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An Analysis upon Various Applications and Developmental Process for Implementation of Total Quality Management in Construction Projects

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Abstract – Total quality management (TQM) is a management philosophy which has been widely implemented in the manufacturing and other services industries, and it shows how significant it can improve the quality in these fields. Few articles and studies attempted to bring the benefits of this philosophy to construction industry. The objective of this paper is to point out the latest studies which focused on increase the business quality through implementing TQM in construction industry and its suitable applications in the different phases of project construction.

Quality systems entail having the organizational structure, responsibilities, procedures, processes and resources for implementing quality management such that there is a guiding framework to ensure that every time a process is performed the same information, method, skills and controls are used and practiced in a consistent manner.

Total Quality Management (TQM) has been defined as a comprehensive systematic, integrated, consistent, organization-wide effort dedicated to customer satisfaction through continuous improvement. With its primary focus being the involvement of everyone, TQM has the potential to improve business results, greater customer orientation and satisfaction, worker involvement and fulfilment, team working and better management of workers within companies. Its ability to adapt to new ideas, tools and methods suggest that it can be applied albeit in an altered form to construction field operations involving workers at levels traditionally regarded as below middle management. However, the construction industry has been slow to embrace the concept of TQM.

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INTRODUCTION

Total Quality Management (TQM) is a systematic management process aimed at achieving the Client's requirements by doing the job right at the first time. It is not a separate management process to be followed. In the words of Burati (2001) "it is a culture and philosophy that must permeate an organisation as the method of management". It should not be confused with Quality Control (QC) and Quality Assurance (QA). Quality Control is based on the inspection of service and work products. Quality Assurance is the means by which an organisation can assure that they have quality system that follows a recognised standard. TQM results from the continuous input of creative ideas, innovative activities and team approaches into the process of implementation. The Client's Representative's main role is to maintain a positive climate and provide the necessary resources and equipment to the participants for continuously improving the process. Both Client and Contractor organisations often rely on their representatives to develop innovations and improvements in their projects.

This study focuses on the changing role of Client's Project Managers when moving away from traditional approaches and implementing TQM. The tasks and practices for Client's Project Manager presented in this study are the initial findings of the current research.

The theory of total quality management is not a new phenomenon. Total quality management was first officially introduced in the 1940's and has continued to change and improve through the years. Even though this concept has not yet been fully accepted by businesses in the United States, the acceptance

and implementation of total quality management programs is increasing. The single greatest obstacle for total acceptance seems to be based on the fact that business managers in the United States are more interested in short term results and profits than in steady, long term growth and improvement. This mindset requires that chief executive officers and top management improve the bottom line rapidly. Usually these results are only temporary and after the initial results begin to taper off, top management personnel move on to a new company. This trend produces negative side effects such as loss of company loyalty and decrease in company knowledge.

As the development and evolution of total quality management is examined, perhaps the realization that only the occurrence of an economic disaster will cause America's corporate giants to open their eyes and apply the basic rules of total quality management. In May 1993, the trade deficit was 10.5 billion dollars, with approximately one half attributable to the Japanese. Obviously, the principles taught to the Japanese people forty years ago by Dr. W. Edwards Deming are still awaiting endorsement by American businesses today.

Total quality management seems to have its roots based on Dr. W. Edward Deming's fourteen points of management. These points, along with other principles of Dr. Deming's, will be examined. Specifically, their application to the construction industry will be explored. The seven deadly diseases and other obstacles which describe reasons why total quality management could fail will be discussed in some detail. Safety management is vital to an organization's success and will also be examined in detail, as will the role of data and statistical methods. Deming's fourteen points of management seem to be the most widely used and accepted when dealing with total quality management. However, for the sake of comparison and reference, Crosby's fourteen steps of quality are as follows: management commitment; quality improvement team; measurement: cost of quality; quality awareness; corrective action; ZD (zero defects) planning; employee education; ZD Day; goal setting; error-cause removal; recognition; quality councils; and, do-it-over-again. Finally, where total quality management is today and where it will be tomorrow will be discussed. Further, one possible plan for implementing total quality management in construction will be presented.

Total quality management, an effective business technique p:edominately used in Japan, is rapidly evolving in American business and industry. This concept consists of:**...** an integrated process involving both management and employees with the ultimate goal of managing the design, development, production, transfer and use of the various types of products and services5 in both the environment and marketplace.

This approach to business strategy involves employees at every level, from the Chief Executive Officer to the blue collar worker who performs custodial duties. To have successful total quality management, the products and services must consist of both quality assurance and quality control. Quality assurance must be differentiated from quality control or inspection, for "although a quality assurance program will include quality control and inspection, both these activities form only a part of a company's total commitment to quality."

The total quality management process must consist of both quality assurance and quality control to insure a marketable, competitive product for today's demanding customer. This management strategy must involve innovation, continual adaptation and risk taking. In order to minimize risks involved, training of quality management must be provided at every level of the organization. Programs often fail "due to lack of understanding or commitment." 9 Quality management is moving to the forefront of American business and should make industries more competitive, both in the United States and in the international market. More and more companies are realizing that with proper implementation of the total quality management process, production will increase and costs will decrease. Even with an average three to five year implementation period, companies are realizing that quality assurance plus quality control equals total quality management and this equation is well worth the overall investment.

The aims of TQM are to achieve customer satisfaction, cost effectiveness, and defect free work through a relentless pursuit of the “war on waste.” The customer will be satisfied only if the product has a very low rate of defects (literally none or zero) and is competitive in price with offerings from other suppliers. TQM achieves customer satisfaction through focusing on process improvement, customer and supplier involvement, teamwork, training, and education. TQM is a culture advocating a total commitment to customer satisfaction, through continuous improvement and innovation in all aspects of the business. The customer, in the ideal culture, does not mean only the final recipient of the organization’s end product or services. The “customer” is also every individual or department and stakeholder within the organization.

