

Measurement of Construction Processes for Continuous Improvement

Revised Final Report

Submitted to

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Executive Summary

The primary purpose of TQM is to provide excellence in customer satisfaction through continuous improvements of products and processes by the total involvement and dedication of each individual who is in any way a part of that product/process. It is a structured approach to improvement. If correctly applied, it will assist a construction company in improving its performance.

Unfortunately the Construction industry, generally, has lagged behind other industries in implementing TQM. The main reason for that has been the perception that TQM is for manufacturing only. One aspect of TQM that has frustrated the construction industry the most has been “**measurement**”. The primary objective of this study was to develop a measurement model - with tools and methodologies for the identification and measurement of construction processes for continuous improvement and customer satisfaction.

Although ‘Total Quality Management’ has been a magic word, methods and techniques to implement the Quality Management program in an Industry are still to be developed. Analysis of questionnaire survey indicates that the major obstacle to implementing a TQM program is changing the behavior and attitude, lack of expertise/resources in TQM, lack of employee commitment/understanding, lack of education and training to drive the improvement process.

The Client Satisfaction Index, the Cause and Effect Diagram and the Improvement Index were developed to find out the major sources of client satisfaction and dissatisfaction in the construction industry. Results of this study show that customer satisfaction can be greatly enhanced by improving construction underestimation, project management coordination, design changes by clients and change orders from procurement department. The above areas were identified from the results of the questionnaire in which we had asked the clients to identify the most important processes that need improvement. This process can be repeated until different areas of improvement are identified through another cycle of the development of the client satisfaction and improvement index. The key to understand is that the client is now a moving target – their expectations and requirements are constantly changing. To keep up with their ever-changing goals, the contractors need to have in place a system of identifying, measuring and continuously improving their tangible and intangible products and services.

Hopefully, this study has succeeded in demonstrating how these objectives can be achieved. There is no intent on the part of the author to imply that the identified main and sub causes of client satisfaction or dissatisfaction are in any way statistically significant. The objective of this study was to develop and demonstrate how a system of continuous improvement can be put in place by measuring different processes. It is sincerely the hope that to that end, the research project has been completed successfully. It is expected that this study will be of a pioneering nature. For the local construction industry, this project has the potential of demonstrating tangible benefits of using TQM in their organizations

CHAPTER 1

Introduction

1. 1 BACKGROUND

The primary purpose of TQM is to provide excellence in customer satisfaction through continuous improvements of products and processes by the total involvement and dedication of each individual who is in any way, a part of that product/process (Ahmed 1993). The principles of TQM create the foundation for developing an organization's system for planning, controlling, and improving quality (Deming 1993).

TQM is a structured approach to improvement. If correctly applied, it will assist a construction company in improving its performance. It involves a strong commitment to two guiding principles: customer satisfaction and continuous improvement. In a study of customer satisfaction factors for clients of the transportation, food, chemical and paper, utilities and other miscellaneous industries, it was found that timeliness, cost, quality, client orientation, communication skills, and response to complaints were most significant (Ahmed and Kangari 1995). Another study suggests that TQM methodology like quality function deployment (QFD), provide a structured framework for continuous improvement and customer satisfaction (Ahmed and Kangari 1996).

In 1992, the Construction Industry Institute, Austin, Texas, published Guidelines for Implementing Total Quality Management in the Engineering and Construction Industry. Their results show that TQM has resulted in improved customer satisfaction, reduced cycle times, documented cost savings, and more satisfied and productive work forces (Oswald and Burati 1992). In the Contractor's Business Management Report's 1996 Contractor Management Survey, 44% of the respondents have or have had TQM programs. One said TQM "raises awareness of quality and helps document result." Another said it's a "must if you are going to be the best in your area." And a third replied, "We continue to identify ways to improve."

Despite the above, Construction, generally, has lagged behind other industries in implementing TQM. The main reason for that has been the perception that TQM is for manufacturing only (Chase 1993). The other major factor inhibiting the implementation of TQM in the construction industry has been the notion that TQM is costly and requires a long time period for implementation. One aspect of TQM that has frustrated the construction industry the most has been "**measurement**" (Hayden 1996).

Many construction companies in the US, Singapore, UK, and other European countries have been using TQM successfully for a number of years now and reaping rich rewards in improved client, consultant, and supplier relations, reduced "cost of quality", on time and within budget project completions, and a well informed and highly motivated team of staff.

Inspection traditionally has been one of the key attributes of a quality assurance/quality control system in the construction industry. Regarding inspection, Deming says, "Routine 100% inspection is the same thing as planning for defects - acknowledgement that the process cannot make the product correctly, or that the specifications made no sense in the first place. Quality comes not from inspection, but from improvement of the process" (Deming 1982). This does not mean that inspection ceases. Instead, it means that more effort is put into preventing errors and deficiencies.

The construction industry has been following a path that has led to lack of trust and confidence, adversarial relations, and increased arbitration and litigation. The industry has become increasingly reliant on burdensome specifications, which seldom says exactly what the owner intends them to say. This has led the owners to shift more of the risks to the contractors (Ahmed 1989). The net outcome is that the construction industry has been bogged down with paperwork, defensive posturing, and generally tends to have a hostile attitude towards the other participants.

TQM can help reverse this trend. Although, not a magic pill or panacea for all illnesses, it will, if properly implemented, help construction companies improve and will help all the parties come closer.

1. 2 OBJECTIVES OF STUDY

TQM places emphasis on prevention, not correction. The goal is work that is 100% free of errors, free of accidents, and 100% free of waste. The name of the game is to do things right the first time, eliminating waste and rework. To do this, it is necessary to focus on “processes.” Basically, a process is a task or a series of tasks. A process might be the vibration of fresh concrete, the fabrication of structural concrete, the preparation of a shop drawing, or a way in which the project manager deals with a client and with other members of the team (AGC 1993).

The primary objective of this study would be to develop a measurement model - with tools and methodologies for the identification and measurement of construction processes for customer satisfaction and continuous improvement. This in turn will lead to an overall improvement of quality, productivity and the competitiveness of the Florida construction industry as it enters into the twenty-first century. Specifically, the aims and objectives of this research project are to:

1. Investigate the adoption and implementation of TQM in the construction industry;
2. Determine the processes (“what to measure”) that are most suitable and appropriate for measurement during the construction project life-cycle and;
3. Develop a model (“how to measure”) for the measurement and evaluation of the quality performances of the construction processes identified in (2) above as a tool for continuous improvement.

1. 3 SCOPE OF STUDY

This project proposes to investigate the adoption and implementation of TQM in the Florida construction industry and develop a “measurement methodology” of construction processes for customer satisfaction and continuous improvement. The main thrust of this research project will be to identify “what” processes can be measured and “how” to measure them. To realize the above objectives, literature search, questionnaires and interviews will be used. The tools used in the measurement will be one or several of the “Tools of Total Quality” such as control and run charts, cause and effect diagrams, flowcharts, check sheets, Pareto diagrams, and histograms.

It is expected that this study will be of a pioneering nature. For the local construction industry, this project has the potential of demonstrating tangible benefits of using TQM in their organizations. This will be done by showing that quality improvement efforts can be quantified, measured, and analyzed - thereby enabling the construction company to continuously improve its products and services to meet and even exceed customer requirements.

1. 4 ORGANIZATION OF THE REPORT

The report is logically organized into six (6) chapters and appendices:

Chapter one is the introduction and is composed of background, objectives of study and scope of study.

Chapter two comprises literature review of all terminologies of TQM, Quality Evolution, Analysis of Management Characteristics, Historical Perspective of TQM, Critical Success Factors in TQM, General Model for Implementing TQM, Other Quality Systems and Quality Improvement Techniques.

Chapter three describes in detail the methodology followed in this research study.

Chapter four investigates the adoption and implementation of TQM in the construction industry based on the results of the first questionnaire.

Chapter five identifies the processes for improvement through a customer survey. The survey asked the customer to rate (on a scale of 1-5) the Construction Company on timely completion of project phases, adequacy of safety program, adherence to project budget, and quality of workmanship. From these customer satisfaction ratings, a customer satisfaction index was developed to measure the company's overall performance in the eyes of its customers. Based on the data obtained in the last step, a graphical tool in the form of a *cause and effect diagram* was used in studying and improving the processes to determine the root cause. Finally, a questionnaire was prepared to develop an improvement index.

Chapter six summarizes the conclusions of this study and recommendations for further research based on the research findings and insight developed during the course of this study.

The appendices include the four questionnaires and the entire material for the interviews.

CHAPTER 2

Literature Review

2. 1 BACKGROUND

For the last few decades Total Quality Management (TQM) techniques have been used extensively and beneficially in the area of manufacturing and industrial engineering to control process and prevent defects before they happen, ultimately saving millions of dollars. TQM focuses on the quality of management systems, not the management of quality, on continuous improvement of process in order to improve every facet of an organization. The implementation of TQM is fundamentally a process of culture change.

2. 2 TERMINOLOGIES

2. 2. 1 Quality

ISO 8402 defines quality as the degree of excellence in a competitive sense, such as reliability, serviceability, maintainability or even individual characteristics.

2. 2. 2 Quality Systems

Quality systems refer to the organizational structure, procedures, processes and resources needed to implement quality management.

2. 2. 3 Quality Assurance

Quality assurance is the planned and systematic activities implemented within quality system and demonstrated, as needed, to provide adequate confidence that an entity will fulfill requirements for quality.

2. 2. 4 Quality Control

Both ANSI and ISO define quality control as the operational technique and activity; for example, providing a means to control and measure the characteristics of a material, structure, component, or system that are used to fulfill requirements for quality.

2. 2. 5 Quality Management

Quality management refers to all activities of overall management functions, especially top management leadership, that determine quality policy objectives and responsibilities for all members of the organization.

2. 2. 6 Total Quality Management

Total quality management is the management approach of an organization, which concentrates on quality based on the participation of its members and aims at long-term success through satisfaction and benefits to all members of the organization and society (ISO 8402 and Griffin 1990).

2.3 QUALITY EVOLUTION

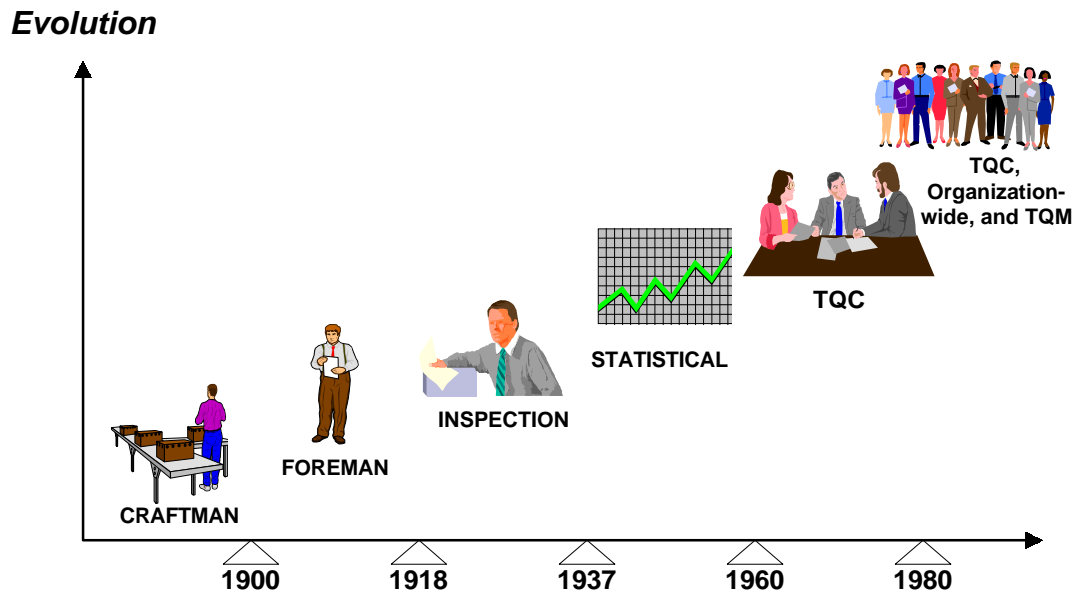


Fig. 2.1 Quality Control Evolution (Source: Feigenbaum (1991))

There are five stages in the evolution of quality control, as defined by Rounds and Chi (1984) and Feigenbaum (1991):

- Craftsman quality control was inherent in manufacturing up to the end of nineteenth century. At that time, a very small number of craftsmen were responsible for the manufacturing of a complete product and each craftsman exclusively controlled the quality of his work.
- Foreman quality control occurred during the industrial revolution when the large-scale modern factory concept developed. During this stage, many craftsmen performing similar tasks were grouped together and supervised by a foreman, who then assumed responsibility for the quality of their work.
- Inspection quality control evolved during the First World War when the manufacturing systems became more complex. Because a large number of craftsmen reported to each production foreman, full-time inspectors were required. This era peaked in the large organizations in between 1920s and 1930s.
- Statistical quality control flourished during the Second World War when tremendous mass production was necessary. In effect, this step was a refinement of the inspection step and resulted in making the large inspection organizations more efficient. Inspectors were provided with statistical tools such as sampling and control charts. W.A. Shewhart developed a statistical chart for the control of product variables in 1924, marking the beginning of statistical quality control. Later in the same decade, H.F. Hodge and H.G. Roming developed the concept of acceptance sampling as a substitute for 100% inspection; this was considered the most significant contribution of statistical quality control.

- Total quality control evolved in the early 1960s in a four-phase process. A dramatic increase in user quality requirements resulted in increasing customer demand for higher-quality products, leading the manufacturer to recognize the inadequacy of existing in-plant quality practices and techniques. All these contributed to excessive quality cost, due to such items as inspection, testing, laboratory checks, scrapping and reworking imperfect products, and customer dissatisfaction. These problems highlighted the dual quality challenge: Providing significant improvement in the quality of products and practices while at the same time, effecting substantial reductions in the overall cost of maintaining quality. Statistical quality control could never meet the challenge; thus, a totally new concept was developed based upon the principle that in order to provide genuine effectiveness, control must start with the design of the product and end only when the product has been placed in the hands of a customer who remains satisfied (Feigenbaum 1991).

2.4 CHARACTERISTICS OF THE CONSTRUCTION INDUSTRY

Construction works are carried out in the form of project. Projects are becoming progressively larger and more complex in terms of physical size and cost. In the modern world, the execution of a project requires the management of scarce resources; manpower, material, money, and machines to be managed throughout the life of the project – from conception to completion. The projects have five distinctive objectives to be managed: scope, organization, quality, cost and time (Fig. 2.4). Construction work requires different trades and knowledge but the management, scheduling, and control of those projects utilize the same tools and techniques, and are subject to constraints of time, cost, and quality. There are also unique characteristics of project, which differ from routine operations.

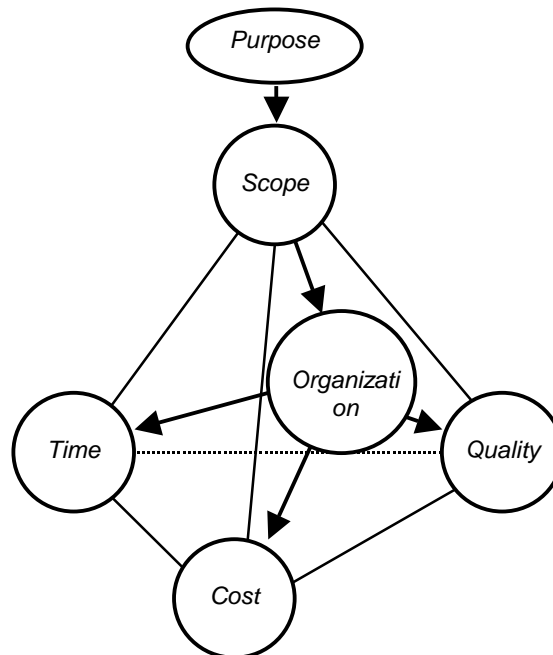


Fig. 2.4 Five Objectives of Project

2. 5 CRITICAL SUCCESS FACTORS IN TQM

TQM has gained widespread global acceptance. However, some have achieved remarkable success while others have suffered dismal failures. Many of the failures can be attributed to a misunderstanding of TQM or the way the organization had implemented TQM.

