arises a designer must consult with respective architect. Otherwise the actual architectural thinking may not be flourished.

03. Some general instruction missing in the drawing

Generally some general instruction is provided with the approved working architectural, structural & electromechanical drawing. But due to some missing information of general instruction in the drawing site cannot perform the work perfectly as per standards and specification which results poor quality of work, more re-work and loss of time, material and money. This happens due to sending working drawing part by part to the site. If full set package drawing including related architectural, structural & electromechanical drawing can be sent to site at a time, this kind of problem can be resolved. For this all the four sections should be worked as a team and coordination among these sections is must.

4.9.4 ARCHITECTURAL PROBLEMS

01. Sometimes violation of RAJUK rules in planning

At the very first step of construction generally a plan is prepared with relevant section and elevation by the architects to submit it to the RAJUK for approval. Before preparing RAJUK document and drawing idea is taken from architect and structural engineer. But after RAJUK approval due to implement better idea and better structural safety some revision is made by architect as well as structural engineer. As a result several problems arise at mid time of construction or finishing time of construction. Such as due to increase of column size for structural safety or increase of retaining wall or shear wall in structural drawing than that of initial architectural drawing parking space reduces in several projects. Parking space shortage creates great problem among developer and clients or flat buyers.

On the other hand some little violation of RAJUK is practiced thinking that it will be mutually resolved with RAJUK later. If it cannot be resolved with RAJUK the rework of those construction increases which results loss of time, material and money.

02. Architectural mistakes and habit of exercise

Sometimes architects mistake in toilet & kitchen internal arrangement which creates problem in practical use. If the site engineer and supervisor are unskilled about the best usable fitting fixture arrangement they usually completed the wrong works as per supplied drawing. As a result complain comes from the flat owners after hand over and the developer does the maintenance work with high cost. To resolve this

problem a team is formed to supervise the initial layout work and internal arrangement of fitting fixture at toilets and kitchens. The team visits every site three times. During one year activity of this team these kinds of problems have been reduced to a great extent.

Another reason behind it the design exercises of architects. Some architects revise their drawing and decision several times ever after the work has been executed. As a result developer lost time, material and money as well as fail to hand over in time. This could provably insufficient practical knowledge of architects. So, to resolve this problem architects should give very wise decision which are practically and financially feasible and acceptable to all. That means architects should have well experienced.

03. Architectural planning without considering tolerance that could happen during construction

Sometimes architects prepare building plan with contact to shore pile protection line. But practically when shore pile driving operation starts, 6" to 1'-0" vertical alignment variation occurred. So ultimately retaining wall shifts inward with shifting shore pile. As a result ramp or parking space becomes congested and critical. To resolve this problem some critical operation is taken up such as shore pile slicing 20'-0" to 30'-0" below the zero level. So it is very dangerous for surrounding multistoried building.

To overcome this situation architects should aware of the practical tolerability of work while planning the outer retaining wall or boundary.

4.10 ROOT CAUSE ANALYSIS

After analysis of the above facts it is seen that majority of the problem is coming from the following points.

01. Incorrect budget preparation
02. Improper design & drawing
03. Material supply and quality problem

04. Proper manpower.

So root cause of these points is analyzed and shown in the following flow charts.

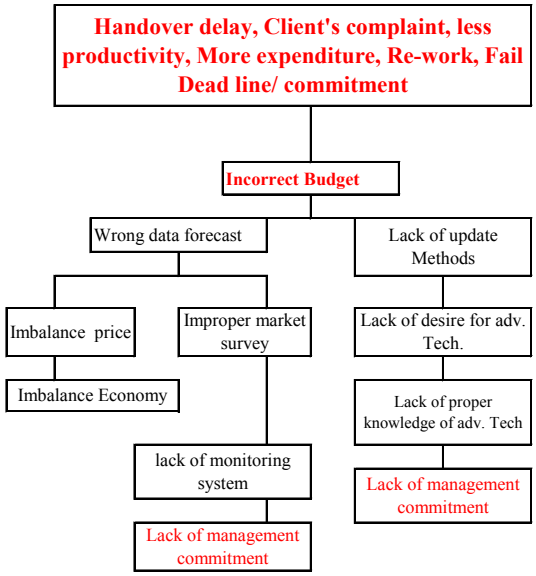

Figure 4.16: Root cause analysis of incorrect budget preparation.