The development of the TQM concept originally took place in the manufacturing industry. Thus, most literature addresses that industry and this gives the misleading impression that the TQM concept cannot be applied to any industry other than manufacturing. One of the main principles of the TQM concept is to

achieve customer satisfaction and this is an important objective for any organization, including construction firms. However, the implementation of TQM might differ from one industry to another.

The construction industry differs from the manufacturing in such a way that makes introducing TQM more challenging. While the manufacturing industry is characterized by a steady-state processes, the construction industry is usually a onetime process (uniqueness). Construction industry is also unique in the following ways:

(1) the mobility of staff;

(2) diversity in the types, forms, and shapes of construction projects;

(3) geographical dispersion;

(4) the contractual relationships;

(5) frequent prototyping of projects; and

(6) the subtle forms of waste that often go unnoticed.

The construction industry has tended to confuse TQM with quality control (QC) and quality assurance (QA), believing that compliance with QA standards such as ISO 9001 and 9002 is all that there is to the application of TQM on construction projects (Jaafari, 2001). This confusion has led to the use of these expressions interchangeably. QA and QC may be considered as separate and related sub-elements of total quality (TQ).

However, QA and QC do not represent the only elements of TQM, as it is a much more comprehensive and broader concept. QA and QC are applied during project implementation while TQM is a strategic philosophy adopted by an organization and implemented on a continuous basis, even if the organization is waiting to perform a new project.

The TQ culture varies from one company to another and from one industry to another. However, the TQ culture, regardless of its differences, aims to achieve common objectives: namely, removal of waste, reduction of costs, improvement of reputation, and increased market share. As can be observed, TQ objectives are dynamic in their nature and this dictates continued updating and upgrading.

Much has been written about what constitutes the basic ingredients or the philosophical pillars of TQM. The number and priority of these elements vary from one author to another and their importance might vary from one organization to another. Also, most of the literature which addresses the elements of TQM is old. The recent literature to address TQM does not emphasize the elements, since these elements have been exhaustively addressed in the literature that appeared when the TQM was in its introductory stage. Sufficient writings about TQM and its elements appeared in late 1980s and early 1990s and its eventual morphing into the Lean Six Sigma movement, as it is known today. If there was a consensus, it would include the following ten components.

Leadership and management commitment - All implementations should begin with leadership and management commitment. They are absolutely essential for the success of any TQM program. Prior to management commitment, management should have a thorough understanding of TQM. This commitment must be coupled with support to make it happen. Once management is committed to TQM, it will provide the necessary resources of time and money to permit improvement. Senior management, in the form of a Quality Steering Committee, might need to draft a vision and mission statements, which summarizes the organization's philosophy with emphasis upon customer satisfaction and quality.

An advisory committee is responsible for establishing and developing the policies and procedures for the TQM implementation process. The committee members should be capable of determining the needs of the organization, opportunities for improvement, and goals for improvement initiatives.

TQM requires employees to do things differently; therefore, participation by management is essential. To achieve the changed behavior of the staff and improve quality, it is very important to change the organizational environment. Without these fundamental cultural changes, an organization's attempt at TQM will fail. This fundamental change cannot be achieved unless management has a long-term obsession with quality work and continued improvement. Management should learn to deal with challenge. They should cause changes and not continue to execute policy and cope with existing organizational systems.

Training - Training is a fundamental element for any successful quality management program. All of the current band of "quality experts" or "gurus," along with many chief executive officers who have successfully implemented TQM in their organizations, unanimously recognize the importance of training. The training program must target everyone in the organization, since quality under the TQM umbrella is everyone's responsibility. All employees from top management to labor should understand: the need

for TQM, understand what TQM is, how it works, and its payoff.

Any training program should include an orientation to the basic concepts and procedures of TQM. This provides employees with a fundamental knowledge which can later be linked to more advanced topics. TQM requires a participative, disciplined, and organized approach to improving process, thus team training is also very important. The training program should cover topics as cause-and-effect analysis, team problem solving, interpersonal communication and interaction, rudimentary statistical methods, cost of quality measurement, and the collection and evaluation of quantitative information.

Communication - Good communication is very important in achieving TQM levels of performance excellence. Good communication will result in eliminating fear. Fear makes employees reluctant to voice their opinions or question policies, procedures, and decisions. In other words, fear prevents employees from being involved. Deming's advises, "drive out fear." This requires a change in management behavior. An employee should know the reasons for rejection of his/her work. The employees should also know the use and the importance of the work he/she produces. If the message is not clearly communicated to the employee, then this could be interpreted to mean to him/her that he/she has no value.

TQM is a conscious process of improvement, and thus good communication and a good feedback system are important to convey ideas to management and to incorporate the necessary changes. One effective strategy might be open lines of communication that allow direct access for any employee, at any level, to contact upper management regarding an idea for improvement or a particular concern. Prior to adopting open lines of communication, employees and management should be trained in this system. Otherwise, it will be an ineffective theoretical approach. It is very important that management reacts to the concerns and ideas of the employees.

Teamwork - Under TQM, teams are very important in achieving an organization's goals. It has been noticed that individuals working together in teams or groups toward common goals are generally more effective than individuals working alone. TQM recognizes that the team approach should not be limited to the internal organization's team, but it should cover vendors and external customers under its umbrella. TQM benefited from the successful experience of "quality circles" in Japan. The essence of quality circles is to have collective awareness and efforts to achieve quality.

The construction project team leader should not play the authority role but rather act as facilitator for these meetings. It is assumed that the team leader should be skilled in such areas as communication, group dynamics, statistical methods, problem-solving methods and techniques, and group leadership.