2. 5. 1 Customer Focus

In the TQM philosophy, total customer satisfaction is the goal of entire system, and a pervasive customer focus is what gets us there. The function of the construction industry is to provide customers with facilities that meet their needs. For a company to remain in business this service must be provided at a competitive cost. TQM is a management philosophy that effectively determines the needs of the customer and provides the framework, environment, and culture for meeting those needs at the lowest possible cost. By ensuring quality at each stage in the construction process, and thereby minimizing costly rework, as well as other costs, the quality of the final products should satisfy the final customer.

By definition, customers may be either internal or external. The external customer is the consumer or client, in other words the end user of the products or services being offered. An internal customer is a second process or department within the organization, which depends on the product of the first. For example, for designers the products are plans and specifications, and the customers are the owner and the contractor responsible for the construction. For the contractor, the product is the completed facility, and the customer is the final user of the facility. There are also customers within the construction organization. These internal customers receive products and information from other groups of individuals within their organization. Thus, satisfying the needs of these internal customers is an essential part of the process of supplying the final external customer with a quality product.

Every party in a process has three roles: supplier, processor, and customer. Juran defined this as the triple role concept. These three roles are carried out at every level of the construction process. The designer is a customer of owner. The designer produces the design and supplies plans and specifications to the contractor. Thus, the contractor is the designer's customer, who uses the designer's plan and specifications to carry out the construction process and supplies the completed facility to the owner. The owner supplies the requirements to the designer, receives the facility from the contractor, and is responsible for the facilities operation (Burati 1992). This clearly illustrates that construction is a process, and that TQM principles that have been applied to other processes are potentially adaptable to the construction industry. (Fig. 2.5)

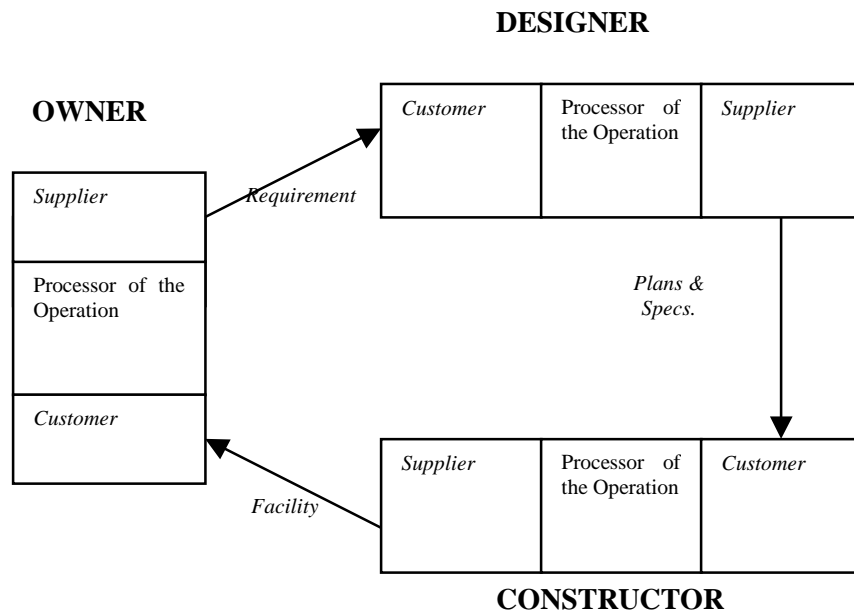


Fig. 2. 5 Juran's Triple Role Concept Applied to Construction

2. 5. 2 Process Improvement

A process is a way of getting things done. A process consists of the tasks, procedures and policies necessary to carry out an internal or external customer need (Adrian 1995). According to the TQM philosophy if the process is correct, so will be the end result (product). Thus the organization should work to improve the process so as to improve the end product or service.

Three different approaches have emerged for improving the efficiency or effectiveness of a process. Continuous improvement is an approach used on an ongoing basis for incremental gains. Benchmarking should be used periodically, and reengineering can be launched occasionally to achieve dramatic breakthrough.

By focusing on process by measurement and analysis, a process can possibly be improved by changing five M's of the process namely man, machine, material, method and measurement. A strong emphasis in process improvement centers on measurement of variation, the control of variation, and the knowledge of variation to seek improvement. This analysis is referred to as statistical process control or statistical analysis. This is at the center of process improvement. The objective of measuring the variation in a process is to learn how to control the variation and also how to improve the process by viewing variation as a tool for improvement. The analysis of the positive side (good performance or quality) of the variation of process is referred to as a "breakthrough improvement" or "breakthrough management" which is another key component of TQM. (Arditi and Gunaydin 1997)

2. 5. 3 Continuous Improvements

The goal of continuous improvement is common to many managerial theories, however, what differentiates TQM is that it specifies a specific step-by-step process to achieve this. This process consists of nine steps as below: Identify the process, Organize a multi-disciplinary team to study the process and recommend improvements, Define areas where data is needed, Collect data on the process, Analyze the collected data and brainstorm for improvement, Determine recommendations and methods of implementation, Implement the recommendations outlined in step six, Collect new data on the process after the proposed changes have been implemented to verify their effectiveness, and Circle back to step five and again analyze the data and brainstorm for further improvement.

The nine-step cycle emphasizes on: focusing the progress, measuring the process, brainstorming for improvement and verification and re-measurement. These four elements are further illustrated in Deming's Plan-Do-Check-Action (PDCA) diagram shown in Fig. 2.6. The PDCA diagram stresses removing the root cause of problems and continually establishing and revising new standards or goals. (Deming 1986)

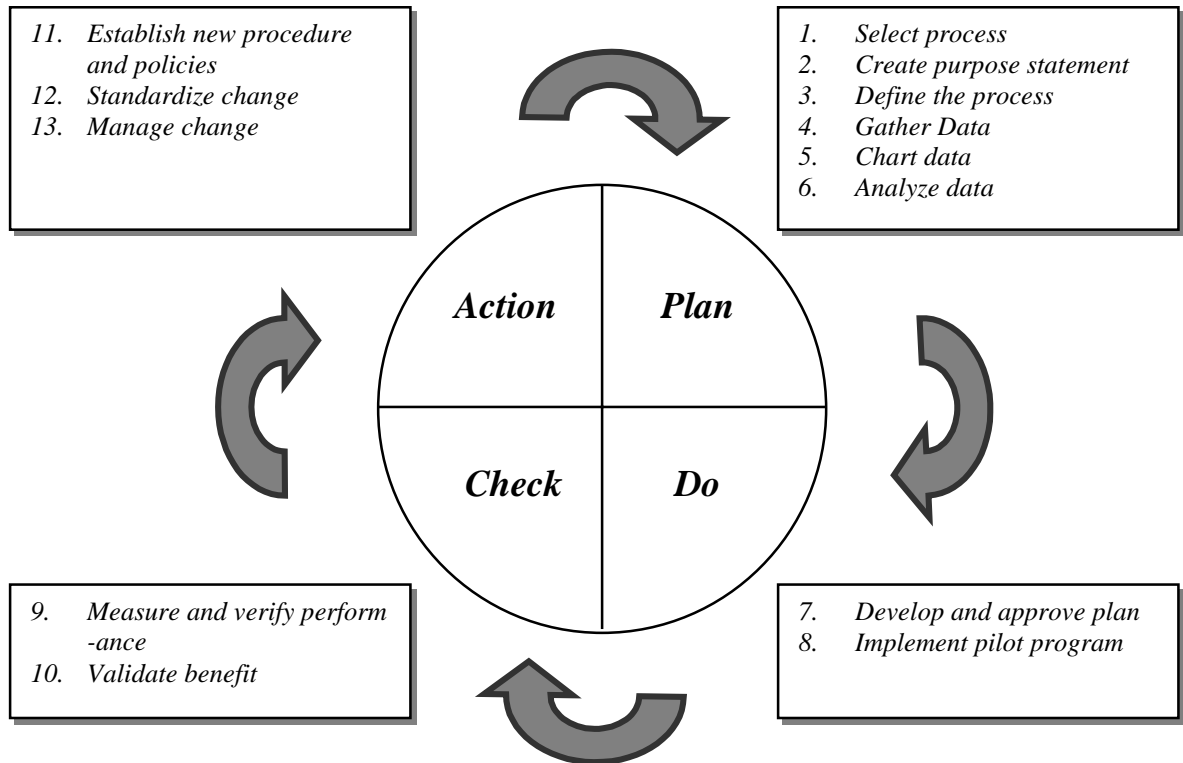


Fig. 2.6 The PDCA Diagram

Under TQM, management in the construction industry has two functions: (1) To maintain and improve current methods and procedures through process control and (2) To direct efforts to achieve, through innovation, major technological advances in construction processes.

The incremental improvement of the process is achieved through process improvement and control. In every construction organization there are major processes by which all the work is accomplished. However, there are innumerable parts in the construction process. Through the

use of flow diagrams, every process can be broken down into stages. Within each stage, input changes to output, and the methods and procedures directing the change of state (i.e. the construction procedures) can be constantly improved to better satisfy the customer at the next stage. During each stage the employees should communicate closely with their supplier and customer to optimize the work process for that stage. This requires each employee to recognize their place in the process and their respective supplier and customer.

2. 6 QUALITY IMPROVEMENT TECHNIQUES

Total Quality Management mainly demands a process of continued improvement aimed at reducing variability. An organization wishing to support and develop such a process needs to use quality management tools and techniques. It is prudent to start with the more simple tools and techniques: Check-sheet, Check list, Histogram, Pareto Diagram, Cause-and-Effect Diagram (Fishbone Diagram), Scatter Chart and Flowchart.

2. 6. 1 Check-sheet

Check-sheet is used to record events, or non-events (non-conformances). They can also include information such as the position where the event occurred and any known causes. They are usually prepared in advance and are completed by those who are carrying out the operations or monitoring their progress. The value of check-sheet can be retrospective analysis, so they help with problem identification and problem solving.

2. 6. 2 Checklist

Checklist is used to tell the user if there is a certain thing, which must be checked. As such, it can be used in the auditing of quality assurance and to follow the steps in a particular process

2. 6. 3 Histogram

Histogram provides a graphical representation of the individual measured values in a data set according to the frequency of occurrence. It helps to visualize the distribution of data and there are several forms, which should be recognized, and in this way they reveal the amount of variation within a process. It should be well designed so that people who carry out the operation can easily use them

2. 6. 4 Pareto Analysis

It is a technique employed to prioritize the problems so that attention is initially focused on those, having the greatest effect. It was discovered by an Italian economist, named Vilfredo Pareto, who observed how the vast majority of wealth (80%) was owned by relatively few of the population (20%). As a generalized rule for considering solutions to problems, Pareto analysis aims to identify the critical 20% of causes and to solve them as a priority.

2. 6. 5 Cause and Effect Diagram (Fishbone Diagram)

Cause and Effect Diagram, which was developed by Karo Ishikawa, is useful in breaking down the major causes of a particular problem. The shape of the diagram looks like the skeleton of a fish. This is because a process often has a multitude of tasks footing into it, any one of which may be a cause. If a problem occurs, it will have an effect on the process, so it will be necessary to consider the whole multitude of tasks when searching for a solution

2. 6. 6 Scatter Diagram

The relationship of two variables can be plotted in the scatter diagrams. They are easy to complete and obviously linear pattern reveals a strong correlation.

2. 6. 7 Flowcharts

Flow chart is used to provide a diagrammatic picture using a set of symbols. They are used to show all the steps or stages in a process project or sequence of events. A flowchart assists in documenting and describing a process so that it can be examined and improved. Analyzing the data collected on a flowchart can help to uncover irregularities and potential problem points.

CHAPTER 3

Methodology

This chapter discusses the methodology utilized to conduct this research study. The data for this research was collected through the use of four (4) questionnaires targeting contractors and clients in the state of Florida and other states to (1) investigate the adoption and implementation of TQM in the construction industry; (2) determine the areas or phases of construction with which the clients are dissatisfied, (3) use TQM tools to identify the major sub causes of client dissatisfaction areas and (4) finally develop an Improvement Index to determine the areas that need improvement. **The main objective as stated earlier is to demonstrate how a system can be developed for the continuous improvement of goods and services for optimal customer satisfaction.**

When it comes to measuring work process, the construction industry does not enjoy a good reputation. The problem, however, can be attributed to the nature of the industry, which lacks solid data gathering and the exceptional fluctuation in productivity. Data collected in a construction project usually lacks consistency in structure and compilation (Choi & Ibbs 1994). Those attempting to measure the performance of construction operations are bound to face difficulties such as incomplete or non-existent data. Unlike manufacturing (and service industry where TQM has been successfully adopted and implemented), the temporary nature of construction projects provides little incentive for structured data gathering and analysis. This in turn is bound to have a significant impact on the actual measurement process.

Since no accurate information regarding the extent of TQM usage in the local construction industry was available, as a **first objective** of this research project, the applicants (contractors and subcontractors) were asked to investigate and document the adoption and implementation of TQM in their business. Questionnaires were developed to elicit information about quality management practices in their businesses. The questionnaire was divided into six parts namely: their knowledge of TQM, their perception of quality, the data acquisition methods used by them, the degree of training provided to their employees towards TQM, and the obstacles faced by them in implementing TQM in their businesses.

The **second objective** of this research project was to determine the areas or phases of construction with which the clients are dissatisfied. The following method was used to identify these areas. A questionnaire called the Client Satisfaction Index was developed and was given to **several** clients and owners to get their feedback on the areas of dissatisfaction by conducting personal interviews with them. The questionnaire was divided into four parts namely: administrative, project management and engineering, construction and logistical. Each area had several activities, which were obtained from various technical papers, journals and existing projects. The clients were asked to identify the activities with which they are most dissatisfied. After reviewing their feedbacks, the major areas of client dissatisfaction were identified.

The **third objective** was to determine the major or important sub causes for the above areas of client dissatisfaction. This was important in order to achieve total quality by improving the identified sub causes. A questionnaire developed using a TQM tool called the *Fishbone Diagram* or the *Cause-and-Effect Diagram*, was sent to **several** contractors and subcontractors to identify the important sub causes. A rating scheme of *not important* to *very important* was used to achieve this purpose.

