AN EMPIRICAL CASE STUDY AND APPROACH ON TQM IN A STIPULATED CONSTRUCTION FIRM

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ABSTRACT: In comparison to other sectors such as manufacturing and service, the construction sector is perceived to impose a low value on performance. TQM is implemented by very few construction companies in this world, and the top-down technique is widely used. To incorporate TQM in a company, top management must contribute to a "bottom-up" strategy by creating a "Quality Circle." According to this study, the first and most important criteria for introducing TQM in construction firms is top management involvement, other obstacles that companies must overcome include a lack of education, lack of confidence, lack of common trust, a lack of skilled staff, market competition, weak strategies and requirements, bad behavior, the availability of experienced field managers, and so on. In this approach, one case study is analyzed to show how Total Quality Management (TQM) is efficiently applied by using a "bottom-up" approach and creating a PMO in an Indian construction company. After some study of the Pareto graph, and identifying root causes using Root Cause analysis, experience is applied in the provided studied construction firm to apply TQM. Following that, a method for applying TQM in a building company is suggested.

Keywords: Total Quality Management (TQM); TQM Gurus, TQM Implementation; TQM tools; Quality Circles; Pareto analysis.

1. INTRODUCTION

Total quality management (TQM) is a concept of continual improvement focusing on the customer and quality[1]. It is the outcome of quality improvement. It was established by Walter Shewhart in the early 1920s when statistical theory was used for product quality control. Following that, in the 1940s, the concept was proposed in Japan under the leadership of Americans such as Deming, Juran, Feigenbaum, and Crosby [2]. Appropriate standards of quality have long been a concern in the construction sector. Each year, significant amounts of time, money, and capital, both human and material, are ruined because of ineffective or nonexistent quality control procedures. Total Quality Management (TQM) principles, first used in Japan and recently adopted in the United States, have boosted production reduced component costs, and enhanced production efficiency in the manufacturing industry. These ideas also apply to the building industry [3].

Quality is a concept used to describe the twenty-first century. Performance would have to be incorporated into all elements of a competitive company if it is to gain market share. Quality is a
resource or an element. Quality is a significant concept that is usually applied to the end-use of a consumer. Quality is characterized as a product's ability to meet the needs of its consumers. In other words, consistency is an indicator of a product's ability to meet the needs of the final consumer. In general, quality refers to the characteristics of an item or service that determine its ability to reliably meet or surpass consumer standards. Characteristics are applied to a product or service at any stage of its life cycle, from content processing to consumer use. As a result, all divisions of an organization have a role to play in deciding the quality of the product or service.

According to Crosby [4], consistency is "conformance to standards or specifications." Quality, according to Juran, is "suitability for use". This usually refers to its consistency, compliance, protection, longevity, and consistency. After World War II, when the Japanese chose to compete on two fronts-quality and price-quality emerged as a major factor in business performance. Before this, US business companies appeared to rely primarily on price, with performance a distant second. The rise of the Japanese impacts the global market landscape. The Japanese introduced a novel concept: improved quality equals lower cost, which was entirely strange at the time, and is still prevalent today. The main subject of "quality" is a compromise seen between a supplier's price and value.

2. LITERATURE REVIEW

2.1. EVOLUTION OF QUALITY

Quality management is a new trend. Clients could choose products that are created using advanced crafts in advanced cultures. Professional craftsmen or artists in those communities oversee their own workshops and educate and track others. A mass manufacturing and regularly scheduled process rendered artisan skills unnecessary. Mass manufacturing was the aim. Eli Whitney was the first pioneer in the United States who introduced parts manufacture for muskets, a practice that set up a musket production line. Several people, including Frederick Winslow Taylor [5], called for the next step. He has been called the "father of research management." His approach also covered aspects of quality management, such as interoperability and the implementation of improved approaches. Henry Ford has made major contributions to improving assembly line quality management and procedures. In Germany, Karl Friedrich Benz is known as the "father of the car," though real mass manufacture started with Volkswagen after World War II. North American industries now stress production at a lower cost and greater productivity.