Customer satisfaction - The main objective of TQM is to achieve customer satisfaction whether the customer is internal (e.g. department in the same organization) or external (e.g. final product recipient). The first step in achieving customer satisfaction is to define the customer's needs and wants and then translate these needs and wants into standards. Customer satisfaction should be limited to meeting the customer's expectations, but it should try to exceed then through continuous improvement. In order to meet the customer's expectations, the organization must adopt an information-gathering program that measures the level of customer satisfaction. Such a program will help the organization to identify areas of dissatisfaction, so corrective action can be taken to eliminate the source of dissatisfaction.

Customer satisfaction in the construction industry can be achieved by implementing the following steps:

(1) make the customer (internal and external) aware of the organization's quality management initiative;

(2) determine customer expectations;

(3) measure the customer's degree of satisfaction; and

(4) take action to improve satisfaction.

TQ and measurement - In order to discover the results of deploying a construction quality program and the areas of future improvement, construction-related quality measures are necessary.

Under a construction industry TQ program, a number of measures can be used to verify and control the inputs and outputs in order to meet the customers' (internal/external) requirements. The measurements provide the organization with baselines for current performance and the degree of improvement after implementation. For example, increasing the employees' satisfaction with the intention of increasing construction project productivity requires measuring employees' satisfaction and initial productivity. Later, when the recommendations for the actions to improve both stakeholders' and employees' satisfaction are launched, both the satisfaction and productivity levels must be premeasured. It is very important to examine the effectiveness of the construction project improvement activities. The costs of increasing employee satisfaction vs the financial gains of the productivity increase are studied.

Improved communication, recognition, removing fear, and leading employees to work with pride result in an increase in employee satisfaction, which, in turn, materialize in their work quality and quantity (productivity). Furthermore, the satisfaction of the employee reflects on his attitude toward others namely his customers and this is important in some businesses (e.g. services) where the attitude of the employees is the marketing tool. In fact, there are a number of reasons for adopting construction project-related quality measurements which may be achieved:

- to be able to attain and sustain reasonable construction project objectives;
- to justify the use of construction project resources;
- to provide standards for establishing construction-related comparisons;
- to determine construction project priority areas that require improvement;
- to provide a scale to allow people (employees) to monitor their performance level;
- to identify construction-related quality problems; and
- to detect any decline in performance.

The main components of any organization, construction or otherwise, are – human resources (employees), process, external customers, suppliers, and other resources (material and equipment). All these elements are governed by management and organization policies and procedures. The construction quality journey considers all these elements and tries to improve them, and different measures and the desired results should be designed for each element.

Continuous improvement - In the words of Oswald and Burati (2002), "Total Quality Management is often termed a journey, not a destination." This is because of its nature as a collection of improvement-centered processes and techniques, which are performed in a transformed management environment. The concept of "continuous improvement" holds that this environment must prevail for the life of the enterprise, and that the methods will become routinely used on a regular, recurring basis. The improvement process never ends; therefore, "no true destination is ever reached." Management under TQM must be supportive to the advancement of technology and management techniques. Major shifts in the levels of performance can be achieved through innovation. Deming's (2000) "plan-do-check-act" (PDCA) cycle is a systematic procedure for improving methods and procedures by focussing on correcting and preventing defects. Avoiding defects by building in quality is usually less costly than the typical approach of attempting after the fact to determine defects through inspections. The PDCA cycle can maintain any improvement and prevent deterioration.

Continuous improvement entails focussing on processes so that they can be changed to be more efficient. The degree of success can be determined by comparing the progress against certain criteria. The process of measuring and comparing the degree of success against predetermined criteria is known as "benchmarking." Benchmarking is a systematic search for best practices that leads to superior performance.

Process improvement - Process improvement has a mutual relationship with continuous improvement. In some literature, process improvement is referred to as statistical methods or statistical process control because measurement and analysis of data are very important for process improvement. Accurate data are very important for both employees and management to make better decisions regarding process improvement. Quality improvement teams can be formed in any organization to examine the processes. The quality improvement team should consist of a representative from each area that might be involved in a process.

The team has to identify and separate causes of quality problems and propose solutions. The proposed solutions should then be screened and the best solution(s) should be selected for implementation. Subsequent performance should be measured and evaluated to determine if further action is necessary. Several tools can be used by the quality improvement team to assist it in studying processes. These tools include histograms, cause-and-effect diagrams, check sheets, Pareto diagrams, graphs, control charts, and scatter diagrams.

In India, construction industry is the second largest company when compared agriculture. Throughout the world, the construction area of civil engineering is one of the most hazardous industries. The level of success of construction projects greatly depends on the quality performance. Poor design and maintenance is major factor that affects the construction. Quality is one of the critical factor in the success of construction project. The concept of construction project development may be impaired without a good knowledge and successful management of the impact of environmental factors influencing the performance of such the project.

TQM focuses on the quality of management system, not the management of quality, on continuous

improvement of processes in order to improve every feature of an organization. Quality as the degree of excellence in a competitive sense, such as reliability, serviceability, maintainability or even individual characteristics. Quality system refer to the organizational structure, procedures, processes and resources needed to implement quality management. This study TQM process is considered as a modern system in the field of quantity, after quality assurance, quality control and ISO in the construction sector.

The study aims to identify and documenting the current status of the quality practices followed in construction industry. To identify the main problems and point out where the scope lies for improving and by what means it is possible to do so. The study commenced with literature review which lead to descriptive study method, questionnaire was floated to construction companies in Tamil Nadu and responses were collected.

The construction industry maintains low quality of standards, low level of communication, low level of inspection and testing and testing low level of training and customer satisfaction. Hence proper care should be taken to improve the above factors by the way of proper maintenance of quality records, periodic meeting regularly and improving lab facilities to test the materials and measure the standards according to Indian standards so that it improves quality of standards, level of communication, inspection and testing customer satisfactions industry. This conclusion is both supported with literature research.