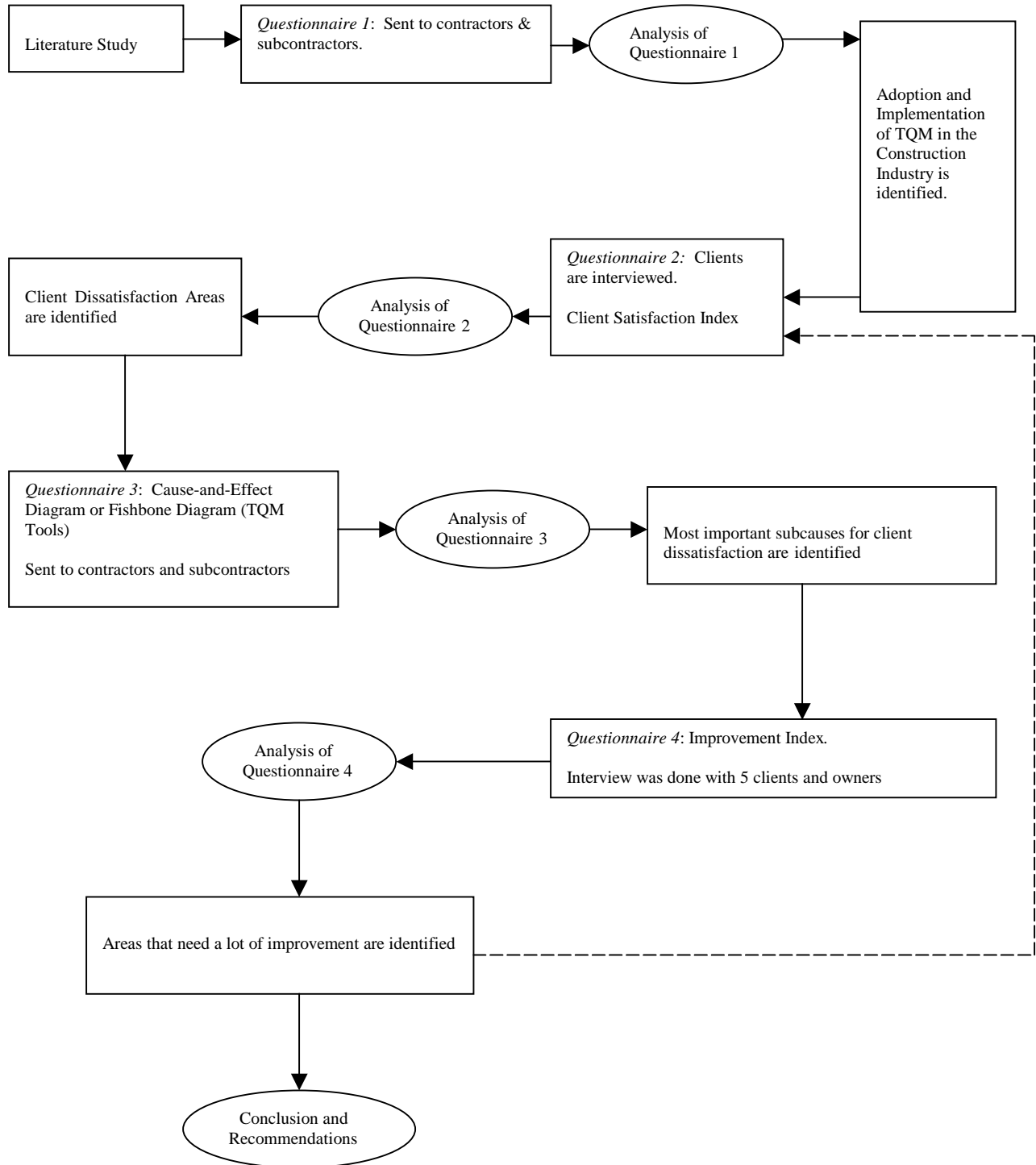
The **fourth objective** of this research project was to identify the areas, which need a lot of improvement in order to achieve total quality in all the areas of construction life cycle. For this

purpose a fourth questionnaire called the Improvement Index was developed and distributed to the same clients and owners who were interviewed for the questionnaire 2 (Client Satisfaction Index). The questionnaire was divided into five parts or areas of client dissatisfaction, which were identified from the second questionnaire. Under each area the most important sub causes that were obtained from the third questionnaire were highlighted. The clients were asked to identify the areas that need a lot of improvement. A rating scheme from *a lot of improvement* to *no improvement* was used for this purpose.

The areas that need a lot of improvement are identified. **The premise is that when those areas or phases are improved then we can attain continuous improvement in the construction industry.** This process is repeated until all the areas are improved and our goal of total quality management is achieved.

The next chapter investigates the adoption and implementation of TQM in the construction industry in the state of Florida and other states based on questionnaire #1, which was sent to approximately 450 construction companies nationwide.

Methodology Flowchart



CHAPTER 4

Adoption and Implementation of TQM in the Construction Industry

4.1 QUESTIONNAIRE # 1

In the previous chapter we discussed the methodology that was implemented to conduct this research project. In this chapter we will analyze the results of the first questionnaire, which deals with the knowledge of TQM within the Florida construction industry.

4.2 ANALYSIS OF QUESTIONNAIRE # 1 RESPONSE RATE

A questionnaire (Appendix A) was prepared to identify: the knowledge of TQM in the construction industry, the perception of quality, and, the methods adopted by the firms to measure customer satisfaction and continuous improvement. This questionnaire was sent to 300 contractors within Florida and 200 contractors and subcontractors outside Florida. 25 companies responded out of which 15 came from within Florida and 10 from outside Florida. The response rate was 5% from the contractors within Florida whereas it was 7% from the contractors outside Florida, which constituted an overall response rate of 6%. Although this research effort focuses on Florida construction industry, the author found that the respondents from within and outside Florida had almost identical views and observations. Therefore, the analysis presented below includes responses from all the contractors and subcontractors.

	Within Florida	Outside Florida	Total
Total Questionnaires sent	300	150	450
No. of Companies Responded	15	10	25
Response Rate	5%	7%	6%

Table 4.1 Breakout of Questionnaire # 1

4.3 ANALYSIS OF RESULTS OF QUESTIONNAIRE # 1

The following tables are the results gathered from Questionnaire #1- Adoption and Implementation of TQM in the Construction Industry, which is composed of 36 questions and divided in six sections as follows:

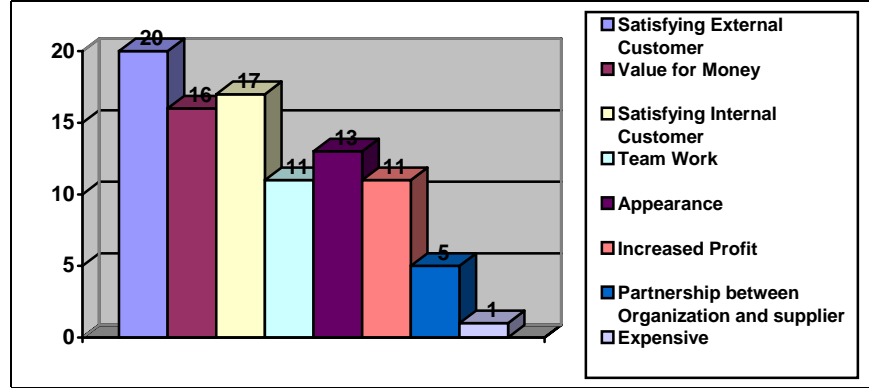
- Knowledge of TQM
- Your perception of Quality
- Data acquisition method
- Quality in your organization
- Training
- Others

In most of the cases the numbers represent the number of companies who gave response to the questions, in other cases an average and a percentage is used.

4. 3. 1 Knowledge of TQM

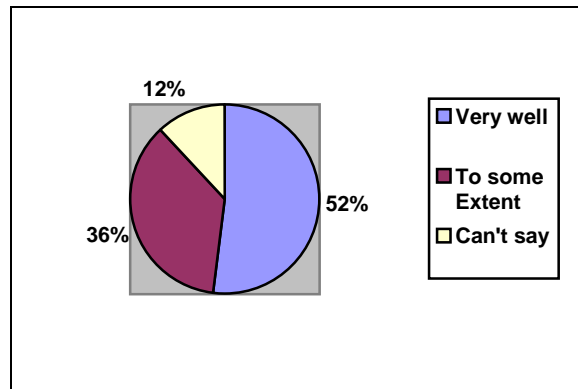
In this section, five questions were asked to evaluate the knowledge of TQM of the contractors in the Construction Industry. The results are as follows.

1. In your view, which of these words best define quality? (Not limited to one answer)



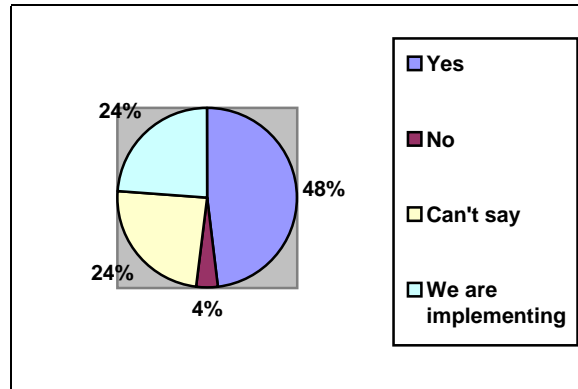
From the above chart, we can see that the majority (over 80%) of the contractors defined quality as satisfying external and internal customers and providing value for money. In other words, customer satisfaction must become the focus of corporate thinking.

2. Do you think that TQM will (or does) work in your organization?



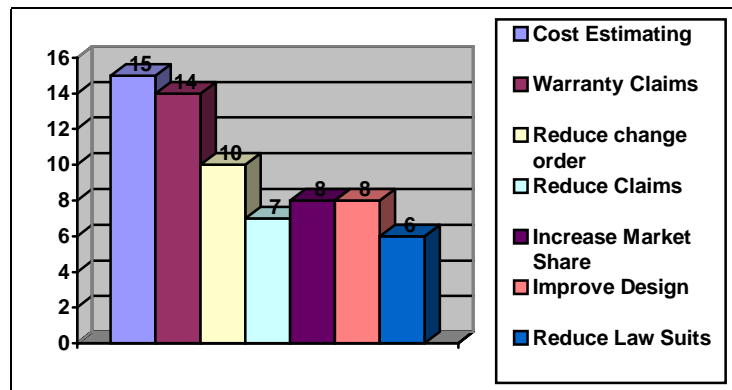
52% of the respondents feel that TQM will work very well in their organizations. 36% of them feel that it will work only to some extent in their organizations. A small minority was unsure about this question.

3. Will a TQM program be beneficial to your organization?



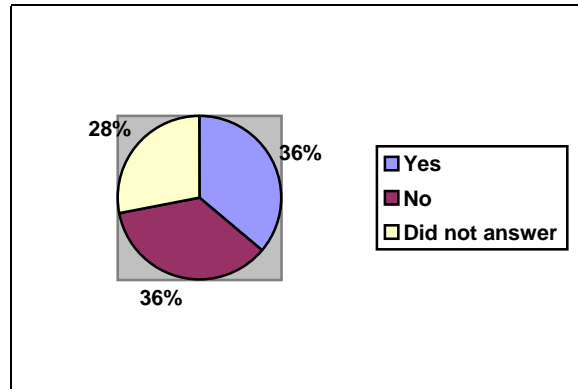
48% or 12 out of 25 respondents said that the TQM program would be beneficial to their organizations; only one contractor said that it is not going to be beneficial whereas 6 said that they are already implementing TQM in their organization.

4. TQM would be used to improve:



From the above chart we can interpret that most of the contractors feel that TQM can be used to improve cost estimating followed by warranty claims and reduce change orders. A small percentage of the respondents feel that TQM can be used to improve project design and reduce lawsuits.

5. Are you aware of any industry programs to implement TQM or the ISO 9000 standards?



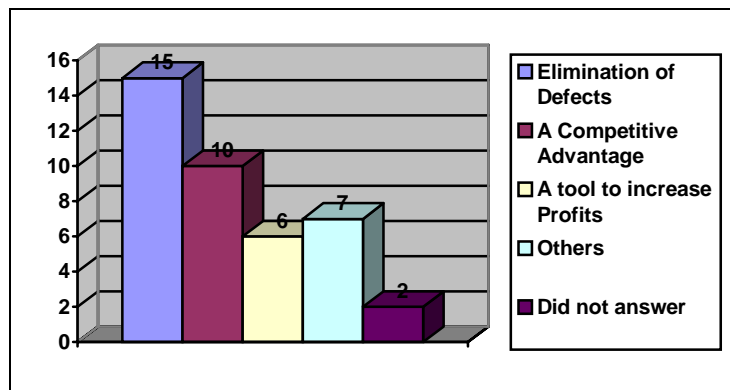
An equal number of respondents (36%) were either aware or unaware of any implementation programs of TQM. 28% chose not to answer this question.

The results from this section show that the majority of the contractors agreed that if a contractor satisfies his clients, the profits would increase in the long run. They feel that TQM will work very well in their organizations and not only that they felt that this program is going to be beneficial for their organizations. They are however not aware of any implementation programs. Most of them feel that TQM is a philosophy used to improve cost estimating and warranty claims. This shows their lack of knowledge about the TQM and the potential benefits in implementing this program in their organizations.

4. 3. 2 Perception of Quality

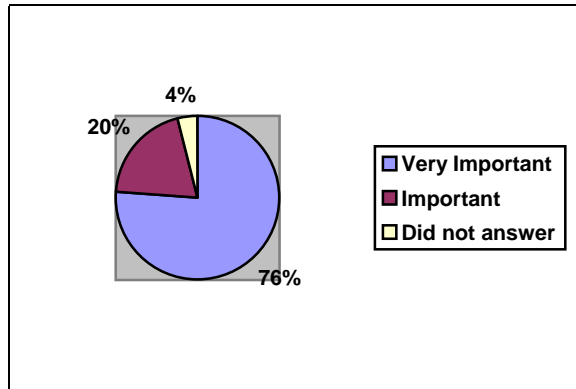
In this section, six questions were asked to evaluate the company’s perceptions of quality.

6. What is your organization’s perception of quality?



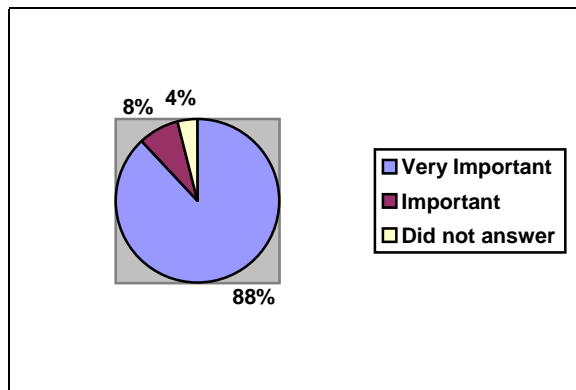
Majority of the respondents perceive ‘Quality’ as elimination of defects (60%). Very few (6 out of 25) respondents felt that ‘quality’ can be a tool to increase profits.

7. How would you rate the importance of product / service quality?



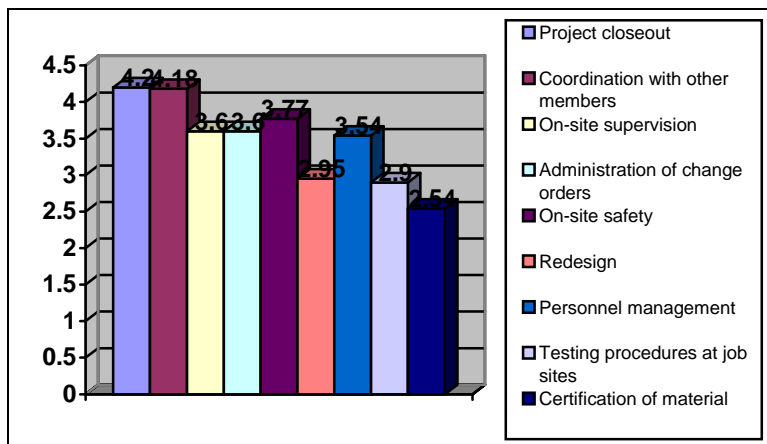
Product / service quality was ranked very high as is evident from the chart. They feel that if their product / service quality is good; it is going to satisfy the clients which will lead to higher profits.

8. How would you rate the significance of customer satisfaction:



The above data reveals that the majority (22 out of 25) of the respondents feel that customer satisfaction is very important.

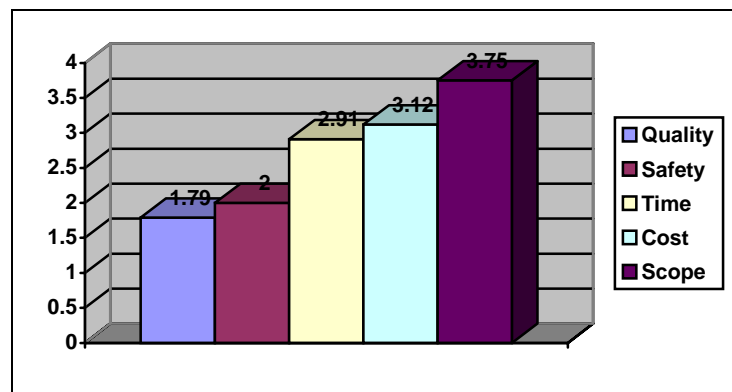
9. Please rate the potential for improvement within the following processes:



Rate the potential for improvement within the following processes	
	High = 5, Low = 1
Close-Out of Projects	4.24
Coordination with project members	4.18
On-Site Safety	3.77
Administration of Change Order	3.60
On- site Supervision	3.60
Personnel Management of Employees	3.54
Redesign	2.95
Testing Procedures at Job Sites	2.90

The above table shows the potential for improvement from the highest to the lowest - from Close-Out of Projects to Testing Procedures at Job Sites.