After the Second World War, Japan wanted to make quality management a citizen as part of restructuring their economy. Several active-quality programs have been created by the Japanese. Quality programs in products from the 1950s through the 1970s led to Japan attaining very high standards of quality. Quality management is becoming more holistic, with considerations for people, methods, and commodities all being included. Many of the approaches not only have strategies, but also quality culture (i.e., citizen factors) [5].

2.2. IMPLEMENTING TQM IN CONSTRUCTION

One critical stage in achieving a whole quality management system in construction is to form a construction team composed of a major contractor and subcontractors who will be committed to the quality process and build a real quality mindset [6].
TQM may be applied in three phases inside an organization: investigation and awareness, planning and coordination, and execution. The majority of firms in the construction sector were hesitant to apply TQM, believing that the ISO 9000 series was sufficient but also that management did not attempt to commit their workforce to more "acculturative stress." Additionally, organizations perceive that there may be other vital concerns, such as safety. Additionally, firms in the construction sector have delayed adopting TQM procedures due to an apparent lack of short-term advantages. Due to the inherent complexity of construction works and their ever-changing atmosphere. The management system must be adaptable, attentive to proper communication, and ever improving. Clients would forgo the constitution of allocating bids based on the lowest bid and instead push to compensate the smartest developers and vendors capable of providing the greatest service. the acknowledged relationship between numerous market situations and TQM procedures. This indicates that competitive forces will drive TQM implementation. Firms should form customer collaborations by emphasizing quality above pricing when selecting vendors.

2.3. QUALITY CIRCLE

Several firms in India have been adopting the quality circles idea over the previous two decades. Factories and many other organizations must integrate quality circles such that the population as a whole can realize the maximum economic advantages and profits. The quality circle organization is an unstructured engagement between the public and private organizations, assisting one another in achieving the company's goals. Several members of the continuous improvement advisory board have been chosen to represent operations, process optimization, innovation, and performance monitoring. This committee serves as an advisory group for quality circles. The advisory board maintains a database of and supervises quality circles in factories and organizations [7].

2.4. RESULTS FROM QUALITY GURUS

It has been determined that each quality guru uses a different approach to TQM. Even so, the author gains a greater understanding of TQM through the principles and methods suggested by these content gurus. Their perspectives provide an excellent basis for undertaking this research. While their approaches to TQM are not identical, they do share the following points:

(1) Management is accountable for committing to, leading, empowering, encouraging, and supporting technological and human processes. The top management must provide the atmosphere and structure for operations within a company. It is critical that management encourages workforce interest in quality enhancement and cultivates a quality culture by altering workers' perceptions and behaviors about quality.

(2) Emphasis is placed on strategy, regulation, and firm-wide assessment practices.

(3) The importance of employee education and preparation is emphasized in terms of changing employees' values, behaviors, and perceptions as well as improving employees' ability to perform their duties.

(4) It is critical to monitor processes and to continuously develop the quality framework and product design. The priority is defect prevention, not post-mortem testing.
(5) Quality is a systemic enterprise-wide operation that spans the supply chain from manufacturers to consumers. Quality management efforts should include all practical practices, including marketing, planning, engineering, sourcing, assembling, testing, shipping, billing, implementation, and operation.

Figure 1. Results from quality Gurus [8].

| S. No | Quality Guru’s          | Contribution                                                                 |
|-------|-------------------------|-------------------------------------------------------------------------------|
| 1     | Edward Deming           | Deming cycle, 14 points for transforming management, seven deadly diseases   |
| 2     | Kaoru Ishikawa          | Quality circle seven quality method, a fishbone diagram                       |
| 3     | J.M Juran               | Quality trilogy, Pareto principle                                             |
| 4     | Philip Crosby           | Zero defect, cost of poor quality, quality is free.                           |
| 5     | Genichi Taguchi         | Quality loss function, Robust design by design of experiment                 |
| 6     | Armand Feigenbaum       | Total quality control                                                        |