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 the process and prevent defects before they happen. TQM focuses on the quality of management systems, not the management of quality, on continuous improvement of processes in order to improve every feature of an organization. The implementation of TQM is fundamentally a process of culture change. ISO 8402:1994 ISO Definitions defines quality as the degree of excellence in a competitive sense, such as reliability, serviceability, maintainability or even individual characteristics. Quality systems refer to the organizational structure, procedures, processes and resources needed to implement quality management. Quality assurance is the planned and systematic activities implemented within quality system and demonstrated, as needed, to provide adequate confidence that an entity will fulfil requirements for quality. ISO 9000 - 2004 defines quality control as the operative 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 fulfil requirements for quality. 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. 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. Abu et al. (2011) in this study TQM process is considered as a modern system in the field of quality, after quality assurance, quality control and ISO in the Construction sector.

BACKGROUND

During the past decades, a number of management alternatives for quality have been developed and practiced in the construction industry. New management approaches for construction projects have mostly been concerned with liabilities and contractual claims between parties, and few have entered into developing systems that enhance open communications and total involvement of the participants in a project.

Despite considerable time and effort being invested in devising various strategies, conflicts and disputes between various parties is still inherent in the construction industry. Duffy (2002) commented this as: "everyone in the construction industry is fighting among themselves instead of serving the needs of the client

According to the Building Research Establishment(1987), two-thirds of the 501 examples of poor quality observed on site were caused by design faults. Of these, 130 were caused by unclear or missing project information. Other causes were, lack of co-ordination of design, too difficult to build, and design not working. This demonstrates that the lack of sufficient information flow and poor co-ordination between participants seriously affects quality in terms of design and construction faults. In recent years, the concept of Total Quality Management (TQM) has been accepted by some as rationale to solve many of these quality problems in the construction industry. Despite the transient, nature of construction industry, the following question is often used:

"why should the construction industry not follow the lead of the manufacturing industry and increase profit by reducing the cost of quality problems through the TQM concept?"

Some research findings prove that TQM has been effectively applied by both owners and contractors in the construction industry. TQM usually starts in construction with the Client's commitment. In the first workshop conducted by Iowa State University on use of TQM in design and construction, a participants

recommended that owners lead the way by first adopting TQM, then requiring other members of the design, construct team. The quality of the service that the Client receives by implementing the concept depends partly on Client's own involvement in, and contact with, the supplier of the services. TQM requires an interdependency between the companies and that the parties adopt a long term - strategies of co-operation, therefore, participation by the Client is essential. Graves (2002) thus pointed out that:

"the standard of service given by the building industry relates closely to the amount of effort expended by the Client in establishing a good brief and satisfaction at the construction stage is closely linked to the degree of control and supervision by the Client".

Relating to Client's participation, Baden, stated:

"many of the technical failures steamed from the failure to recognise to extent to which the building Client should participate, not only in fully exploring and analyzing with the designer his/her requirements in the early stages of the project, but also, then and subsequently, in making a full case study of the ability and suitability of the resources of those organisations through which his/her requirements will be fulfilled1'.

Both of these statements stress the importance of demonstrable participation by the Client when reducing failures and improving quality in construction. However, whether the Client is naive or sophisticated, the presence of an individual or team representing the Client is inevitable. It is apparent that, on behalf of the Client, the participation of the Client's Representative is an essential ingredient for any successful TQM programme. The Client's Project Manager has a key role to play in acting as a communication channel and co-ordination tool between external professionals, contractors and other members of the Client organisation. However, current literature indicates little focus on direct investigation of the role of the Client's Project Manager within the TQM framework. Hensey (2003) states that about 95 per cent of current literature on TQM focuses on: 1. necessities, benefits, and advantages; 2. philosophies, concepts, and principles; 3. cultural and operating changes; 4. successful strategies and firms. To emphasis this, Barrett (2003) calls for research on the role of individuals during the various phases of implementation of TQM.

TQM-ROLE OF CLIENTS' PROJECT MANAGERS

In traditional management systems, the role of the Client's Project Managers are often based on a policy of management by control' to achieve or complete the project by the required date, within budget, and to the required quality. This approach may be somewhat successful, simple, logical and consistent, but problems such as delay and low quality may arise when the work gets distorted. In this system, all participants are motivated to achieve the target with different goals, which can lead to adversarial relationships, reduced communications and accusations when goals are not met.

In TQM, quality is everyone's business, it can be achieved only through mutual trust, co-ordination. and teamwork. It needs the Client's Project Manager to participate in the process, instead of inspecting it. The Client's Project Manager should focus on operational goals, and co-ordinate the team of all kinds to provide support for the process of operation. Based on the current literature and preliminary interviews within the construction industry, the responsibilities of Clients' Representatives and the best practices to successfully perform each responsibility were established.

The main responsibilities of Client's Project Manager: preparing and organising; developing project definition; procurement; organising a joint co-ordination team; design management; safety management; measuring and reviewing performance; communication; motivation; co-ordination; documentation; and project port-mortem. Many of these responsibilities are performed by the Clients' Project Managers jointly with the other members of the project organisation. In the following sections, the relevant issues and tasks to be considered for each responsibility are briefly defined and the best practices to accomplish these responsibilities are suggested.

Preparing and organizing - Pre-Planning and organising principally includes the development of Client's quality programme and organising the Client's organisation for TQM. Before a quality programme can be finalized, the Client's readiness for the programme and objectives have to be evaluated. The main objectives of this task are to set objectives; establish policies to meet objectives; develop organisational structures; and delegate authority and responsibility. The following practices are suggested for the improvement of the preparing and organising task.