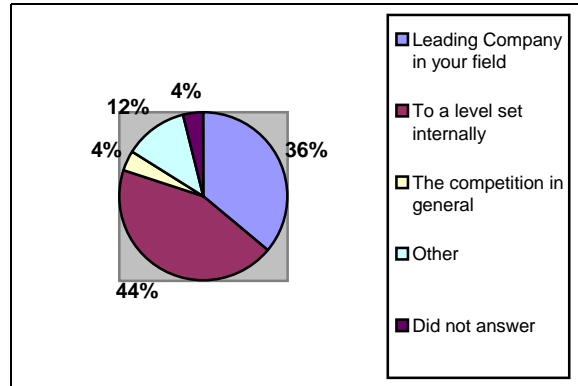
10. Please rank in order of importance:



One of the most interesting issues was the fact that when the companies were asked to rank in order of importance: Cost, Scope, Time (Schedule), Quality and Safety within the construction field, it was found that Quality occupied the last position. The following is the order of importance according to the survey:

1. Scope
2. Cost
3. Time
4. Safety
5. Quality

11. Do you set your quality goals to the level of:



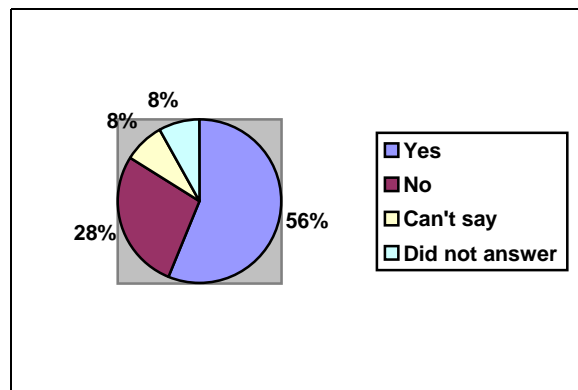
When the contactors were asked to identify one of the areas to which they set their quality goals to, 44% of them answered that they set their quality level internally. 36% said that they set their quality goal to the level of a leading company in their field.

The analysis of this section tells us that the majority of the contractors perceive quality as a competitive advantage next to elimination of defects. They feel that that product / service quality is very important for them in gaining customers satisfaction because it ultimately translates to higher profits for them. They feel that customer satisfaction is their main goal. Interestingly however, when they were asked to rank in the order of importance the following attributes: Quality, Safety, Time, Cost and Scope; they ranked scope and cost as the important considerations followed by Timeliness, Safety and Quality.

4. 3. 3 Data Acquisition Methods

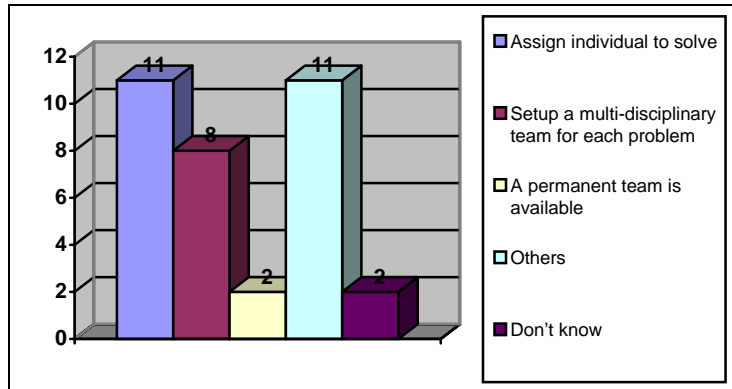
In this section eight questions were asked to know how they gather information.

12. Do you collect data to measure the performance of operations?



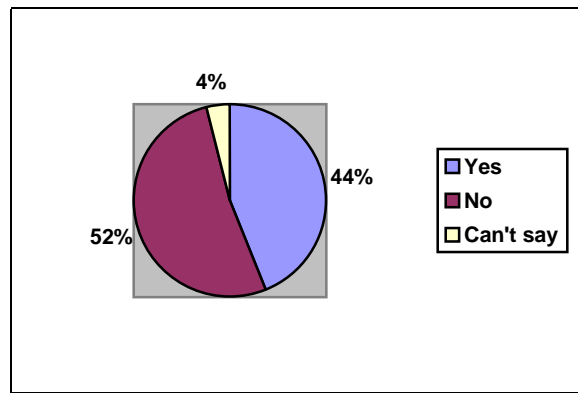
The results show that the majority of the companies do collect data to measure the performance of operations.

13. How does your Organization solve problems?



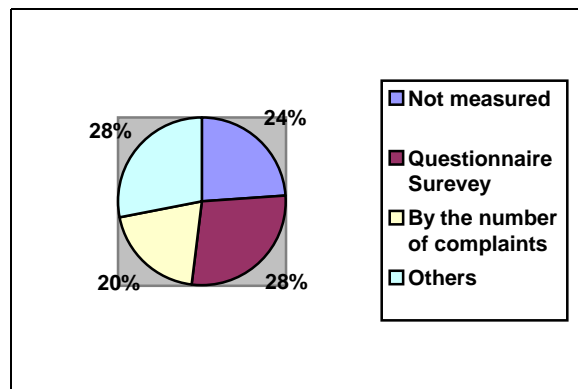
When they were asked how would their organization solve problems, 44% of them said that they assign an individual to solve where as the other half said that they have other ways of solving the problems.

14. Do you have a system for gathering customer suggestions?



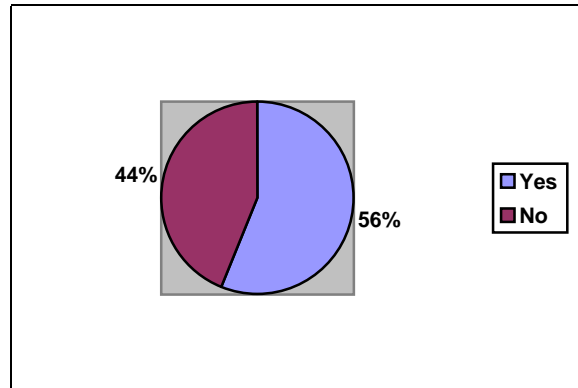
The above graph depicts that 52% of the companies have a system for gathering customer suggestions whereas 44% do not.

15. How do you measure customer satisfaction?



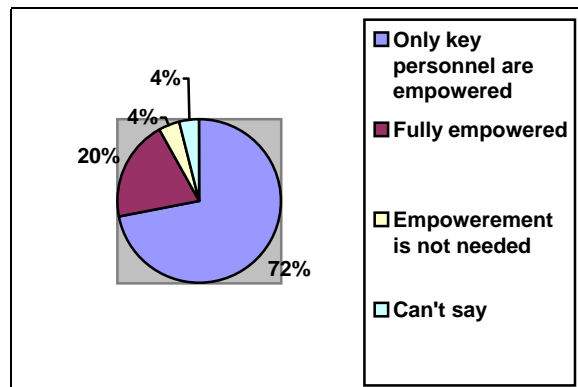
28% measure customer satisfaction through questionnaire surveys, 20% by the number of complaints and 28% by various other methods.

16. Do you have a system for gathering employee suggestions?



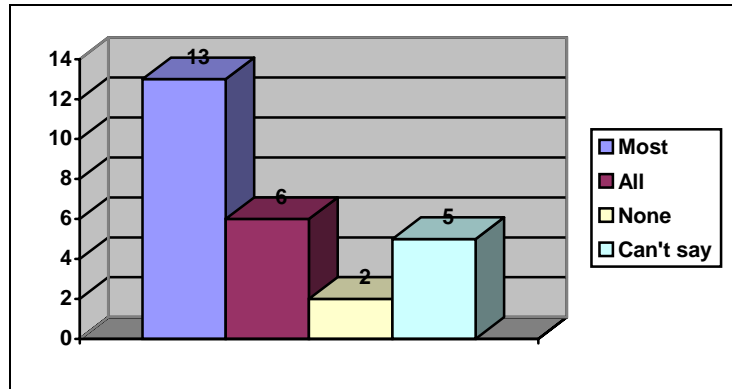
56% have a system for gathering employee suggestions whereas 44% do not.

17. Are employees empowered to make significant changes to operations?



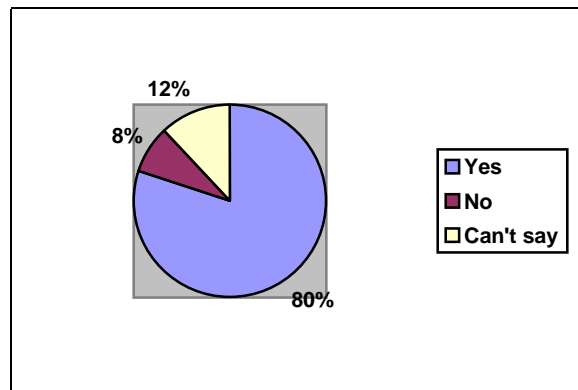
When they were asked whether their employees are empowered to make significant changes to operations, 72% said that only certain key personnel are empowered in their organization to make any significant changes whereas 20% of them said that their employees are fully empowered.

18. Are suppliers/subcontractors rated?



52% of the contractors (13 out of 25) said that they rate most of their suppliers and subcontractors where as 24% (6 out of 25) said that they rate all of their suppliers and contractors.

19. Defects in services are identified and subcontractors are required to pay for or correct them:

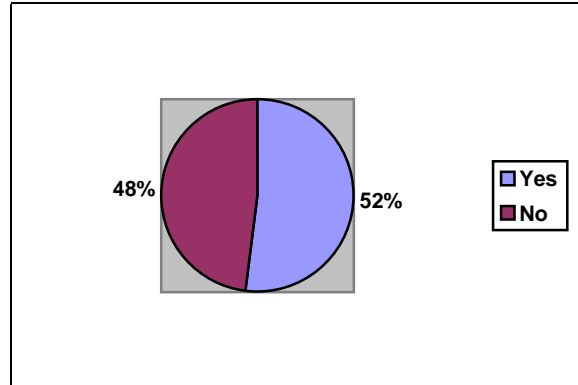


The results of this section show that the majority of the companies do collect data to measure the performance of operations and the way they solve problems is assigning an individual to solve them. On the other hand, 52% of the companies have a system for gathering customer suggestions but just 28% measure customer satisfaction through questionnaire surveys. 20% gather customer suggestions by the number of complaints or other methods. In most of the cases the suppliers and the subcontractor are rated (52%) and when defects in services are identified, they are required to pay for or correct them.

4.3.4 Quality in their organization

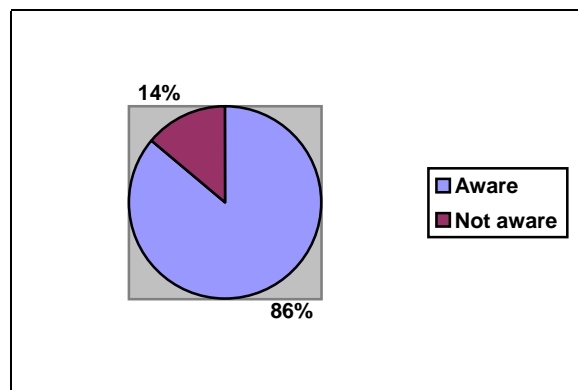
In this section, contractors were asked 12 questions to find out about quality in their organizations.

20. Has your organization developed a clear definition of quality?



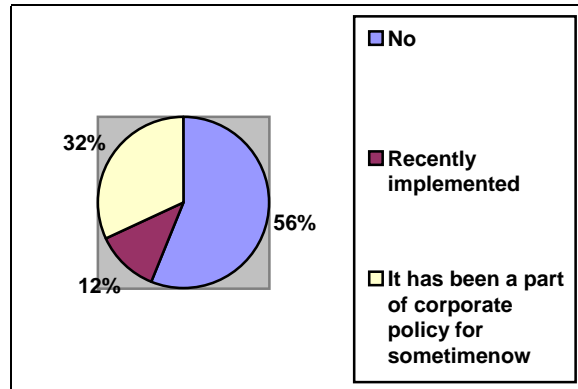
In this question contractors were asked whether they developed a clear definition of quality in their organizations, the responses for this tells us that only 52% did whereas the other half did not.

21. Percentage of employees who are aware of the importance of quality?



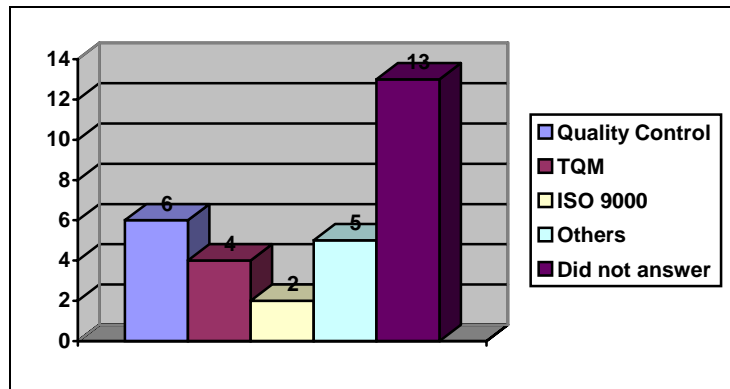
Although 52% of the organizations have developed a clear definition of quality, 86% of the employees in those companies are aware of the importance of quality within the construction field.

22. Does your organization have a quality improvement program?



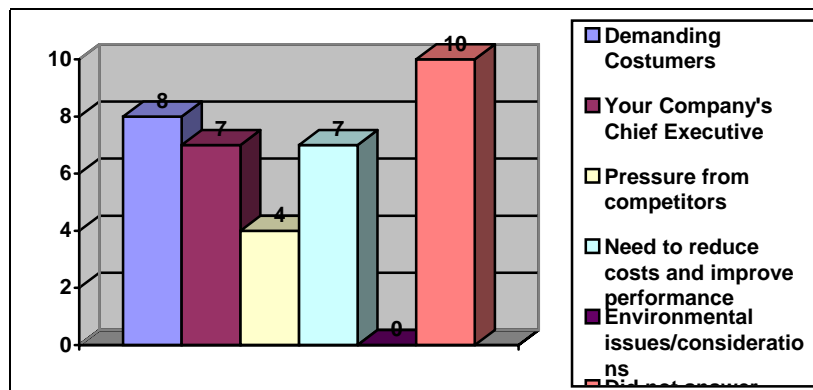
Majority of the organizations don't have a quality improvement program.

23. What type of quality improvement program do you have?



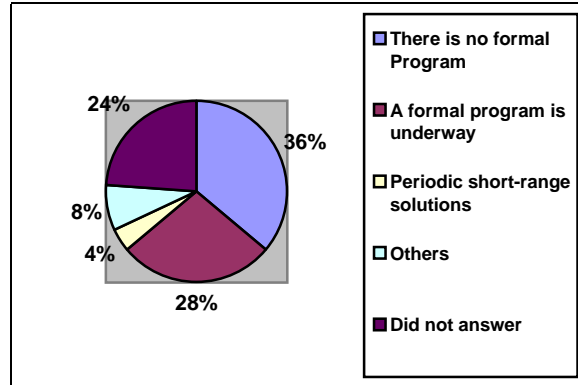
52% of them do not have a quality improvement program, only 12% have a program and the types of quality improvement programs used are quality control (24%), Total Quality Management (16%) and 8% said they use ISO 9000.

24. Which of the following factors provided the motivation to start TQM



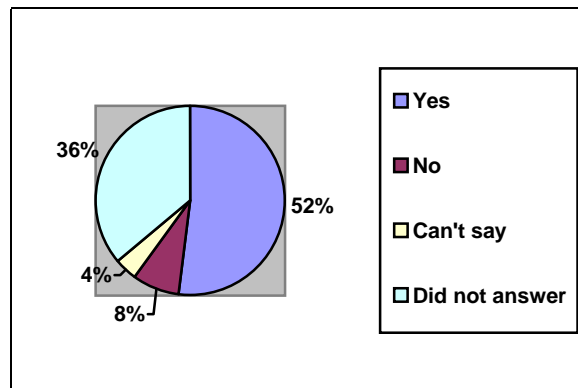
10 out of 25 respondents said that demanding customers is one of the main reasons that provided the motivation to start Total Quality Management program. Other factors are pressure from competitors (16%) and company’s Chief Executives’ commitment (28%).