2.5. QUALITY TOOLS

Numerous instruments and approaches for quality assurance have been identified by researchers. A single tool is a device that serves a defined objective and is often used independently, whereas a method has a broad use and is seen as a collection of tools [9]. Practical ways, qualities, procedures, or strategies that may be applied to specific activities are referred to as tools and techniques. They are used, among several other aspects, to support good transformation and progress [10]. There are several high-quality and problem-solving tools available. To focus the context, the seven fundamental quality tools and tools emphasized in the six-sigma programmed and education were chosen. These seven quality tools were chosen since they are most well recognized, promoted, and implemented [11].

Additionally, comparable organizations employ various Quality Tools (QTs), with significant effects. Currently, companies hire the QTs indicated by the quality improvement paradigm. However, no organization can profit from every QT, and there is no guidance to assist companies in making decisions on which ones to utilize [12]. The basic seven fundamental tools are a Check sheet, Histogram, Pareto analysis, Process flow chart, Cause-Effect diagram, Scatter diagram, Control chart [13]. In this study, we are only using two of the seven fundamental tools. Those two fundamental methods are Check sheet and Pareto analysis.
3. RESEARCH METHODOLOGY

A construction firm in Hyderabad, India, has been chosen as a case study from the start of the research. Data was collected in this company and analysis was done. This company's primary objective is the development of buildings and the sale of apartments. They construct residential and industrial buildings and then sell them to customers. The following are the reasons for choosing this firm: there are a lot of opportunities for implementing quality tools in various areas of the company's market, and the author of this research is a full-time employee of this company. This company’s managers tried to increase the efficiency of their jobs as well, but they did not achieve the best results.

A check sheet is used to gather information from an external flat buyer as well as internal staff. The gathered data is then evaluated using Pareto analysis to classify the key problems that can have the greatest benefits if solved. The root causes of a process flow are identified. Identifying root causes necessarily involves any method of research. Finally, several basic root causes for change are defined.

4. DATA COLLECTION

A preliminary investigation was conducted to gain an understanding of the work procedures of various divisions of a construction company, such as construction managers, construction sites, ready-mix concrete plants, architecture division, architect section, quality control section, real estate section, human resources section, and marketing section. Additionally, it assists in identifying any potential problems in the work phase that appear regularly in specific sections.

Data was gathered from 100 external consumers (flat purchasers) on their perceptions of quality and management problems. The data gathered is then summarized on the check sheet. Another internal client (staff member) check sheet is accomplished by gathering data from the firm's internal staff about their knowledge and perceptions of quality problems. The data gathered by the checklist is then ready for Pareto analysis. The data is sorted ascending, and average percentages are calculated by counting or comparing the frequency of occurrences. According to Vilfredo Pareto's 80-20 rule, vital few and trivial much are defined. Following the review and identification of problems by various teams and divisions of the construction company, detailed outcomes are listed, such as identified major problems, minor problems, and specific points to be resolved for effective TQM implementation. Finally, some specific topics are addressed briefly.

4.1. CHECK SHEET

The check sheet, alternatively referred to as a "Defect Concentration Diagram," is a data collection sheet. It is a straightforward tool for storing information for later processing. The data collection sheet should be pre-printed and extremely systematic and organized, making it easier to identify the issue. This is a general-purpose method that can be used for several purposes but is most often used to determine the occurrence or trends of accidents, incidents, faults, defect position, and defect causes. This is a commonly used method for analyzing efficient processes for statistical quality control purposes [10].
4.2. PARETO ANALYSIS

Pareto analysis is a decision-making methodology that utilizes statistics to identify a small number of tasks that have a major overall impact. It is widely used and simple to execute the tool. Pareto analysis is a reasonably straightforward technique for determining which activities or conditions in an organization can have the greatest effect [14]. It arranges the data/factors in descending order of their number of occurrences. The cumulative frequency is multiplied by 100. The "vital few" elements constitute the majority (80%) of a total number of occurrences, while the "useful many" account for just 20% of occurrences, which is also referred to as the 80-20 law established by Italian economist Vilfredo Pareto [Formatting Citation].