Practices for the improvement of preparing and organising

- Determine the focus, concerns and the ability levels of Client's organisation for planned improvement, by conducting first party audit.
- Visit companies who had successfully implemented TQM, and consider their

accomplishments before preparing a quality plan.

- Appoint Quality Consultant for advice, if necessary.
- Prepare a Quality policy for the Client's organisation.
- Establish organisational structures and responsibilities.
- Prepare education and training requirements for all levels of staff.
- Delegate the in-house quality champion or externalquality consultant to train the Client's organisation on professional, quality, technology, and team building skills.
- Delegate appropriate responsibilities and authority to the respective personnel, for conducting quality programme.

Developing project definition - Project definition involves defining the Client's requirements through careful planning and forethought. It includes the feasibility study of the project. The following practices for the improvement of Developing project definition' task have been identified.

Practices for the improvement of developing project definition

- Analysis the Client's brief, and highlight any omissions.
- Establish programme and staffing requirements for producing project definition.
- Apply Quality Function Deployment (QFD) and other TQM tools to develop Clients' requirements, and identify quality characteristics for accomplishing Client's requirements.
- Involve construction professionals to achieve constructability in project definition.
- In project definition, define project specific quality plan to implement TQM.

Procurement - The procurement task involves the selection of suitable contractors, professions and other participants to the project. The main objective is to ensure that the participants for the project are acquired in the most effective way. The following practices are suggested for the improvement of the procurement task.

Practices for the improvement of procurement

- Depending on the size of Client's organisation and nature of the project appoint a selection team to select project participants.
- Ensure that the selection team is represented by all sections of the organisation (i.e. marketing, operations, engineering, purchasing, construction, etc.).
- Set criteria for the Contractor selection process and ensure that this include technical skills, quality and safety systems.
- Identify the potential Contractors through questionnaire requests or preliminary interviews or by checking British Standards registration.
- Conduct an audit against identified firms, and assess that their equipment and systems satisfy the quality plan.
- Request tenderers to notify any of the aspects for quality improvement not included in the quality plan.
- Select the Contractor, who meets the pre-determined selection criteria, and seek Client's approval.

Conduct interviews with the Contractor, share project objectives and management policy, and agree the formation of a joint co-ordination team. When preparing contract document, minimise unnecessary contract terms which impose more risks and liabilities on contractor. Ensure that the co-ordination agreement and safety plans are included in the contract.

To pre-qualify Designers and Consultants consider the principles used in the Contractor selection process. Ensure that the Main Contractor adopts qualitative approaches in the selection process of Sub-contractors and vendors. Ensure that the selected Sub-contractors have got enough equipment to satisfy the quality plan. Advice the Main Contractor the principles of selection of Sub-contractors and vendors.

Organising a joint co-ordination team - Under most partnering arrangements, a joint co-ordination team should be established at the earlier stage of the project. This team should be represented by members of both the Client and Contractor. Plans and objectives specific to the project should be shared between the parties. An action plan for co-ordination, problem solving, performance measurement, communications, etc. should be prepared jointly. The

plan should address the involvement of appropriate parties form both organisations. In accordance with the action plan, responsibility and authority are delegated to the respective personnel. To improve the efficiency of this tasks, the following practices have been identified.

Practices for the improvement of organising a joint co-ordination team

- Conduct meetings of top level representatives from all parties, and share project plan and objectives.
- Assist the members to jointly develop action plans for problem solving, resolving disputes, performance measurement, communications, and corrective actions.
- Assist the members to establish the joint team and delegate responsibilities and authority to the appropriate personnel.
- Ensure that the membership of the joint team is well balanced by the representatives of the Client and the Contractor.
- Depending on the nature of project and problem, assist the joint team in appointing quality improvement team and corrective action teams.
- Record the agreed action plans, and communicate it to the entire organisation.
- Delegate the quality champion or quality consultants to train the members of the co-ordination team on quality tools and technology and team building skills.

Design management - Design management for Client's Representatives includes co-ordinating the design team for continuous improvement and checking that the design confirms and satisfies the Clients' requirements. The following practices have been identified for the improvement of the design management task.

Practices for the improvement of design management

- If design responsibility is left to the Contractor, during the pre-bid assessment, assess the design capabilities of Contractor's professionals and ensure that they have enough design expertise.
- If separate design professionals are to be appointed, pre-qualify them by auditing their expertise.
- Consult the Contractor and construction professionals for advice during the preliminary design, and achieve constructability in the earlier phase of the design.
- Provide the Designer with necessary design input data as and when required, and without delay.
- Before issuing design inputs, ensure that they are completely checked and reviewed right at the first time.
- Ensure that the detailed design satisfy fire and means of escape regulations, building regulations, health and safety regulations, and traffic and noise control regulations, etc.,

Ensure that training on health and safety at work is given by the Contractors to the workers, including those who are actually carrying out construction work.

THE CONCEPT OF TOTAL QUALITY MANAGEMENT

Total Quality Management (TQM) is a system focusing on customer satisfaction through a concept of "continuous improvement". This concept emerged after the 1980s with the purpose of developing and expanding quality management strategy by adding more aspects related to quality. Most of the literature indicates that the interest in the TQM concept at the level of production began in USA was as only theories and implemented in practice in JAPAN after World War II in order to improve the quality of industrial production consistently and comprehensively. One of the major reasons the Japanese have been so successful in business is their ability to take a concept or idea from another culture and improve on it in a uniquely Japanese fashion. The growing intensity of global competition, especially from Japan, led the US to follow Japanese strategy. This happened when Hewlett-Packard criticized US chips manufacturers for poor product quality compared with their Japanese competitors.