25. Your organization’s quality improvement program can be described as:



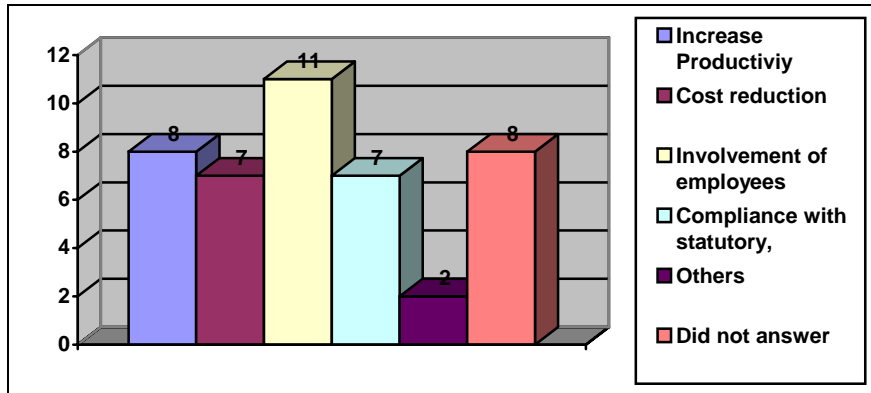
36% of the contractors said that they do not have any Quality Improvement Program (QIP) in their organizations while 28% said that they do have a formal QIP underway in their organizations.

26. Does your QIP have the full support of top management?



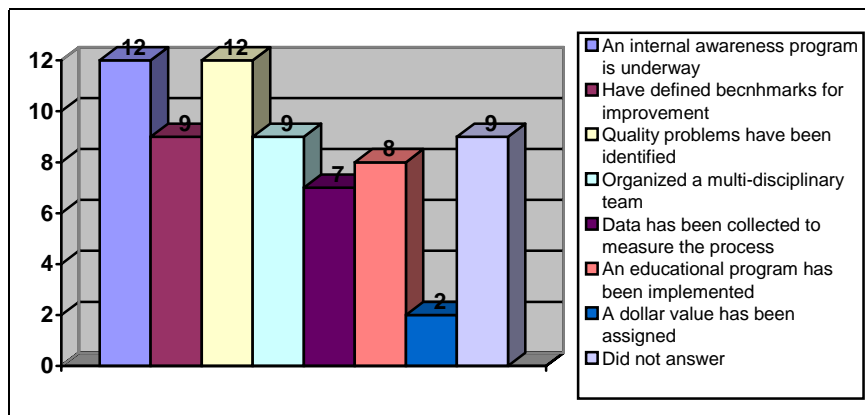
Although majority of the organizations do not have a QIP in their company, those that do said that they have the full support of the top management of their plan. 36% did not answer.

27. The major objectives of your quality programs are:



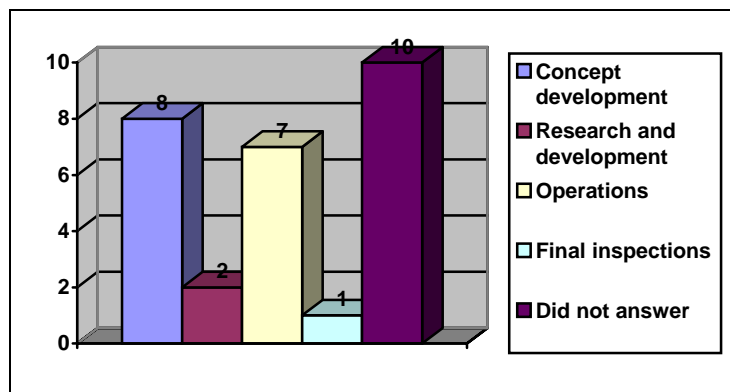
44% (11 of 25) said that that employee involvement was the main objective followed by increased productivity and cost reduction.

28. Steps taken in your quality improvement plan include:

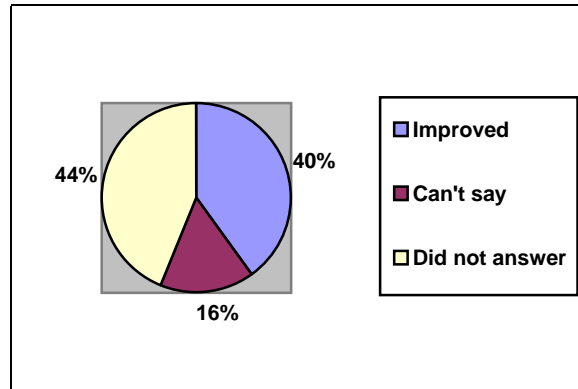


12 out of 25 respondents said that creating an internal awareness program and identifying quality problems are the two major steps they have taken in their quality improvement plan.

29. Quality is first incorporated in the project at:

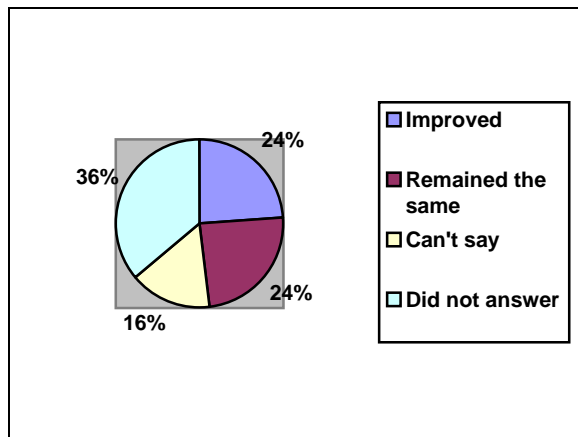


30. After the implementation of your quality improvement program, service / product quality has:



These two figures tell us that after the implementation of a quality improvement program in their companies, the service quality as well the relationship with customers and suppliers has improved

31. After the implementation of your quality improvement program, relationship with your customers and suppliers has:

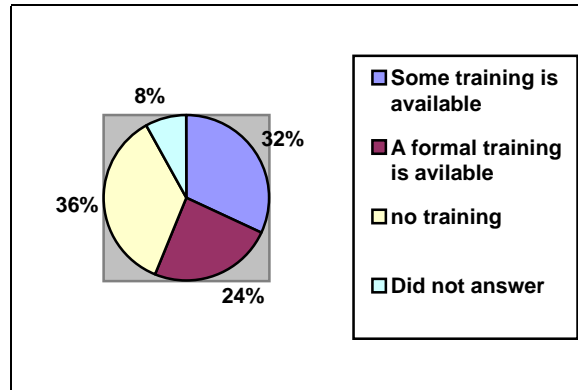


In summary, we observe from this section that although only about 50% of the contractors surveyed had a clear definition of quality in their organizations, 86% are aware of the importance of quality. The majority of the respondents said that they do not have a formal Quality Improvement Program (QIP) in place. Those that do, however, have the full support of their top management. Also, they use a mix of Quality Control, TQM and ISO 9000 principles in their QIP. Demanding customers, CEO commitment and competitive pressures were identified as the key reasons for implementing the quality improvement programs. Main objectives of the QIP are employee involvement followed by increasing productivity and cost reduction. 40% of the contractors felt that the quality of their products and services improved after implementing such a program.

4. 3. 5 Training

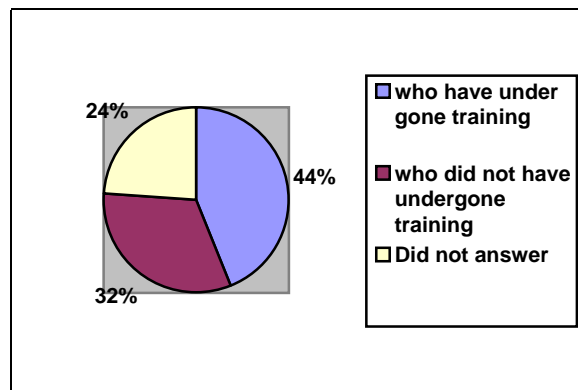
In this section, contractors were asked 4 questions to find out about the training they provide to their employees in their organizations.

32. Is formal training in TQM or other quality improvement philosophies given to employees?



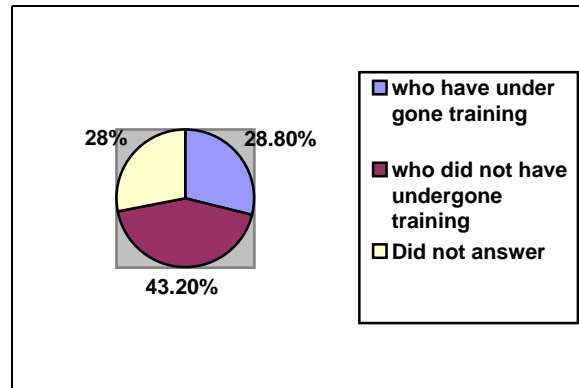
58% of the companies provide some to no training to their employees. Only 24% said that they provide formal training in TQM or other quality improvement philosophies.

33. Percentage of managerial / supervisory staff who have undergone quality improvement training:



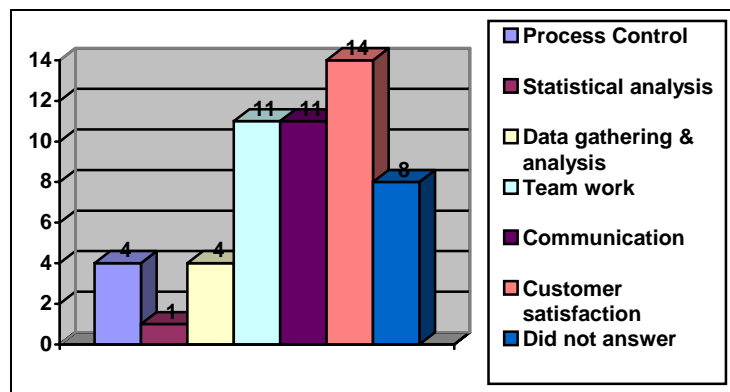
44% of the contractors said that their managerial/supervisory staff have undergone quality improvement training.

34. Percentage of non-managerial / technical staff who have undergone quality improvement training:



The number is even lower for non-managerial positions (29%).

35. Training currently emphasizes:



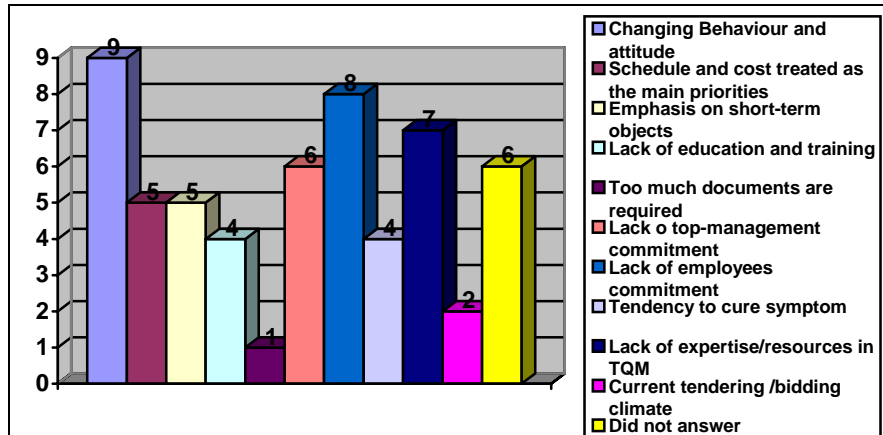
Training programs mostly emphasize customer satisfaction as a primary goal followed by teamwork and communication.

4. 3. 6 Others

The following shows the obstacles in the implementation of Total Quality Management Program - most important to least important based on the data gathered.

1. Changing behavior and attitude
2. Lack of expertise/resources in TQM
3. Lack of employee commitment/understanding
4. Lack of education and training to drive the improvement process
5. Schedule and cost treated as the main priorities
6. Emphasis on short-term objects
7. Tendency to cure symptom rather than getting to the root cause of a problem
8. Too many documents are required (lack of documentation ability)

36. Obstacles in the implementation of TQM program:



The next chapter explains and analyzes the results of the remaining three questionnaires of this research project, which are Customer Satisfaction Index, Cause-and-Effect or Fishbone Diagram and Improvement Index.

CHAPTER 5

Client Satisfaction Index, Cause-and-Effect Diagram and Improvement Index

5.1 QUESTIONNAIRE # 2 (CLIENT SATISFACTION INDEX)

A second questionnaire focusing on the customer was created to identify the processes for improvement. It was called “Client Satisfaction Index” (Appendix B). A client survey is an invaluable aid in determining how well a construction company is doing in meeting customer’s expectations. The real value of the survey was that it identified areas for improvement. The customer satisfaction index is the measurement of a company’s overall performance in the eyes of its customers.

The survey asked the customer to rate the construction company in several categories such as timeliness, safety, budget, cleanliness, cooperation, workmanship, etc. These categories were identified through a detailed review of published technical papers, trade journals and existing projects.

This questionnaire was prepared after analyzing the results of the first questionnaire and reference from books. The questionnaire was divided in four sections: Administrative, Project Management and Engineering, Logistical and Construction. A rating scheme was used ranging from strongly satisfied to strongly dissatisfied.

5.2 QUESTIONNAIRE RESPONSE RATE

Based on the checklist developed, a detailed questionnaire was prepared (as shown in Appendix B) and a total of eight (8) interviews were conducted with the owners and clients within Florida.

5.3 CLIENT SATISFACTION IDENTIFICATION

The critical problems related to client dissatisfaction are shown in tables 5.1, 5.2, 5.3 and 5.4. Each table categorizes the problem in each section based on the percentage of the responses.

Table 5.1					
Administrative	Strongly Satisfied	Satisfied	Neither Satisfied nor Dissatisfied	Dissatisfied	Strongly Dissatisfied
1) Relationship between parties	18.18%	54.55%	18.18%	9.09%	0.00%
2) Adequacy of office personnel	18.18%	63.64%	9.09%	9.09%	0.00%
3) Project Cost within the Budget	0.00%	72.73%	18.18%	9.09%	0.00%
4) Knowledge of client needs	18.18%	54.55%	27.27%	9.09%	0.00%
5) Attention to client priorities	9.09%	63.64%	0.00%	27.27%	0.00%
6) Adequacy of supervision	9.09%	36.36%	45.45%	9.09%	0.00%
7) Coordination with regulatory agencies	18.18%	63.64%	9.09%	9.09%	0.00%
8) Adequacy of planning	0.00%	63.64%	9.09%	27.27%	0.00%
9) Adequacy of Training	0.00%	54.55%	27.27%	18.18%	0.00%
10) Customer Satisfaction	18.18%	54.55%	27.27%	0.00%	0.00%

In the above Table 5.1, (clients are dissatisfied with: a) attention to client priorities (27.27%), and b) adequacy of planning (27.27%).

Project Management and Engineering	Strongly Satisfied	Satisfied	Neither Satisfied nor Dissatisfied	Dissatisfied	Strongly Dissatisfied
1) Progress Review Meetings	27. 27%	36. 36%	36. 36%	0. 00%	0. 00%
2) Adequacy of Project Control	27. 27%	36. 36%	36. 36%	0. 00%	0. 00%
3) Adequacy of Safety Program	18. 18%	45. 45%	27. 27%	9. 09%	0. 00%
4) Estimating	27. 27%	45. 45%	18. 18%	9. 09%	0. 00%
5) Interaction With Architect/Engineer	27. 27%	45. 45%	9. 09%	18. 18%	0. 00%
6) Scheduling	9. 09%	45. 45%	9. 09%	36. 36%	0. 00%
7) Adequacy of supervision	27. 27%	36. 36%	36. 36%	0. 00%	0. 00%
8) Shop drawing review	9. 09%	45. 45%	45. 45%	0. 00%	0. 00%
9) Adequacy of planning	27. 27%	9. 09%	45. 45%	18. 18%	0. 00%
10) Adequacy of subcontractor selection	18. 18%	18. 18%	45. 45%	0. 00%	0. 00%

In table 5. 2 which is related to Project Management and Engineering, the clients are dissatisfied with **scheduling (36. 36%)**

Logistical	Strongly Satisfied	Satisfied	Neither Satisfied nor Dissatisfied	Dissatisfied	Strongly Dissatisfied
1) Adequacy of Storage	0. 00%	45. 45%	45. 45%	9. 09%	0. 00%
2) Adequacy of Warehousing	9. 09%	45. 45%	27. 27%	9. 09%	9. 09%
3) Adequacy of Delivery	9. 09%	54. 45%	18. 18%	18. 18%	9. 09%
4) Adequacy of Maintenance	9. 09%	45. 45%	36. 36%	9. 09%	0. 00%

In table 5.3 the clients are dissatisfied with **adequacy of delivery (18. 18%)**.