Typically, the results of a Pareto analysis are described by a Pareto chart. The map illustrates the different variables considered in descending order. This map is shown in the format of a bar chart in descending order and assists in identifying the aspects that are critical by superimposing a line graph that cuts an 80% average percentage and assists in finding out the factors that have the minimum number of benefits and vice versa. Joseph Juran expanded on this idea and discovered that it applies to a wide variety of areas of daily life [16]. For instance, it can be extended to a variety of topics, including looking for books online in a library resources database, deciding which activities in a project can have the greatest effect, finding the main sources of consumer concerns about goods or services, and identifying the products or services that generate 80% of the profit.

4.2.1. PARETO ANALYSIS OF CHECK SHEET DATA

Figure 2. The Pareto Chart illustrates the relationship between external customers (flat buyers) and issues related to quality and service.
Table 1. The Pareto Chart illustrates the relationship between external customers (flat buyers) and issues related to quality and service.

| S. No | Name of Complaints                                      | Frequency | Cumulative | Cumulative % |
|-------|-------------------------------------------------------|-----------|------------|--------------|
| 1     | Handover delay                                        | 100       | 100        | 11%          |
| 2     | O & M (operation and maintenance) handing over        | 96        | 196        | 21%          |
| 3     | Availability of Skilled and experienced O&M team      | 94        | 290        | 31%          |
| 4     | Plaster crack                                         | 93        | 383        | 41%          |
| 5     | Bad workmanship                                       | 91        | 474        | 51%          |
| 6     | Sanitary fitting height issues                        | 86        | 560        | 60%          |
| 7     | Addition /omission mismanagement and delay            | 83        | 643        | 69%          |
| 8     | Door, window related problems                         | 74        | 717        | 77%          |
| 9     | Snag Works                                            | 65        | 782        | 84%          |
| 10    | Dampness Issues                                       | 32        | 814        | 88%          |
| 11    | Tiles hallow Sound problems                           | 23        | 837        | 90%          |
| 12    | RCC construction joints crack                         | 16        | 853        | 92%          |
| 13    | RCC top floor ceiling leakage                         | 14        | 867        | 94%          |
| 14    | Parking problem                                       | 14        | 881        | 95%          |
| 15    | Pressure problem in water taps                        | 12        | 893        | 96%          |
| 16    | Electrical line related problems                      | 12        | 905        | 98%          |
| 17    | Drainage problem                                      | 8         | 913        | 98%          |
| 18    | Toilet floor slope problem                            | 6         | 919        | 99%          |
| 19    | Lift related problem                                  | 5         | 924        | 100%         |
| 20    | Others                                                | 3         | 927        | 100%         |

Figure 3. Internal employee survey on quality problems. The survey is done using 100 cases (at Site & management at the Head Office)
5. RESULTS AND DISCUSSIONS

After Pareto analysis, the major causes identified are Handover delay, O & M (operation and maintenance) handing over, Availability of Skilled, and experienced O&M team, Plaster crack, Bad workmanship, Sanitary fitting height issues, Lack of incentives, Motivational deficit, Inexperience of labor, Inaccurate master budget, Inexperience of Supervisor, Modifications to the scope, Overhead reduction policy, The Inexperience of Site Engineer, Recruitment discrimination, Inappropriate HR function.

The following consequences usually occur because of the mentioned major causes. Failure to meet the deadline, client satisfaction is low. Increased costs for rework, materials, and labor. Additional expense and loss, Additional time, Incompatibility of areas, Conflict with a neighbor. Reduced output (low productivity), Negative impact on brand reputation, Unsafe superstructure, a threat to life Additional correction, resolve to failure.