The TQM concept is one of the modern management concepts which helped to increase the competitiveness between organisations. This has resulted from the level of customer awareness which helps them to select a product or service of high quality and at a reasonable price. Electronic Business Magazine reported in (1992) that 91 % of 70 companies using TQM had indicated that, their quality had improved when compared with their competitors (Talha, 2004). In general, TQM is a way for managers to improve the effectiveness, flexibility, and competitiveness of a business as a whole.

TQM is considered by many researchers as an important approach in quality and business performance improvement, and therefore other industries are forcing the construction industry to adopt TQM. Pheng and Ann Teo (2004) discussed the implementation of TQM in construction firms, and concluded in their study that TQM has been recognized as a successful management philosophy in the manufacturing and service industries, so can likewise be embraced in the construction industry to help raise quality and productivity.

The United States and European industry are beginning to understand that poor quality costs companies a high amount in sales revenues nationally, and improving the quality of goods and services will help to improve productivity, lower costs and increase profitability. The United States and Europe have woken up little late, after the competitiveness of Japanese manufacturing in the early 80's. There is no doubt that most of Japanese products are better quality, and lower cost than US and European products, which may be a result of Japanese manufactures understanding the TQM concepts earlier than others.

Quality Assurance (QA) and Quality Control are both very critical terms. According to the Manual of Professional Practice for Quality in the Construction Project, "Quality Assurance (QA) is a program covering activities necessary to provide quality in the work to meet the project requirements. On the other hand Quality Control (QC) is the specific implementation of the QA program and related activities".

TQM system is an integrated system of methods, principles, and best practices that provide a framework for organisations to strive for excellence in the everyday process. To become a world class competitor, companies need a model to integrate continuous improvement tools into system that involves participative cross- functional implementation. The various models proposed by experts may support organisations in the TQM implementation process. There are some examples of some models which have recently been proposed. One is the TQM-efficient model (TQMEF), proposed by (Subhash and Narag, 2007), and aimed at recommending a TQM model for Indian organisations, as shown in Figure (1). A crucial element of TQM that has emerged is processes and efficiency. Without adequate attention to efficiency, there will be no product improvement and all TQM effort will be wasted. The TQM managers must keep an eye on cost and waste reduction, resources planning and utilization and above all safety to have a positive impact on society and growth of the organization. The main issue is focusing on customer satisfaction and making operation efficient.

The other is that of the Leicester Business School which developed a TQM Excellence Model, named 'LETQMEX', as shown in Figure (2), which aims at providing a step- bystep improvement opportunity for firms which are committed to satisfying customers better through TQM.

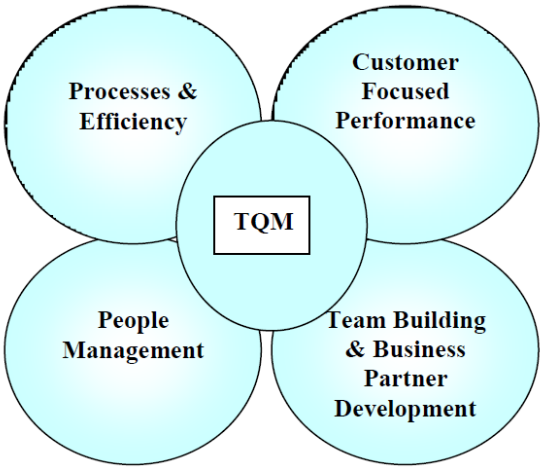
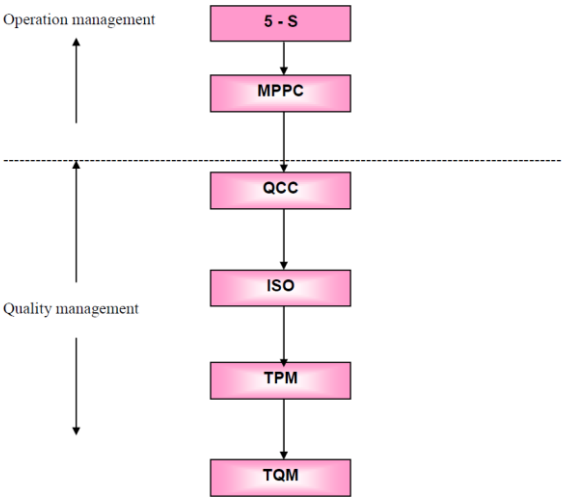


Figure 1: TQMEF (TQM-Efficiency) Model.



Key:

5-S - Seiri, Seiton, Seiso, Seiketsu, Shitsuke
MPPC - Marketing, Production and purchasing control
QCC - Quality Control Circles
ISO - ISO 9000 Series
TPM - Total Productivity Maintenance
TQM - Total Quality Management

Figure 2: The LETQMEX MODEL.

TQM evolved in the 1980s and began to have a major impact on management and engineering approaches to long-term success through customer satisfaction. It is based on the participation of all members of an organisation in improving processes, products, service and the culture in which they work. Garvin (1984) outlined the evolution of TQM as the outcome

of four major eras of development. He illustrates the evolutionary process where quality has moved from an initial stage of inspecting, sorting and correcting standards to an era of developing quality manuals and controlling process performance.

The third stage regards comprehensive manuals including areas of an organisation other than production, and the use of standard areas of an organisation other than production, and the use of standard techniques such as statistical process control (SPC). The Quality Control aimed to prevent the defects, Oakland, and Marosszeky (2006).

Define quality control as "essentially the activities and techniques employed to achieve and maintain the quality of a product, process, or service. It includes a monitoring activity, but is also concerned with finding and eliminating causes of quality problems so that the requirements of the customer are continually met". To simplify this definition one can say, Quality Control means a set of activities and methods used to complete quality requirements, by registering, analysing and writing all reports about information related to quality, so this information is the basis when making decisions related to quality, and although quality control is more sophisticated than mere entrance to inspection.