Construction	Strongly Satisfied	Satisfied	Neither Satisfied nor Dissatisfied	Dissatisfied	Strongly Dissatisfied
1) Project Quality	27. 27%	63. 64%	9. 09%	0. 00%	0. 00%
2) Adequacy of job site personnel	18. 18%	45. 45%	27. 27%	9. 09%	0. 00%
3) Material Quality	36. 36%	54. 55%	9. 09%	0. 00%	0. 00%
4) Quality of workmanship	18. 18%	54. 55%	18. 18%	9. 09%	0. 00%
5) Equipment Quality	18. 18%	36. 36%	36. 36%	9. 09%	0. 00%
6) Timely completion of project phases	9. 09%	45. 45%	36. 36%	9. 09%	0. 00%
7) Knowledge of the project	27. 27%	72. 73%	0. 00%	0. 00%	0. 00%
8) Site cleanliness	0. 00%	36. 36%	45. 45%	18. 18%	0. 00%
9) Adequacy of processing change Orders	0. 00%	22. 22%	33. 33%	33. 33%	11. 11%
10) Project closeout	0. 00%	44. 44%	44. 44%	11. 11%	0. 00%

In the above table (Table 5. 4), which is related to Construction the clients were mainly dissatisfied with **adequacy of processing change orders (33. 33%)**.

From the above identified processes with which the clients are generally dissatisfied, a new questionnaire was prepared using a TQM tool, called the Cause-and-Effect Diagram (Fishbone Diagram) that is explained in the coming paragraphs.

5. 4 QUESTIONNAIRE # 3 (CAUSE-AND-EFFECT DIAGRAM)

Based on the client satisfaction index, five sets of questionnaires (Appendix C) using the Cause and Effect Diagram were developed to investigate the problems related to client dissatisfaction. They are:

1. Poor planning
2. Lack of attention to client priorities
3. Poor scheduling
4. Inadequate change orders processing
5. Poor delivery schedule and methods

Once these five main causes of client dissatisfaction were known, the many sub causes, which contribute to the main causes were then identified through literature review and personal knowledge and experience of the author.

5. 4. 1 Poor Planning (Fig. 5. 1)

The root causes for poor planning are as follows:

- a. Labor
 - Productivity, subcontractors and quality of workmanship affect labor
- b. Equipment
 - Theft, supervision and damage are the main causes for poor quality of equipment
- c. Materials
 - Suppliers of materials and their quality affect material management
- d. Time
 - Design errors, changes in weather conditions and change orders are the leading causes for time related delays.
- e. Money - The following are the main subcauses:
 - Inflation
 - Funds
 - Interest rates
 - Loans
 - Cost Estimation
 - Cash Flow

5. 4. 2 Lack of Attention to Client Priorities (Fig. 5. 2)

The root causes for lack of attention to client priorities are:

- a. Coordination
 - The relationship between owner and contractor, contractor and subcontractor, and contractor and designer is very important for proper coordination during a project.
- b. Supervision
 - The supervision of shop drawings, specifications and design affect relationship with the clients.

- c. People
 - Training given to employees, their experience and the instructions affect the relationship with their client.
- d. Controlling - The following are the main subcauses:
 - Budget
 - Suppliers
 - Quality
 - Time
 - Subcontractors

5. 4. 3 Poor Scheduling (Fig. 5. 3)

Poor scheduling is caused by:

- a. Network Model
 - The network model is the most important part of scheduling. Activities and their relationship form the basis of a network model. Lack of attention to the network model results in a bad schedule.
- b. Communication
 - The communication between the estimating department, superintendent and the project manager is very important in putting up a realistic and workable schedule.
- c. Design:
 - The causes for bad design are:
 - Defectiveness
 - Incomplete design
 - Omissions
- d. Site Conditions
 - The features of the site like soil boring data and depth of water table should be tested in the lab before work on the site commences. Supervision of the site should be carried out at all times.

5. 4. 4 Processing Change Orders (Fig. 5. 4)

- a. Materials
 - Change orders are caused by defectiveness in materials and equipment and the availability of the materials and equipment.
- b. Weather Conditions
 - Floods and hurricanes are the common causes for delays in a project.
- c. Clients
 - A good percentage of change orders are initiated by the clients themselves
- d. Design
 - A change in design results in change orders. Clients or differing site conditions mainly cause these changes.
- e. Construction: Change orders result when there is a change in design, material or type of construction. These changes are caused by:
 - Omission in design
 - Unrealistic schedule
 - Errors in design
 - Equipment failure
 - Differing site conditions

5. 4. 5 Poor Delivery (Fig. 5. 5)

Poor delivery are caused by:

- a. Suppliers
 - Suppliers are the main cause for poor delivery of materials and equipments. Availability of materials and equipments are the main cause for this.
- b. Scheduler
 - Delay in schedule results in ordering of key materials and equipments for the site late. This delay is sometimes caused by improper input from the subcontractors.
- c. Method
 - Ambiguity in the method of delivery of materials and equipments delays the project, which results in client dissatisfaction.
- d. Procurement Department
 - Change orders and bureaucracy in the procurement department also result in poor delivery of materials and equipment.

5.5 ANALYSIS OF THE RESULTS OF QUESTIONNAIRE # 3

Based on the above analysis, the Cause and Effect diagram was developed and presented to five contractors for their detailed input. They were asked to identify the very important subcauses for the various causes of client dissatisfaction (Poor Planning, Lack of Attention to Client Priorities, Poor Scheduling, Poor Processing of Change Orders, and Poor Delivery) discussed earlier.

A rating scheme was used from Not Important (1) to Moderately Important (2,3,4) to Very Important (5). From the analysis of the results of the Fishbone diagram (Table 5.5, 5.6, 5.7, 5.8 and 5.9) we identified the very important subcauses from the other subcauses. They are:

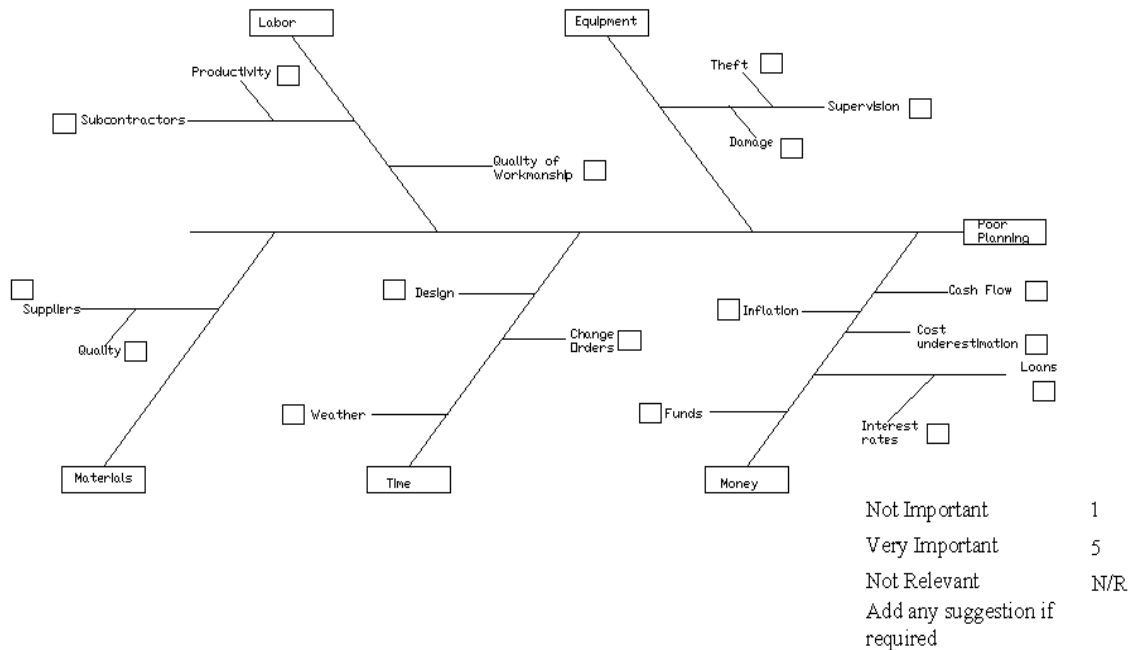


Fig. 5. 1 Administrative – Poor Planning

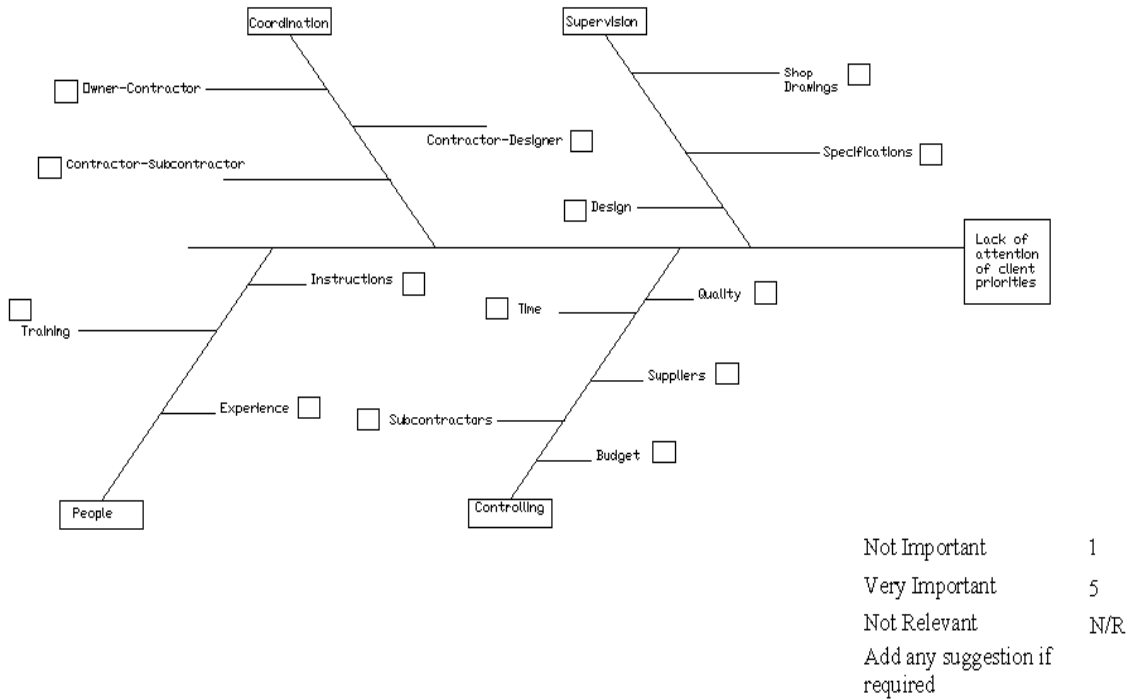


Fig. 5. 2 Administrative – Lack of Attention to Client Priorities

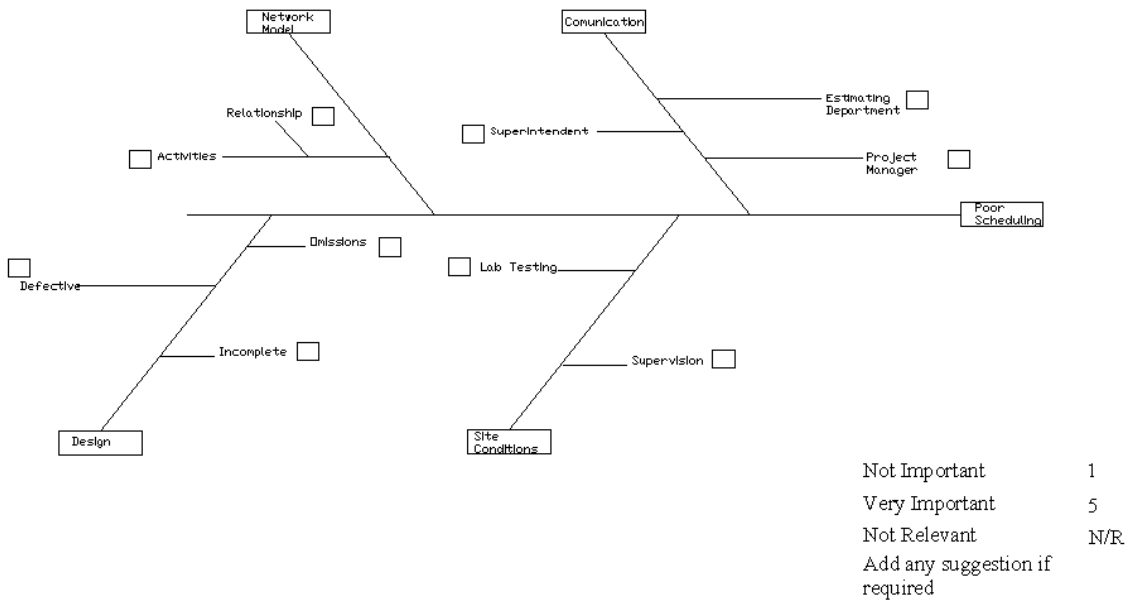


Fig. 5. 3 Project Management and Engineering – Poor Scheduling

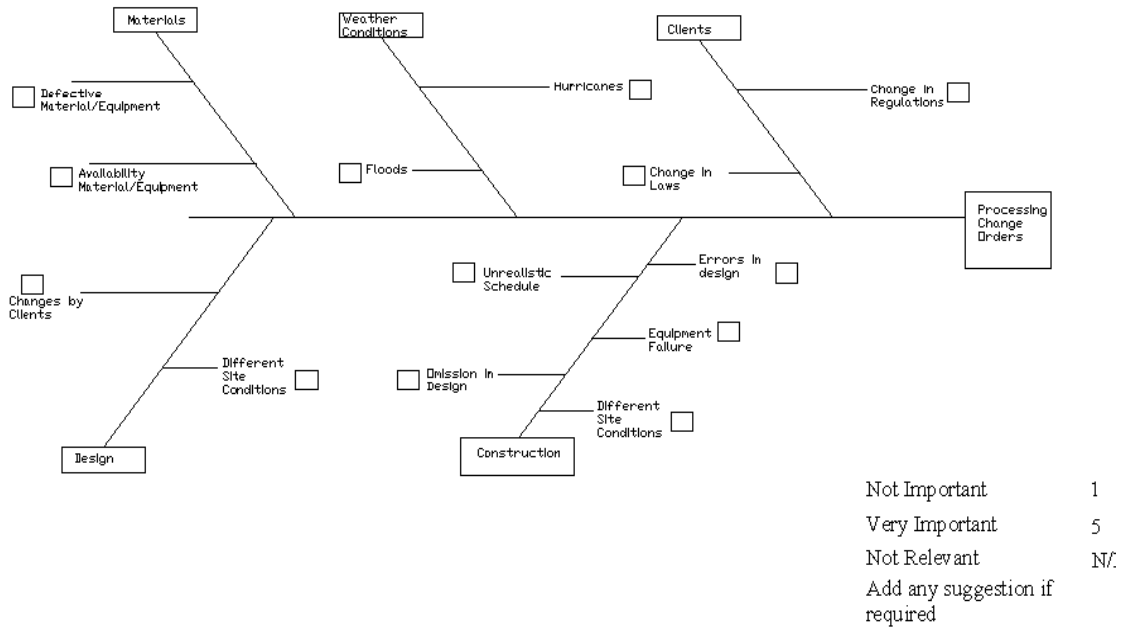


Fig. 5. 4 Construction – Processing Change Orders

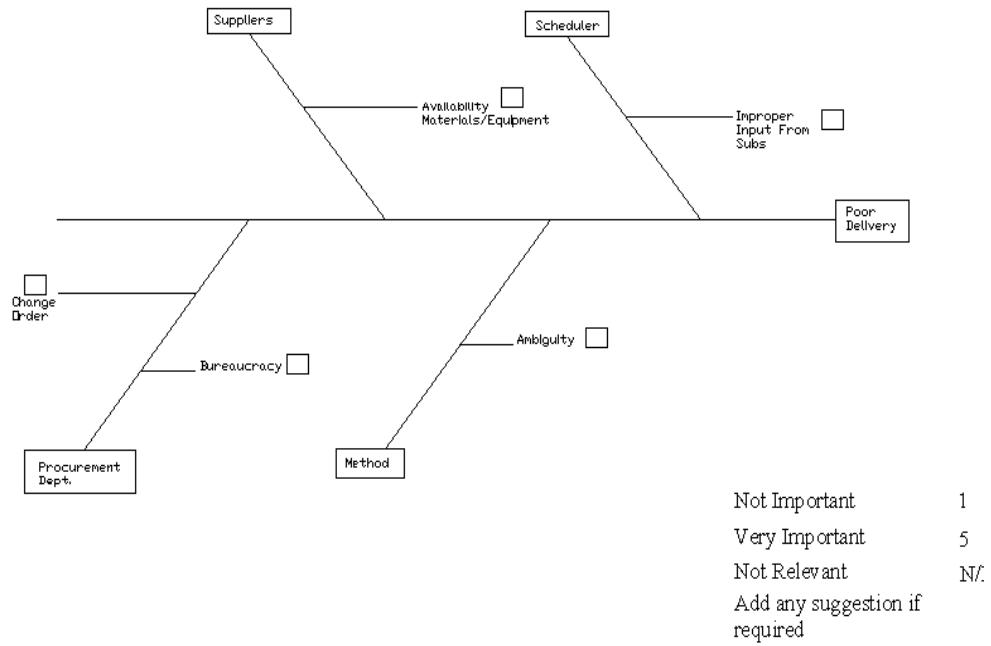


Fig. 5. 5 Logistical – Poor Delivery

1. Poor Planning (**Table 5. 5**)
 - Quality of Material
 - Manage Change Orders
 - Cash Flow Analysis
 - Construction Underestimation
 - Quality of Workmanship
 - Damage to Equipment