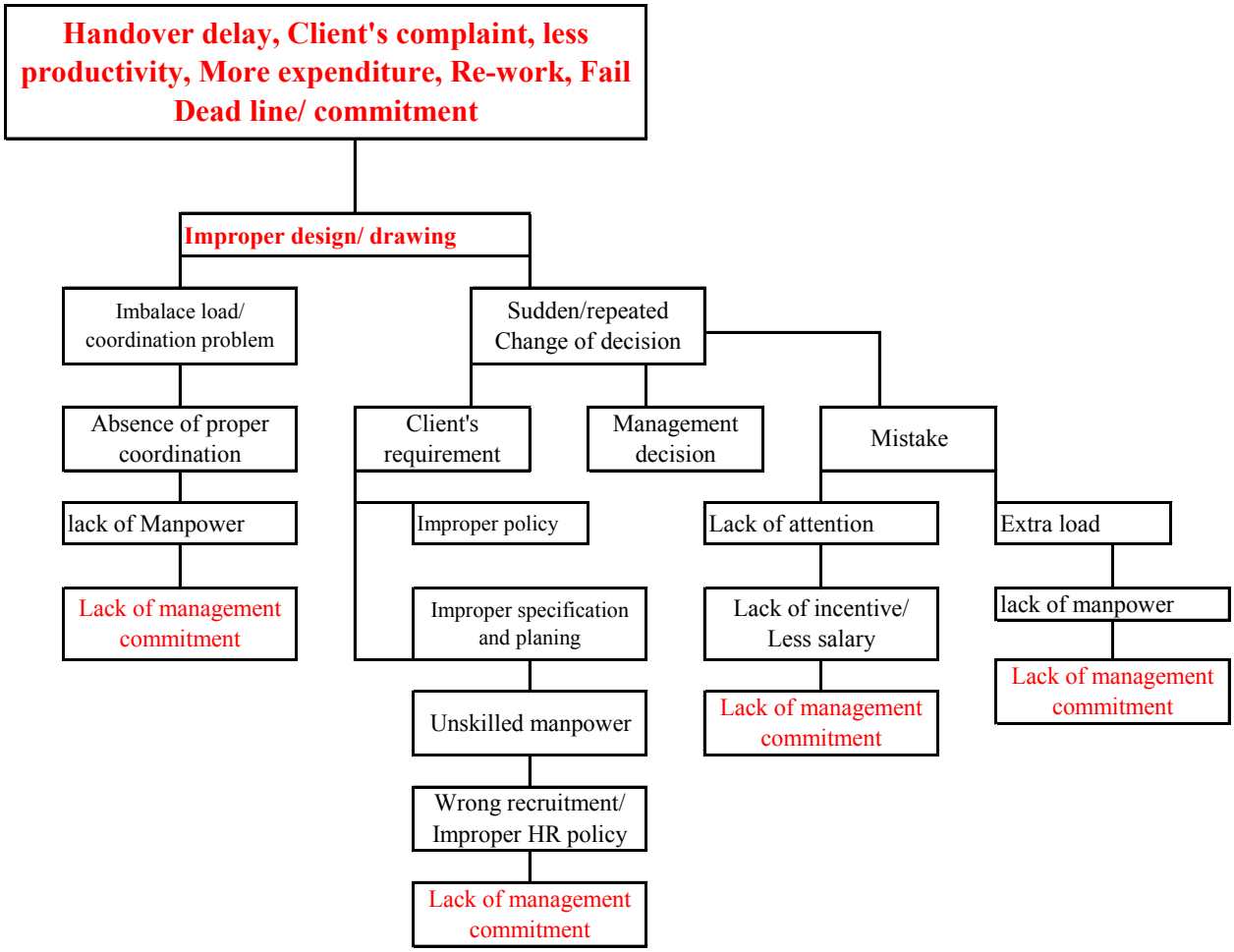

Figure 4.17: Root cause analysis of improper design/drawing.