The historical development of quality as a management concept demonstrates that its evolution did not occur abruptly in sudden changes in management philosophy, but gradually through stable consistent improvement. This reflects a series of management innovations that were created during the twentieth century. Therefore, the TQM movement was not formulated as a separate philosophy, but derived from previously established scientific management concepts.

Most of the writers on TQM have their own definition, so TQM is one of the most popular modern management concepts. For the past 25 years, most governments and organisations have implemented a TQM concept.

CHARACTERISTICS OF SUCCESSFUL TQM COMPANIES

The construction industry has arrived late to TQM, probably due to the tendency to easily brush aside anything in management that is new, or to dismiss TQM as a fad. Continuous improvement is not a fad but a necessary part of management's obligation to properly run its company. Gone are the boom days when quality did not matter due to the volume of work available and the ease of obtaining work. The attitude of construction managers and contractors was simply to add it to the bill, because the owner will pay for it. In other words, in those boom days Cost plus Profit equaled Price. Now, however, the new attitude is Price minus Cost equals Profit. Owners are now demanding higher quality work, and at a lower cost. In attempting to keep pace with the new attitude, a quality management system that helps keep costs down is well worth implementing.

The characteristics that are common to companies that successfully implement TQM in their daily operations are listed here.

- Strive for owner/customer satisfaction and employee satisfaction
- Strive for accident-free jobsites
- Recognize that the owner/customer provides the revenue while the employees are responsible for the profit
- Recognize the need for measurement and fact-based decision making
- Arrange for employees to become involved in helping the company improve
- Train extensively
- Work hard at improving communication inside and outside the company
- Use teams of employees to improve processes
- Place a strong emphasis on the right kind of leadership, and provide supervisors with a significant amount of leadership training
- Involve subcontractors and suppliers, requiring them to adopt TQM
- Strive for continuous improvement

Quality principles that successful TQM companies recognize The quality principles that successful TQM companies recognize and attempt to continually incorporate into their actions are the following:

- People will produce quality goods and services when the meaning of quality is expressed daily in their relations with their work, colleagues, and organization.
- Inspection of the process is as important as inspection of the product. Quality improvement can be achieved by the workers closest to the process.

- Each system with a certain degree of complexity has a probability of variation, which can be understood by scientific methods.
- Workers work in the system to improve the system; managers work on the system to improve the system.
- Total quality management is a strategic choice made by top management, and must be consistently translated into guidelines provided to the whole organization.
- Envision what you desire to be as an organization, but start working from where you actually are.
- Studies have indicated that people like working on a quality-managed jobsite especially due to the cleaner site and safer place to work.
- Accept the responsibility for quality. Establish datums for measurement.
- Use the principle of get it right, the first time, every time.
- Understand that quality is a journey, not a destination. It consists of steps that form a process that is continuous.

The goal of management is to create a culture of quality across the entire project site--get the job done right, the first time, every time. As in the airline industry where 99-percent quality is not good enough, the construction industry also needs to strive for 100-percent quality. Today, the number of contractors being considered for projects by some owners is growing smaller, and only those contractors who can produce quality work are being asked to bid by these owners. Every effort to incorporate the above principles into the company's actions will further quality production.

TOTAL QUALITY MANAGEMENT PERFORMANCE MEASURES

Organizations A and B have different ways of measuring the performance of TQM. These are discussed below.

Top Management Commitment-The degree of visibility and support that management takes in implementing a total quality environment is critical to the success of TQM implementation. Organization B lacked that commitment from top management, which was why TQM was unable to be implemented in its entirety. There were no commitments to replace the person responsible for implementing TQM and there was no sharing of TQM knowledge. In Organization A, top management supported TQM through the allocation of budgets, planning for change ~right at the beginning of implementation!, and providing methods of monitoring progress of construction works.

The main support came from the visibility of this commitment. The staff from its headquarters believed that if it is clearly visible that top management was committed to implementing TQM, employees would naturally follow suit. Management also reduced traditionally structured operational levels and unnecessary positions within the organization. This can be seen in the lean organization chart of Organization A in Fig. 3 when compared with that of Organization B in Fig. 4. They believed that simplifying the organization would lead to the establishment of an infrastructure of integrated business functions participating as a team and supporting the strategic vision of the company.

Customer Involvement and Satisfaction- Organizations A and B both have customer feedback forms to assess the level of customer satisfaction for each project. In addition to that, timely and dependable deliveries are ensured. Organization A aims to provide customers with timely information and quick responses to complaints, whilst maintaining the corporate goal of reducing the number of complaints. Organization B utilizes customer surveys, measures the percentage of repeat customers, and uses this information to assess customer satisfaction.

Within the project structure, customer satisfaction is achieved by ensuring that drawings and specifications are communicated to the rest of the parties should there be any changes. The parties affected by the changes can then promptly adjust their information and help to reduce the amount of time wasted.

Employee Involvement and Empowerment- Organization A demonstrates empowerment by allowing its project managers to take full responsibility and make decisions for their project. Project managers are allowed to make financial decisions but must ensure that the project budget is not exceeded. They should refer the issue back to the top management of Organization A if they are not sure of the appropriate decision. Employees are encouraged to present improvement and cost saving suggestions to management and to a certain degree, are allowed to self-implement solutions. However, the quality systems manager of Organization B mentioned that this system of feedback and suggestions did not work for them. This was because the ideas were either not substantial enough to warrant change or nobody made any suggestions. When employees first joined Organization A, they were oriented to the philosophy of the company of commitment to never-ending improvement. They were informed of the strategic

goals of the company and made to feel that they are part of a team. Training was extended to the employees of Organization A as opposed to the case of Organization B where training was only extended to top management. As Organization A had resources from its headquarters in Japan, they were more willing to spend time and money on training employees in the management of TQM principles, problem-solving, and most importantly, teamwork. The quality systems manager of Organization B did not have the details of the training program implemented for top management except that the training was to educate them about TQM concepts and principles. The employees of Organization B were not sent for training as the decision against implementing TQM was made before training could commence.