2. Lack of Attention to Client Priorities (**Table 5. 6**)
 - Training of Personnel
 - Cost Control
 - Quality Control
 - Contractor-Subcontractor Coordination
 - Conformance to Specifications

3. Poor Scheduling (**Table 5. 7**)
 - Incomplete Design
 - Site Condition Supervision
 - Project Management Coordination
 - Network Model Selection

4. Processing Change Orders (**Table 5. 8**)
 - Design Changes by Clients
 - Errors in Construction Design
 - Defective Material/Equipment
 - Weather Delays

5. Poor Delivery (**Table 5. 9**)
 - Change Orders from Procurement Department
 - Ambiguity in Methods
 - Availability of Materials/Equipments

Table 5.5 - Poor Planning			
1. Equipment	Not Important (1)	Moderately Important (2,3,4)	Very Important (5)
a. Theft	-	100%	-
b. Supervision	-	75%	25%
c. Damage	-	25%	75%
2. Labor			
a. Productivity	25%	50%	25%
b. Subcontractors	25%	25%	50%
c. Quality of workmanship	-	25%	75%
3. Materials			
a. Suppliers	25%	50%	25%
b. Quality	-	25%	75%
4. Time			
a. Weather	50%	50%	-
b. Design	-	50%	50%
c. Change Orders	-	25%	75%
5. Money			
a. Funds	25%	50%	25%
b. Inflation	50%	50%	-
c. Cash Flow	-	25%	75%
d. Cost Underestimation	-	25%	75%
e. Loans	-	75%	25%
f. Interest Rates	25%	50%	25%

Table 5.6 - Lack of attention to client priorities			
1. Supervision	Not Important (1)	Moderately Important (2,3,4)	Very Important (5)
a. Shop Drawings	25%	75%	-
b. Specifications	25%	-	75%
c. Design	-	100%	-
2. Coordination			
a. Owner-Contractor	-	50%	50%
b. Contractor-Subcontractor	-	25%	75%
c. Contractor-Designer	25%	25%	50%
3. People			
a. Experience	25%	25%	50%
b. Instructions	-	75%	25%
c. Training	-	25%	75%
4. Controlling			
a. Budget	-	25%	75%
b. Suppliers	-	75%	25%
c. Quality	-	25%	75%
d. Time	-	75%	25%
e. Subcontractors	25%	50%	25%

Table 5.7 - Poor Scheduling			
1. Communication	Not Important (1)	Moderately Important (2,3,4)	Very Important (5)
a. Project Manager	-	25%	75%
b. Estimating Department	-	75%	25%
c. Superintendent	-	75%	25%
2. Design			
a. Incomplete	-	25%	75%
b. Omissions	-	75%	25%
c. Defective	25%	50%	25%
3. Network Model			
a. Relationship	-	75%	25%
b. Activities	-	50%	50%
4. Site Conditions			
a. Lab testing	25%	50%	25%
b. Supervision	-	25%	75%

Table 5.8 – Processing Change Orders			
1. Client	Not Important (1)	Moderately Important (2,3,4)	Very Important (5)
a. Change in regulations	50%	50%	-
b. Change in law	75%	25%	-
2. Weather Conditions			
a. Hurricanes	-	50%	50%
b. Floods	-	50%	50%
3. Materials			
a. Defective Material/Equipment	-	25%	75%
b. Availability Material/Equipment	-	75%	25%
4. Design			
a. Differing Site Conditions	-	75%	25%
b. Changes by clients	-	25%	75%
5. Construction			
a. Differing site conditions	50%	50%	-
b. Equipment failure	50%	50%	-
c. Errors in design	-	25%	75%
d. Unrealistic schedule	-	75%	25%
e. Omission in design	-	50%	50%

Table 5.9 - Poor Delivery			
	Not Important (1)	Moderately Important (2,3,4)	Very Important (5)
1. Scheduler			
a. Improper input from subs	-	75%	25%
2. Suppliers			
a. Availability of materials and equipment	-	25%	75%
3. Procurement Department			
a. Change Orders	-	25%	75%
b. Bureaucracy	25%	50%	25%
4. Method			
a. Ambiguity	25%	-	75%

5.6 QUESTIONNAIRE # 4 (IMPROVEMENT INDEX)

Every process has a customer, so an improvement is: doing a better job of satisfying the downstream customer. After the subcauses related to client dissatisfaction were found, a new questionnaire was prepared to measure the improvement. This questionnaire was called “Improvement Index” (Appendix D), which was given to clients to obtain their feedback on the areas, which need a lot of improvement. A total of five (5) interviews were conducted with the same owners and clients who were interviewed for the Client Satisfaction Index.

This questionnaire was prepared after analyzing the results of questionnaire 3 by identifying the most important subcauses for client dissatisfaction. This questionnaire was divided into five areas which were previously identified as areas of client dissatisfaction: *Administrative* - Poor Planning and Lack of Attention to Client Priorities; *Project Management and Engineering* - Poor Scheduling; *Construction* - Processing Change Order and *Logistical*- Poor Delivery. A rating scheme was used from “A lot of improvement” to “No improvement”.

5.7 ANALYSIS OF THE RESULTS OF QUESTIONNAIRE #4 (IMPROVEMENT INDEX)

After using the continuous improvement tool, the following tables (table 5.10, 5.11, 5.12, 5.13 and 5.14) show the results from the improvement index:

	A lot of Improvement	Improvement	Little Improvement	No Improvement
1. Quality of Material	15%	24%	28%	33%
2. Manage change order	11%	31%	36%	22%
3. Cash Flow Analysis	39%	26%	25%	10%
4. Construction Underestimation	58%	31%	9%	2%
5. Quality of Workmanship	15%	16%	52%	17%
6. Damage to Equipment	6%	22%	51%	21%

	A lot of Improvement	Improvement	Little Improvement	No Improvement
1. Training of Personnel	7%	23%	49%	21%
2. Cost Control	57%	32%	8%	3%
3. Quality Control	33%	23%	35%	9%
4. Contractor-Subcontractor Coordination	11%	26%	45%	18%
5. Conformance to Specs.	61%	25%	7%	

	A lot of Improvement	Improvement	Little Improvement	No Improvement
1. Incomplete Design	42%	34%	15%	9%
2. Site Condition Supervision	19%	24%	39%	18%
3. Project Management Coordination	59%	36%	2%	3%
4. Network Model selection	29%	29%	35%	7%

	A lot of Improvement	Improvement	Little Improvement	No Improvement
1. Design Changes by Clients	60%	34%	6%	0%
2. Errors In Construction Design	26%	26%	25%	23%
3. Defective Material/Equipment	25%	29%	24%	22%
4. Weather Delays	18%	21%	39%	22%

From the above tables we can determine that the clients' satisfaction level will increase with the improvement of the following processes.

- Construction Underestimation
- Cost Control
- Conformance to specifications
- Incomplete Design

- Project Management Coordination
- Design Changes by Clients, and
- Change Orders from Procurement Department

This way the contractors now have a quantifiable process to try to improve. If these steps are repeated throughout the life of a project, a system of continuous improvement and customer satisfaction through measurement of construction processes will have been developed.

CHAPTER 6

Conclusion and Recommendations

The main objectives of this study were to (1) Investigate the adoption and implementation of TQM in the construction industry; (2) Determine the processes (“what to measure”) that are most suitable and appropriate for measurement during the construction project life-cycle and (3) Develop a model (“how to measure”) for the measurement and evaluation of the quality performances of the construction processes identified in (2) above as a tool for continuous improvement.

When it comes to measuring work process, the construction industry does not enjoy a good reputation. The problem, however, can be attributed to the nature of the industry, which lacks solid data gathering and the exceptional fluctuation in productivity.

6. 1 PHASE I

The first stage of this study identified the current implementation and adoption of TQM principles in the construction industry through an in-depth questionnaire. The questionnaire was divided into **six parts** namely: their knowledge of TQM, their perception of quality, the data acquisition methods used by them, quality in their organization, the degree of training provided to their employees towards TQM, and the obstacles faced by them in implementing TQM in their businesses. The conclusions from these six sections are briefly discussed below.

6. 1. 1 Knowledge of TQM

The results from this section show that the majority of the contractors agreed that if a contractor satisfies his clients, the profits would increase in the long run. They feel that TQM will work very well in their organizations and not only that they felt that this program is going to be beneficial for their organizations. They are however not aware of any implementation programs. Most of them feel that TQM is a philosophy used to improve cost estimating and warranty claims. This shows their lack of knowledge about the TQM and the potential benefits in implementing this program in their organizations.

6. 1. 2 Perception of Quality

The analysis of this section tells us that the majority of the contractors perceive quality as a competitive advantage next to elimination of defects. They feel that product/service quality is very important for them in gaining customers satisfaction because it ultimately translates to higher profits for them. They feel that customer satisfaction is their main goal. Interestingly however, when they were asked to rank in the order of importance the following attributes: Quality, Safety, Time, Cost and Scope; they ranked scope and cost as the important considerations followed by Timeliness, Safety and Quality.

6. 1. 3 Data Acquisition Method

The results of this section shows that the majority of the companies do collect data to measure the performance of operations and the way they solve problems is assigning an individual to solve them. On the other hand, 52% of the companies have a system for gathering customer suggestions but just 28% measures customer satisfaction through questionnaire surveys. 20% gather customer suggestions by the number of complaints or other methods. In most of the cases the suppliers and the subcontractor are rated (52%) and when defects in services are identified, they are required to pay for or correct them.

6. 1. 4 Quality in their Organization

We observe from this section that although only about 50% of the contractors surveyed had a clear definition of quality in their organizations, 86% are aware of the importance of quality. Majority of the respondents said that they do not have a formal Quality Improvement Program (QIP) in place. Those that do, however, have the full support of their top management. Also, they use a mix of Quality Control, TQM and ISO 9000 principles in their QIP. Demanding customers, CEO commitment and competitive pressures were identified as the key reasons for implementing the quality improvement programs. Main objectives of the QIP are employee involvement followed by increasing productivity and cost reduction. 40% of the contractors felt that the quality of their products and services improved after implementing such a program.

6. 1. 5 Training

In majority of the companies, their employees are not given a formal training in TQM or other quality improvement programs. 44% of the companies reported that managerial/supervisory staff have undergone quality improvement training while 29% of the companies provided training on quality management philosophies to non-managerial and non-technical staff. Training programs mostly emphasize customer satisfaction as a primary goal followed by teamwork and communication.

6. 1. 6 Barriers to Implementing Total Quality Management

The following listing gives a breakdown from the most important obstacle to the least important one.

1. Changing behavior and attitude.
2. Lack of expertise/resources in TQM.
3. Lack of employee commitment/understanding.
4. Lack of education and training to drive the improvement process.
5. Schedule and cost treated as the main priorities.
6. Emphasis on short-term objectives.
7. Tendency to cure symptom rather than getting to the root cause of a problem.
8. Too many documents are required (lack of documentation ability).

It is easy to infer from the above that although 'Total Quality Management' has been a magic word in the construction Industry for the past few years, methods and techniques to implement the Quality Management program in the Industry are still to be developed. The basic problem attributed to a lack of expertise or resources for implementing quality improvement programs is the difficulty in assessing what to measure and how to measure them – particularly the intangible aspects of quality. Without measurement, the notion of continuous improvement is hard to follow.

To take care of the above, an attempt has been made to measure the Client Satisfaction Index. This gives us a direct reference point from where quality improvement steps can be initiated in the construction industry. Various possibilities of client satisfaction were thus listed and rated. This gives us a measure or an index of client satisfaction or dissatisfaction. This is discussed in Phase II of the study.

6. 2 PHASE II

In the second phase of this study the second questionnaire focusing on the customer was created to identify the processes for improvement.

From the analysis of this questionnaire, the Client Satisfaction Index was developed which lists the major causes of dissatisfaction for the clients. They are:

- Lack of attention to Client Priorities
- Poor Planning
- Poor Scheduling
- Inadequacy in Processing Change orders
- Poor Delivery Schedules and Methods

Next, a third questionnaire was developed using the cause-and-effect diagram to identify the sub causes for the main causes of client dissatisfaction. This was presented to contractors and their feedback was sought through structured interviews. The results are summarized below.

The major sub causes for the **lack of attention to client priorities** were:

- Lack of Personnel Training
- Lack of Quality and Cost Control
- Inadequacy in Contractor-Subcontractor Coordination, and
- Lack of Conformance to Specifications

The main sub causes for **poor planning** in the construction industry were:

- Low Quality of Material and Workmanship
- Poor Management of Change Orders
- Poor Cash flow Analysis
- Construction Underestimation, and
- Poor Equipment Management

The sub causes for **poor scheduling** were:

- Incomplete Design
- Lack of site Condition Supervision
- Inadequacy in Project Management Coordination, and
- Improper Network Model Selection

The main factors for the **inadequacy in processing change orders** were:

- Changes in Design by Clients
- Errors in Construction Design
- Defective Materials/Equipment, and
- Weather Delays

The sub causes for the **poor delivery schedules and methods** in the construction industry were:

- Ambiguity in Methods,
- Change Orders from Procurement Department and
- The Availability of Materials and Equipment.

6. 3 PHASE III

This analysis led us to the final phase of the research study where the most important identified sub causes by the contractors were presented to the same owners who had participated in questionnaire #2. In questionnaire #4 they were asked to indicate a measure of their satisfaction if the contractors made improvements to the identified sub causes. We call this the improvement index.

Following are the areas that would increase customer satisfaction the most if the contractors improve them.

- Construction Underestimation
- Conformance to Specifications
- Project Management Coordination
- Design Changes by Clients, and
- Change Orders from Procurement Department

Customer satisfaction can be greatly enhanced by improving construction underestimation, conformance to specifications, project management coordination, design changes by clients and change orders from the procurement department. The above areas were identified after analyzing the results of the last questionnaire in which we had asked the clients to identify the most important processes that need improvement.

This process can be repeated until different areas of improvement are identified through another cycle of the development of the client satisfaction and improvement index. The key to understand is that the client is now a moving target – their expectations and requirements are constantly changing. To keep up with their ever-hanging goals, the contractors need to have in place a system of identifying, measuring and continuously improving their tangible and intangible products and services.