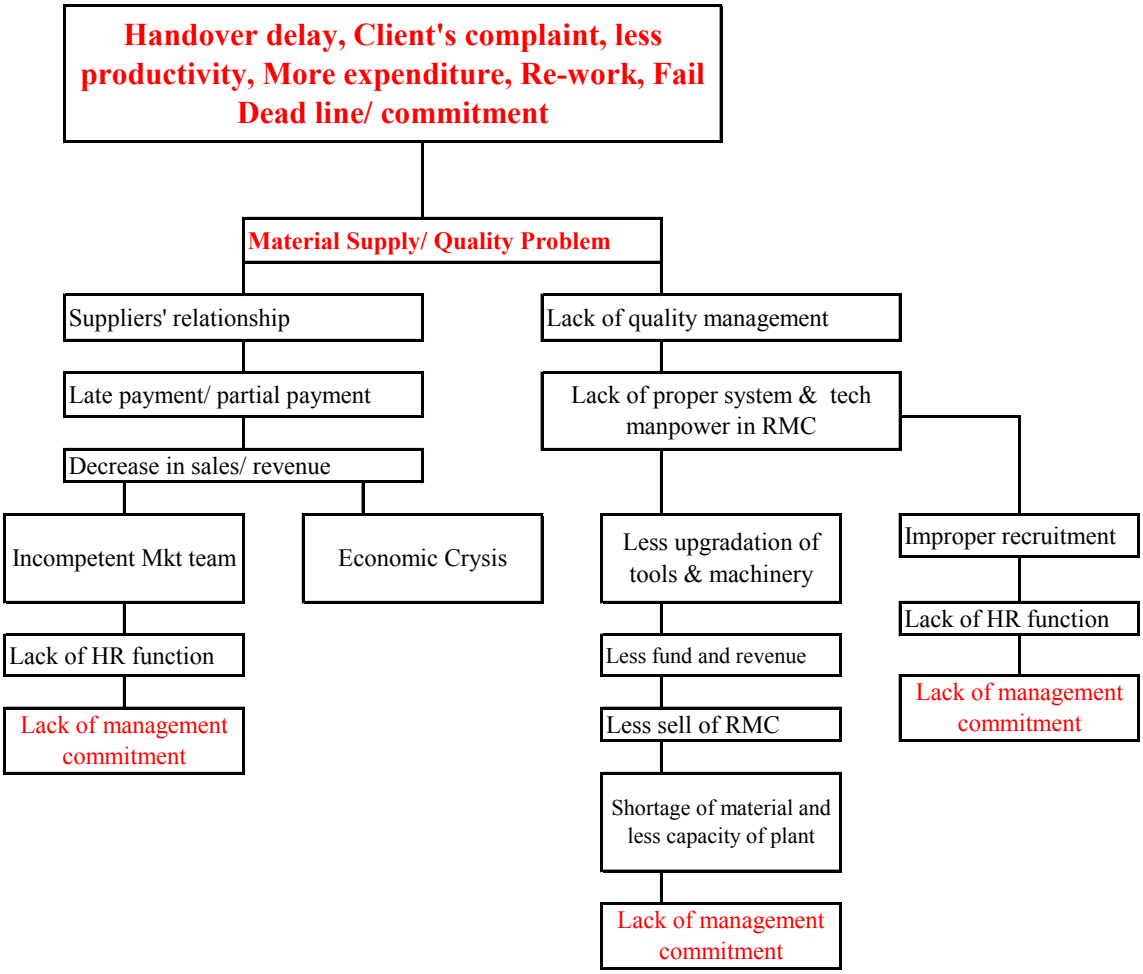

Figure 4.18: Root cause analysis of material supply/quality problem.

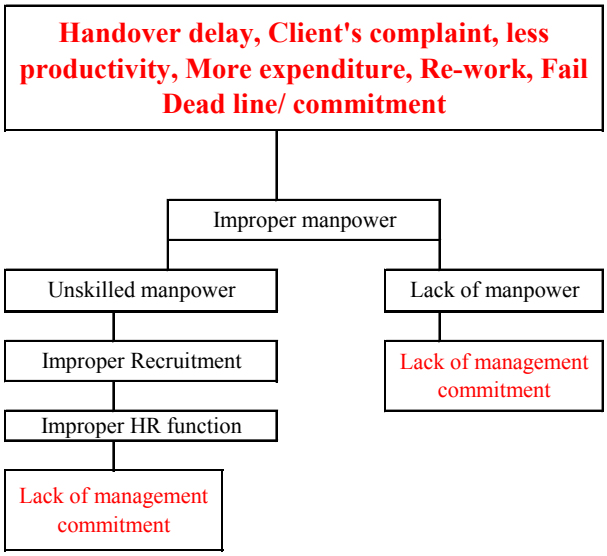

Figure 4.19: Root cause analysis of improper manpower.