5.1. PROBLEMS IN MANAGEMENT

5.1.1. Inadequate performance appraisal and motivation of staff

Employee satisfaction is another parameter that can be used to evaluate quality management. This tool is quite effective at enhancing the quality of work. Employees will be highly motivated.
if their work is properly reviewed and rewarded consistently. Although this organization has a human resources department, they are not completing their primary tasks, which include proper employee performance appraisal and reward based on demand, ongoing staff training, and inspiring staff through promotional offers. They are predominantly driven by upper management. As a result, some prospective workers become dissatisfied and reduce their productivity.

5.1.2. Lack of skilled employees
According to the approach, the primary impediment to construction sector efficiency is a lack of education. The majority of subcontractor employees are not properly trained. They often come from rural areas and learn the trade of masonry from a master mason. They lack formal schooling and theoretical expertise. Thus, upon inspection, it is discovered that they are operating outside of established regulations and norms. As a result, qualitative work cannot be achieved to the required standard, and occasionally, rework is required, paying higher costs in terms of material and labor.

5.1.3. Inadequate Education
Another issue with this organization is a lack of awareness. The majority of this company's subcontractors and workers are not properly educated in their respective industries. Without any theoretical basis, most of them become experts by doing the job. They frequently make mistakes in their job because of poor supervision and a lack of skilled management. Furthermore, because they lacked theoretical understanding, various subcontractors performed the same work in a variety of ways. This is a relatively typical problem in India.

5.1.4. The cost reduction policy is implemented by management.
The corporation in question is still conscious of this style of management. Even after the loss of the higher price, they still believe that quality is a matter of the additional expense. To a far greater extent, other activities may be accomplished at this price. The evidence presented here shows that these companies are not truly raising their investment in their construction phase or not investing in their workers' training. To cut costs, the entire management team must look for ways to cut costs throughout the development process. As a result, it is difficult to catch deadlines or accomplish poor work. Because of this, it tends to provide low productivity for businesses and low-quality production.

5.1.5. Lazy and rude attitude
Unmotivated and unpleasant behaviors have been increased by the competitive market, incompetent management procedures, and a complete absence of better standards. Prominent words and phrases, which include "It isn't my responsibility" and "If it isn't broken, don't fix it," often reflect opinions shared by consumers. Some feel slightly familiar to you. They all lead to problems. This approach is typically the result of less motivation, more compensation, greater pressure, and management techniques that seem to be unfriendly to the workforce.

5.2. PROBLEMS ASSOCIATED WITH DESIGN
5.2.1. Dissimilarities in the design processes of all designers
Structural designs for almost identical types of structures are being carried out in a structured way by many designers. Certain generic systems, such as shoreline security and soil excavation, shore pile bracing, column-beam framework, column, beam, and slab size and thickness, and so on, maybe
kept consistent if designers consult with one another through the design process. There is a consultant with whom architects consult and get guidance from time to time during the design process. However, perfect design resemblance is not reached. The difficulty stems from the lack of desire to consult with experts. Another reason is that this section lacks a senior coordinator.

5.2.2. Inadequate communication with the corresponding architect

Construction is the process of constructing, reconstructing, adding to, subtracting from, or renovating. Thus, design modification or amendment is a common phenomenon in construction organizations. A building's fundamental theory is developed by an architect. An architect often creates planning, modeling, and viewpoint. The designers specify exactly the materials required, such as reinforcement, concrete, cement, bricks, or blocks. Additionally, he makes recommendations to the architect on the thickness and size of the RCC member. Thus, if a designer wants to alter or revise a design, he or she must communicate with the authorized architect. Otherwise, true architectural thought may be stifled.

5.3. PROBLEMS RELATED TO ARCHITECTURE

5.3.1. Errors in architecture and a lack of motivation

Architects can make plumbing fixture design mistakes that influence performance. They frequently created the erroneous setup as specified in the drawings. Complaints occur from tenants after handover, with the developer financing the operational costs. A committee was recruited to monitor the initial planning work and internal arrangement of the bathroom and kitchen fixtures. We examined the sites three times. The challenges of this squad have been much decreased in one year. Additional reasons include architectural design activities. Following the work's completion, architects modify their designs and recommendations multiple times. As a result, developers lose resources, materials, and money as well as miss deadlines. In general, the expertise of architects is inadequate. The only solution is for architects to make sensible and reasonable recommendations that everyone can accept. This suggests architects should have experience.