Hopefully, this study has succeeded in demonstrating how these objectives can be achieved. There is no intent on the part of the author to imply that the identified main and sub causes of client satisfaction or dissatisfaction are in any way statistically significant. The objective of this study was to develop and demonstrate how a system of continuous improvement can be put in place by measuring different processes. It is sincerely the hope that to that end, the research project has been completed successfully.

Bibliography

AGC. (1993). IMPLEMENTING TQM IN A CONSTRUCTION COMPANY. PUBLICATION NO. 1121, THE ASSOCIATED GENERAL CONTRACTORS OF AMERICA.

Alfeld, Loui Edward, Construction Productivity, Mgraw-Hill, 1988.

Ashford, J.L. (1989), The Management of Quality in Construction, E.& F.N. Spon, London.

Adrian, J.J. 1995, Total quality management, The Illinois Department of Transportation

Arditi D. & Gunaydin H.M. 1997, Total quality management in the construction process, International Journal of Project Management 15: 235-243

Bate, P. 1994 Strategies for cultural change, Butterworth Heinemann

Bhote K.R. & Bhote A.K. 2000, World class quality, Amacom New York

Boaden R. & B. Dale 1992, Total quality management in the construction industry: A preliminary analysis, International Journal of Technology Management 7-1: 224-253

Burati J.L., J.J. Farrington and W.B. Ledbetter 1992, Cause of quality deviation in design and construction, Journal of Construction Engineering and Management 118: 34-49

Burati J.L., Matthews M.F., Kalindi S. N. 1992, Quality management organizations and technique, Journal of construction Engineering and Management 118: 112-128

Burati J.L., Matthews M.F., Kalindi S.N. 1991, Quality management in construction Industry, Journal of construction Engineering and Management 117(2): 341-359

Crosby P.B. 1979, Quality is free, McGraw-Hill Book Co., Inc. New York

David S. et al 1990 Becoming the international vendor of choice through systematic segmentation and research, ASQC Quality Congress Transactions 702

Dening, W.E. 1986, Out of the crisis, Center for Advanced Engineering Study, MIT Cambridge Mass

Dumas, R.A. 1989, Organization wide quality: How to avoid common pitfalls, Quality Progress 22(5): 41-44

Farhad A., Enno K. 1998, The need for a cost-effective ness system, Transactions of Aace International; Morgantown 5-8

Flood R.L. 1993, Beyond TQM, John Wiley & Sons, Ltd. Chichester, England

Gorge S. and Weimerskirch A. 1994, Total quality management – Strategic and techniques proven at today's most successful companies, John Wiley & Sons, Inc. New York

Greene G.P. 1993, Total quality management in construction industry: A cultural challenge, Engineering Management Journal 5-2: 21-27

Imai M. 1986, Kaizen – The key to Japan's competitive success, McGraw-Hill New York

Jerald L.R., N.I. Chi 1985, Total quality management for construction, Journal of Construction Engineering and Management 111: 117-128

Juran J.M. 1988, Juran's quality control handbook, McGraw-Hill Book Co., Inc. New York

Kanji G.K., Wong A. 1998, Quality culture in construction industry, Total Quality Management 9(4&5): 133-140

Kumaraswamy M.M. 1996, The pursuit of quality in Hong Kong construction, Engineering, construction and Architectural Management 4:289-306

- Kwok L. and Dean T. 1998, Conflict management in the Asia Pacific, John Wiley & Sons, Inc. New York
- Ledbetter W.B. 1994, Quality performance on successful projects, *Journal of Construction Engineering and Management* 120: 34-46
- Leonard, F.S. and Sasser, W.E. 1982, The incline of quality *Harvard Business Review* 60(5): 163-171
- Leslie L. 1999, TQM tools for the construction industry, *Engineering Management Journal* 11: 23-27
- Michael G.S. 1997, Beyond project control – the quality improvement approach, *Transactions of Aace International; Morgantown* 262-268
- Oakland J.S. & Aldridge A.J. 1995, Quality Management in Civil and Structural Engineering Consulting, *International Journal of Quality and Reliability Management* 12: 32-48
- Pheng L.S. 1993, The rationalization of quality in the construction industry: Some empirical findings, *Construction Management and Economics* 11: 247-259
- Porter L.J. & Parker A.J. 1993, Total quality management – the critical success factors, *Total Quality Management* 14
- Scholtes, P.R. 1988, *The team handbook*, the Joiner Associates
- Smith S. 1988 *How to take part in the quality revolution: A management guide*, PA Management Consultants, London
- Smith, S. and Smally, M. 1988, *Total quality management: Best practice in the USA and Japan*, PA Management Consultants London
- Sommerville J. 1994, Multivariate barrier to total quality management within the construction industry, *Total Quality Management* 5: 289-298
- Sommerville J. 1997, The culture for quality within the UK construction industry: temporal relatedness and dominance, *Total Quality Management* 8: 279-285
- Sommerville J., R.K. Stocks and H.W. Robertson 1999, Cultural dynamics for quality: The polar plot model, *Total Quality Management* 10: 725-732
- Steve P. 1999, Partnering and the management of construction disputes, *Dispute Resolution Journal* 54: 16-22
- Tenner A.R. & Irving J. D. 1994, *Total quality management – Three steps to continuous improvement*, Addison-Wesley Publishing Company Massachusetts
- Turner J.R. 1993, *The handbook of project-based management*, McGraw-Hill London
- Tyler A.H. & Frost D.T. 1993, Implementation of a construction industry quality assurance system, *International Journal of Quality and Reliability Management* 10: 9-18
- Umeda T. 1996, *TQM practice in Asia-Pacific firms*, Asian Productivity Organization Tokyo
- W.B. Ledbetter 1994, Quality performance on successful project, *Journal of Construction Engineering and Management* 120: 35-46
- Whitter S., Smith S., Tranffield D. and Foster M. 1992, Implementing total quality, *International Journal of Technology Management* 7: 235-243
- Wong A., Fung P. 1999, Total quality management in the construction industry in Hong Kong: a supply chain management perspective, *Total Quality Management* 10: 199-209
- Yates J.K. & Anifetos S. 1997, International standard and construction, *Journal of Construction engineering and Management* 123: 127-137.

Appendix A

Questionnaire 1

ADOPTION AND IMPLEMENTATION OF TQM IN THE FLORIDA CONSTRUCTION INDUSTRY

DEPARTMENT OF CONSTRUCTION MANAGEMENT



INTRODUCTION

Many construction companies in the US, Singapore, UK, and other European countries have been using Total Quality Management (TQM) successfully for a number of years now and reaping rich rewards in improved client, consultant, and supplier relations, reduced “cost of quality”, on time and within budget project completions, and well informed and highly motivated team of staff.

OBJECTIVES

This project plans to investigate the adoption and implementation of TQM in the Florida construction industry and develop a measurement methodology of construction processes for customer satisfaction and continuous improvement. A process might be the vibration of fresh concrete, the fabrication of structural concrete, the preparation of a shop drawing, or a way in which the project manager deals with a client and with other members of the team. It is expected that both the contractors and clients will reap rich rewards from this project in terms of improved quality and productivity, competitiveness and client orientation and customer satisfaction.

INSTRUCTIONS

Please take a look at the following questionnaire and try to answer correctly and accurately, as many questions as possible. All the information gathered here will be kept strictly confidential and will be used only for research and analysis purposes without mentioning the person or company names.

Company Information

Name of the company: _____

Nature of company (prime contractor/sub-contractor/consultant/supplier/vendor):

Size of the company (no. of persons): _____ (admin) _____ (technical)

Age of the company: _____

Ongoing/completed projects in Florida: _____

_____Would you like to be contacted again regarding this questionnaire, if your answer is YES, please write down your name and contact details: _____
_____**Your Knowledge of TQM****1. In your view, which of these words best define quality? (not limited to one answer)**

- Expensive
- Satisfying internal customer (within the organization)
- Satisfying external customer (outside the organization)
- Appearance
- Increased profit
- Value for money
- Teamwork
- Partnership between organization and supplier

2. Do you think that TQM will (or does) work in your organization?

- Very well
- To some extent
- Won't work
- Can't say

3. Would a TQM program be beneficial to your organization?

- We are implementing such a program
- Yes
- No
- Can't say

4. TQM would be used to improve:

- Project design
- Cost estimating
- Warranty claims
- Reduce change order
- Reduce claims
- Increased market share
- Reduced lawsuits

5. *Are you aware of any industry programs to implement TQM or of the ISO 9000 standards?*

Your Perception of Quality

6. *What is your organization's perception of quality?*

- Elimination of defects
 - A tool to increase profits
 - A competitive advantage
 - Others (please specify)
-

7. *How would you rate the importance of product/service quality:*

- Very important
- Important
- Somewhat important
- Can't say

8. *How would you rate customer satisfaction:*

- Very important
- Important
- Somewhat important
- Not important
- Can't say

9. *Please rate the potential for improvement within the following processes:*

<i>(Scale 1 to 5, 1:Low 5:High)</i>	<i>High</i>	<i>Low</i>	<i>No</i>
● On-site supervision	5-4-3-2-1		0
● Redesign	5-4-3-2-1		0
● Testing procedures at job sites	5-4-3-2-1		0
● Certification of material	5-4-3-2-1		0
● Administration of change orders	5-4-3-2-1		0
● Close-out of projects	5-4-3-2-1		0
● On-site safety	5-4-3-2-1		0
● Personnel management of employees	5-4-3-2-1		0
● Coordination with other members of a project	5-4-3-2-1		0

10. *Please rank in order of importance (1,2,3,4,5):*

- Cost : _____
- Scope : _____
- Time (Schedule) : _____
- Quality : _____
- Safety : _____

11. *Do you set your quality goals to the level of:*

- The leading company in your field
 - The competition in general
 - To a level set internally
 - Other (please specify)
-

Data Acquisition Method**12. Do you collect data to measure the performance of operations?**

- Yes
- No
- Can't say

13. How does your organization solve problems?

- Assign individual to solve
 - Set up a multi-disciplinary team for each problem
 - A permanent team is available
 - Other (please specify)
-

14. Do you have a system for gathering customer suggestion?

- Yes
- No
- Can't say

15. How do you measure customer satisfaction?

- Not measured
 - Questionnaire surveys
 - By the number of complaints
 - Other methods (please specify)
-

16. Do you have a system for gathering employee suggestions?

- Yes
- No
- Can't say

17. Are employees empowered to make significant changes to operations?

- Fully empowered
- Only key personnel are empowered
- Empowerment is not needed
- Can't say

18. Are suppliers/subcontractors rated?

- All
- Most
- None
- Can't say

19. Defects in services are identified and subcontractors are required to pay for or correct them:

- Yes
- No
- Can't say

Quality in your Organization**20. Has your organization developed a clear definition of quality?**

- Yes
- No
- Can't say

21. Percentage of employees who are aware of the importance of quality?

_____ %

22. Does your organization have a quality improvement program?

- No (Please go to next section of question)
- Such a plan is under consideration
- A quality improvement program has been implemented recently
- A quality improvement plan has been a part of corporate policy for some time now

23. What type of quality improvement program do you have?

- Total Quality Management
 - ISO 9000
 - Quality Control / Quality Assurance
 - Others (please specify)
-

24. Which of the following factors provided the motivation to start TQM

- Pressure from competitors
- Demanding customers
- Your company's Chief Executive
- Environmental issues/considerations
- Need to reduce costs and improve performance

25. Your organization's quality improvement program can be described as:

- There is no formal program
 - Periodic short-range solutions or motivational program
 - A formal program is underway with widespread employee awareness
 - Others (please specify)
-

26. Does your quality improvement plan have the full support of top management?

- Yes
- No
- Can't say

27. The major objectives of your quality programs are:

- Increase productivity
- Cost reduction
- Involvement of employees in the quality building effort
- Compliance with statutory, environment and safety requirement
- Others (please specify)

28. Steps taken in your quality improvement plan include:

- Organized a multi-disciplinary team
- Data has been collected to measure the process
- A dollar value has been assigned to the cost of quality
(cost of quality = cost of conformance + cost of non-conformance)
- An internal awareness program is underway
- An educational program has been implemented
- Quality problems have been identified
- Have defined benchmarks for improvement

- 29. Quality is first incorporated in the project at:**
- Concept development
 - Research and development
 - Operations
 - Final inspection
- 30. After the implementation of your quality improvement program, service/product quality has:**
- Drastically improved
 - Improved
 - Remained the same
 - Decreased
 - Can't say
 - Not applicable
- 31. After the implementation of your quality improvement program, relationship with your customers and suppliers has:**
- Drastically improved
 - Improved
 - Remained the same
 - Decreased
 - Can't say
 - Not applicable

Training

- 32. Is formal training in TQM or other quality improvement philosophies given to employees?**
- No training is given (please skip the rest of question)
 - Some training is available
 - A formal training program is in effect
 - Other (please specify)
-
- 33. Percentage of managerial/supervisory staff who have undergone quality improvement training"**
_____ %
- 34. Percentage of non-managerial/technical staff who have undergone quality improvement training"**
_____ %
- 35. Training currently emphasizes:**
- Process control
 - Statistical analysis
 - Data gathering & analysis
 - Team work
 - Communication
 - Customer satisfaction

Others**36. Obstacles in the implementation of TQM program**

- Changing behavior and attitude
- Schedule and cost treated as the main priorities
- Emphasis on short-term objects
- Lack of education and training to drive the improvement process
- Too much documents are required (Lack of documentation ability)
- Lack of top-management commitment/understanding
- Lack of employees commitment/understanding
- Tendency to cure symptom rather than get to the root cause of a problem
- Lack of expertise/resources in TQM
- Current tendering/bidding climate

Appendix B

Questionnaire 2

CLIENT SATISFACTION INDEX

Please mark just one appropriate box

1. Administrative	<i>Strongly Satisfied</i>	<i>Satisfied</i>	<i>Neither Satisfied nor Dissatisfied</i>	<i>Dissatisfied</i>	<i>Strongly Dissatisfied</i>
1) <i>Relationship between parties</i>					
2) <i>Adequacy of office personel</i>					
3) <i>Project Cost within the Budget</i>					
4) <i>Knowledge of client needs</i>					
5) <i>Attention to client priorities</i>					
6) <i>Adequacy of supervision</i>					
7) <i>Coordination with regulatory agencies</i>					
8) <i>Adequacy of planning</i>					
9) <i>Adequacy of Training</i>					
10) <i>Customer Satisfaction</i>					
Any other remarks					

2. Project Management and Engineering	<i>Strongly Satisfied</i>	<i>Satisfied</i>	<i>Neither Satisfied nor Dissatisfied</i>	<i>Dissatisfied</i>	<i>Strongly Dissatisfied</i>
1) <i>Progress Review Meetings</i>					
2) <i>Adequacy of Project Control</i>					
3) <i>Adequacy of Safety Program</i>					
4) <i>Estimating</i>					
5) <i>Scheduling</i>					
6) <i>Interaction With Architect/Engineer</i>					
7) <i>Adequacy of supervision</i>					
8) <i>Shop drawing review</i>					
9) <i>Adequacy of planning</i>					
10) <i>Adequacy of subcontractor selection</i>					
Any other remarks					

Please mark just one appropriate box

3. Construction					
	<i>Strongly Satisfied</i>	<i>Satisfied</i>	<i>Neither Satisfied nor Dissatisfied</i>	<i>Dissatisfied</i>	<i>Strongly Dissatisfied</i>
1) <i>Project Quality</i>					
2) <i>Adequacy of job site personel</i>					
3) <i>Material Quality</i>					
4) <i>Quality of workmanship</i>					
5) <i>Equipment Quality</i>					
6) <i>Timely completion of project phases</i>					
7) <i>Knowledge of the project</i>					
8) <i>Site cleanliness</i>					
9) <i>Adequacy of processing change orders</i>					
10) <i>Project closeout</i>					
<i>Any other remarks</i>					

4. Logistical					
	<i>Strongly Satisfied</i>	<i>Satisfied</i>	<i>Neither Satisfied nor Dissatisfied</i>	<i>Dissatisfied</i>	<i>Strongly Dissatisfied</i>
1) <i>Adequacy of Storage</i>					
2) <i>Adequacy of Warehousing</i>					
3) <i>Adequacy of Delivery</i>					
4) <i>Adequacy of Maintenance</i>					
<i>Any other remarks</i>					

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