4.11 RESULT AND DISCUSSION

From **Pareto analysis** is it seen that about 80% external complaints coming from flat buyer

on quality related problems can be lowered by solving only 7 nos major problems such as:

1. Handover delay.
2. Slow work progress.
3. Plaster crack
4. Bad workmanship
5. Sanitary & plumbing problem
6. Addition omission mismanagement & delay
7. Door & window related problem.

Up to 80% of internal problems of the firm can be lowered by solving only 11 nos major problems such as:

1. Cost reduction by mgt.
2. Less salary
3. Wrong master budget
4. Lack of incentive
5. Lack of motivation
6. Unskilled labour
7. Biased recruitment
8. Improper HR function
9. Lack of in-time decision
10. Unskilled supervisor
11. Unskilled site engineer

And

Up to 80% concrete failure can be minimized by solving major 5 causes such as:

1. Tech. Supervision
2. Under grade 1/2" stone chips
3. Aggregate washing
4. Unskilled labour
5. Wrong mix design

From the **Cause Effect diagram and process analysis** it is seen that the majority of problems are coming from 6 nos major points such as:

1. Management
2. Manpower
3. Method

4. Measurement
5. Machine &
6. Environment

So, to solve the defect on the work process of the construction firm attention must be given on the above points.

From the **root cause analysis** it is seen that in the majority cases the ultimate root case is ***"Lack of Management's Commitment"***. Some other minor causes are as below:

1. Improper budget
2. Improper design/ drawing
3. Material procurement & supply
4. Manpower issue
5. Methods
6. Measurement
7. Tool and machinery etc.

So, Commitment of the top management is very essential for successful implementation of TQM in a company. Particularly, commitment of the Chief Executive Officer (CEO) is a precondition to TQM. If the CEO says, "Yes, go-on I am with you" - that means he is not interested about TQM and nothing will happen. But if he says, "Come on- Let us go for it" – then everything will happen. Refer to the case study of literature review, the Managing Director himself went for quality and he arranged training, seminar for all employees himself, for this reason all employees were able to form successful Quality Circles and to implement TQM in the firm. In the same way in this construction firm quality management can also be achieved by forming successful Quality Circles in each section of each department. Top management has to support directly to these Quality Circles and suitable and expert facilitator to be assigned for the aid of proper function of those Quality Circles.

Chapter 5
Conclusion and Recommendation

5.1 CONCLUSION

The construction industry has numerous problems in getting quality performance as a result of the complicated nature of the industry. TQM is being increasingly applied to the construction company to solve quality problem. The implementation of a TQM required a culture change and change in management behavior. Traditionally construction firms are misunderstood and have been set-up wrongly in many organizations. The organization need to shift from their current culture to a TQM culture that focuses on quality as a key strategy. A review of literature, findings and analysis of a case study in different department and sections of a construction firm identifies some important elements that contribute to successful path to implementation of TQM, which include top management commitment, training and education, teamwork, people management and empowerment, supplier relationship, quality planning and strategic, process management, rewards and recognition and effective communication. These dimensions of quality culture should be adopted by the construction organization in implementing TQM for continuous improvement.

5.2 RECOMMENDATIONS FROM CASE STUDY

Based on the analysis of overall analysis and findings the following recommendations can be made for implementing successful Total Quality Management.

01. At first Top Management commitment is a must.
02. Improve Human Resource policy for appropriate recruitment.
03. Improve planning and design phase before starting construction.
04. Improve material quality management.
05. Improve Supply Chain Management.
06. Provide institute training.
07. Optimize the efforts of teams, groups and staff areas by forming **Quality Circles**.
08. Encourage education and self improvement for everyone.
09. Follow Juran‟s Ten Steps to Quality Improvement. [Ref. to Chapter 2, Juran‟s Approach to TQM]
10. Emphasize on the strategy, policy, and firm-wide evaluation activities.
11. Recognize and reward the employees for their quality improvement efforts.