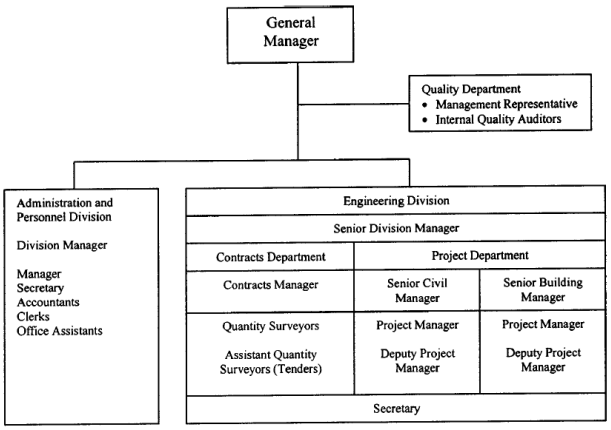


Fig. 3. Chart of Organization A.

Customer–Supplier Relationship-As for evaluating suppliers in order to identify if the organization should offer more jobs to them in the future, Organizations A and B monitor the percentage or the number of orders that were delivered late. Organization B has a vendor evaluation form for all suppliers and subcontractors in terms of delivery and work performance.

Both organizations have a few suppliers with whom they work closely. These partnerships are based on the quality of their work and their actions in documenting improvement processes for continuous improvement in quality standards.

Process Improvement and Management-TQM is also concerned with adding value to processes, increasing quality levels, and raising productivity. As for raising productivity, Organization A measures productivity on site by calculating the amount of finished work divided by the number of hours used to complete the work, using fewer but higher skilled workers. A defect cost index was set up to calculate the cost and number of defects for all completed projects to enable the organization to prevent such defects from occurring again. The costs of defects during the defect liability period and the estimated costs of defects during the project are added up. This is then divided by the direct costs of defects, including that of subcontractors and multiplied by 100. The index should not have a value larger than 3.

So far, all projects of Organization A were below this value. Organization B also measures the amount of defects but they do not use a special index.

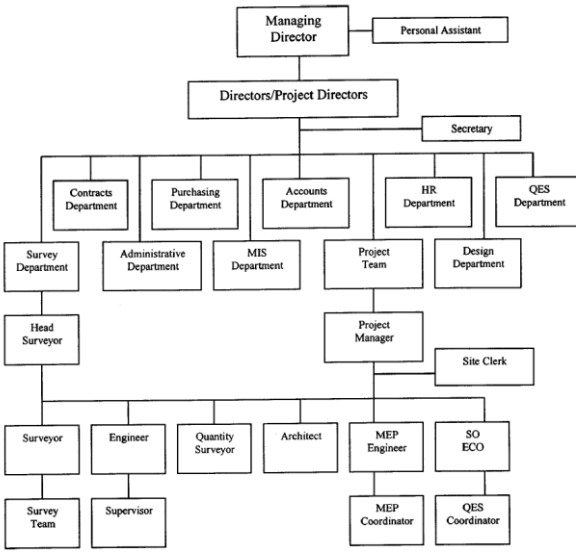


Fig. 4. Chart of Organization B.

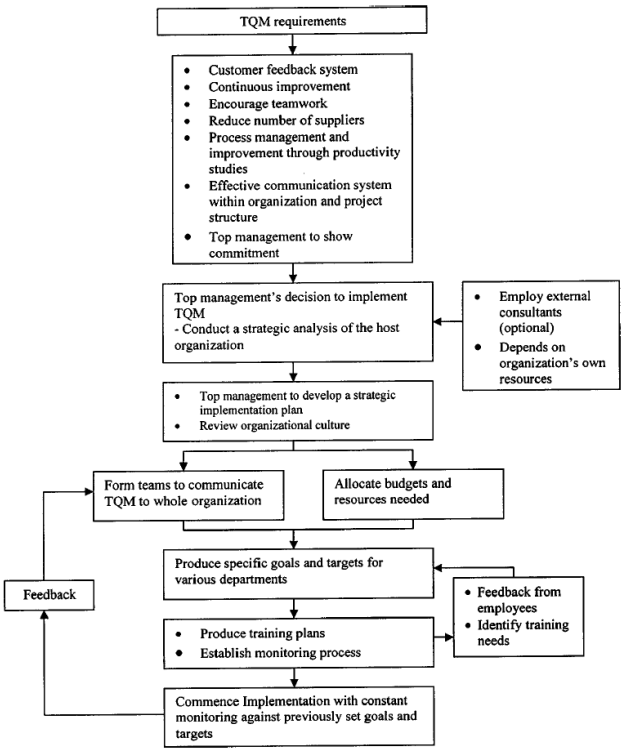


Fig. 5. Framework for implementing total quality management.

CONCLUSION

This paper pointed out how construction professionals implement TQM and its tools in their projects in the different stages (design and construction). From the results and conclusions from each case study included in this paper, it's clearly now that TQM is not a fad and how much benefits that TQM can bring to your construction business (Improve business quality, increase customer satisfaction, reduce cost, save time and much more).

The reason that the construction industry has arrived late to TQM is that the construction professionals unaware of the TQM principles and techniques. It is apparent that if TQM is to be implemented successfully on construction sites the inhibitive issues that have been identified from the literature and the contractor survey need to be addressed on a comprehensive and integrative basis. The principles of TQM should be applied beyond management levels and include workers on construction sites. These workers must be empowered, involved and trained in problem solving.

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