6. CONCLUSION

The construction sector has various challenges in achieving high-quality performance because of the sector's complexity. TQM is progressively being used in the construction industry to address quality issues. TQM deployment requires a shift in organizational culture and management behavior. Historically, building enterprises have been overlooked and have been structured inappropriately in several companies. The organization's present culture must be transformed into a TQM environment that prioritizes quality as a primary strategy. A review of the literature, findings and analysis of a case study conducted in various departments of a construction firm recognizes several key aspects that lead to the effective implementation of TQM, including organization commitment, education and training, teamwork, human resource management, and empowerment, supplier relationships, quality planning and strategic, process management. These quality culture elements should be incorporated into the construction organization's TQM implementation for continual development.

REFERENCES

[1] T. Elghamrawy and T. Shibayama, “Total Quality Management Implementation in the Egyptian,” vol. 24, no. 3, pp. 156–161, 2008.
[2] I. Othman, S. Norfarahhanim, M. Ghani, and S. Woon, “The Total Quality Management (TQM) journey of Malaysian building contractors,” Ain Shams Eng. J., no. xxxx, 2020.

[3] D. Arditi and H. M. Gunaydin, “Total quality management in the construction process,” vol. 15, no. 4, pp. 235–243, 1997.

[4] W. J. Miller, “Working Definition for Total Quality Management (TQM) Researchers,” J. Qual. Manag., vol. 1, no. 2, pp. 149–159, 1996.

[5] J. Yong and A. Wilkinson, “The long and winding road: The evolution of quality management,” Total Qual. Manag., vol. 13, no. January 2015, pp. 37–41, 2010.

[6] L. S. Pheng, “A framework for implementing TQM,” TQM Mag., vol. 8, no. 5, pp. 39–46, 2006.

[7] R. Kumar, R. Duhan, and S. Duhan, “Quality Circle: A Methodology to Identify Scope of Quality Improvement through Kaizen Approach,” vol. 5, no. July, pp. 43–51, 2015.

[8] B. Neyestani, “Principles and Contributions of Total Quality Management (TQM) Gurus on Business Quality Improvement,” SSRN Electron. J., 2018.

[9] J. Jos and V. Sabater, “Quality tools and techniques: Are they necessary for quality management?” vol. 92, pp. 267–280, 2004.

[10] P. G. H. R.E. McQuater, C.H. Scurr, B.G. Dale, “Using quality tools and techniques successfully,” TQM Mag., vol. 7, no. 6, pp. 37–42, 2006.

[11] C. Hagemeyer, J. K. Gershenson, and D. M. Johnson, “Classification and application of problem-solving quality tools: A manufacturing case study,” vol. 18, no. 5, pp. 455–483.

[12] E. Aspinwall and P. A. Sampaio, “Total Quality Management & Business Excellence Performance measures and quality tools in Portuguese small and medium enterprises: survey results,” no. June 2015, pp. 37–41.

[13] M. Sokovi, J. Jovanovi, and A. Vujovi, “Basic Quality Tools in Continuous Improvement Process,” vol. 55, pp. 1–9, 2009.

[14] H. F. Cervone, “Managing Digital Libraries: Applied digital library project management task importance rankings,” 2009.

[15] G. Karuppusami and R. Gandhinathan, “Pareto analysis of critical success factors of total quality management: A literature review and analysis.

[16] F. Talib, Z. Rahman, M. N. Qureshi, and T. Roorkee, “Pareto Analysis Of Total Quality Management Factors Critical To Success For Service,” Int. J. Qual. Res., vol. 4, no. 2, pp. 155–168, 2010.