12. Ensure participation of all persons from all departments in continuous improvement of quality.
13. Follow the problem solving process as below for implementing TQM.

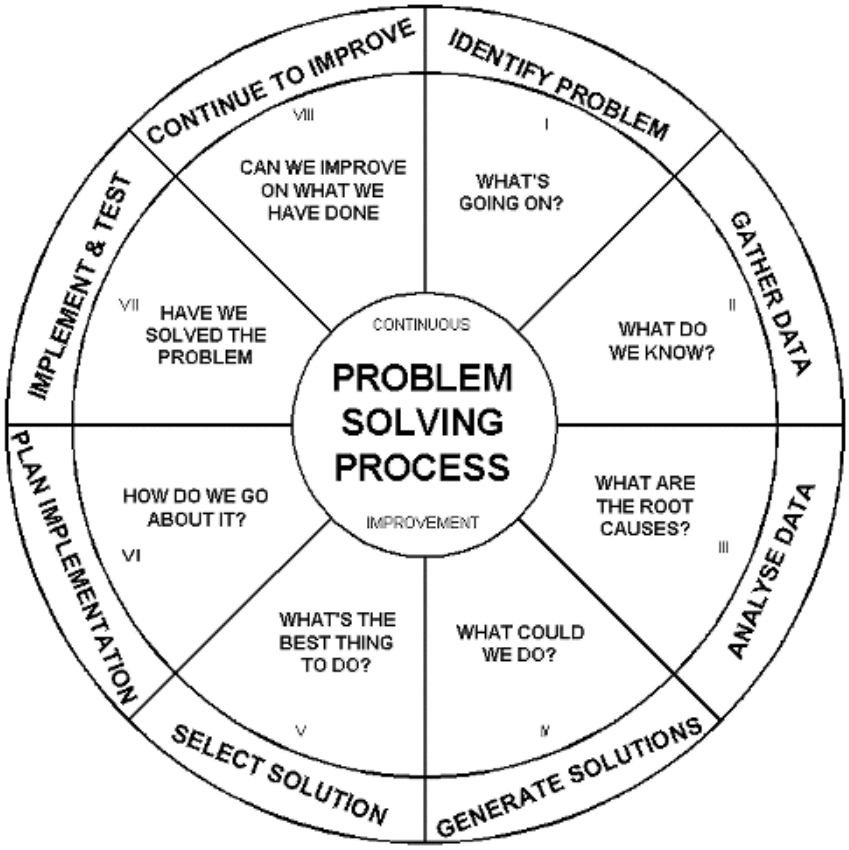

Figure 5.1: Problem solving process.

5.3 RECOMMENDATION FOR FUTURE RESEARCH

Since TQM is a new concept in Bangladesh and it is not yet widely used in construction industry of Bangladesh, there is a huge scope of research in this sector. While searching the literature regarding TQM implementation in construction firm of Bangladesh, I found only one research paper that is done at Structural Engineers Limited, a construction firm in Dhaka performed by the Managing Director of that firm. According to that research and the case study of my research only a few areas are explored and some basic tools of TQM are used to analyze the problems. For in depth research in construction firm advanced tools of TQM can be applied for analysis. So further study can be done in different dimension. Some of them are furnished below:

1. TQM tools can also be implemented in Accounts section, Administration section, HR section, Supply Chain Management section, In-house Sub-contractors section, Interior Design section, Every Construction Projects Sites, Block Manufacturing Plant etc.

2. Other philosophies and Tools of TQM; for example Kaizen, PDCA cycle, QFD, Process capability analysis, Control Charts can be implemented for in dept research.
3. Team work or joint research will be helpful in data collection from such large scale of construction firm.

5.4 LIMITATION OF THIS RESEARCH

Due to restriction of some departments as per company policy required data collection is not possible. Also it was so difficult to collect data from all available department and sections alone within limited time. So check sheet and Pareto analysis cannot be performed for all departments. The research is performed within a short time frame, so only some basic Tools of TQM is implemented for analysis. The research is focus on mainly quality of works, so other items of the firm are not discussed and analyzed. So, little variation of the analysis output result may arise with other research on this area.

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