Study of TQM & Six Sigma Concept For Construction

Rakesh Firodiya[1], Upendra Saharkar[2]
[1, 2] Department of Civil Engineering
[1, 2] Dr.D.Y Patil Institute of Engineering & Technology, Ambi, Pune

Abstract- *The manufacturing industry has developed Total Quality Management (TQM) concepts, first applied in Japan and in recent years used in the United States, which have increased productivity, decreased product cost and improved product reliability. TQM focuses on process improvement, customer and supplier involvement, teamwork, and training and education in an effort to achieve customer satisfaction, cost effectiveness, and defect-free work. TQM provides the culture and climate essential for innovation and for technology advancement. Six sigma can be used for achieving and maintaining quality of construction activities in residential buildings.*

Keywords- TQM, Quality, Construction.

I. INTRODUCTION

Great expenditures of time, money and resources, both human and material, are wasted each year because of inefficient or non-existent quality management procedures. The manufacturing industry has developed Total Quality Management (TQM) concepts, first applied in Japan and in recent years used in the United States, which have increased productivity, decreased product cost and improved product reliability. Japanese construction companies, benefiting from the experiences of Japanese manufacturers, began implementing TQM during the 1970s.

Quality in Construction

Requirements may be simple or complex, or they may be stated in terms of the end result required or as a detailed description of what is to be done. But in popular terms, quality is obtained if the stated requirements are adequate, and if the completed project conforms to the requirements. Some design professionals believe that quality is measure by the aesthetic of the facilities they design. building's psychological impacts on its inhabitants, the ability of a landscaping design to match the theme of adjacent structures, and the use of bold new design concepts that capture people's imaginations. Because aesthetic definitions of quality are largely subjective, major disagreements arise as to whether quality has been achieved or not. Since objective definitions of aesthetic quality do not exist, design professionals generally take it upon themselves to define the aesthetic quality of their designs. Quality can also be defined from the view point of function, by how closely the project conforms to its requirements. Using this definition, a high quality project can be described by such terms as ease in understanding drawings, level of conflict in drawings and specifications, economics of construction, ease of operation, ease of maintenance, and energy efficiency. In the construction industry, quality can be defined as meeting the requirements of the designer, constructor and regulatory agencies as well as the owner.

II. FACTORS THAT AFFECT QUALITY

Establishing the project requirements for quality begins at project inception. A careful balance between the owner's requirements of the project costs and schedule, desired operating characteristics, materials of construction, etc. and the design professional's need for adequate time and budget to meet those requirements during the design process is essential. Owners balance their requirements against economic considerations and, in some cases, against chance of failure. The design professional is obligated to protect public health and safety in the context of the final completed project. The constructor is responsible for the means, methods, techniques, sequences, and procedures of construction, as well as safety precautions and programs during the construction process] Project requirements are the key factors that define quality in the process of construction. The process of construction can be broken down into three main phases, namely,

(1) The planning and design phase,
(2) The construction phase, and
(3) The maintenance and operation phase.

TQM requirements

TQM is a process that requires universal involvement to be successful. This includes customer involvement. As more and more companies become involved in the TQM process and demands for improved quality increase, this concept becomes increasingly important. Customers may be either internal or external. Satisfying the needs of these customers is an essential part of the process of supplying the final external customer with a quality product. Juran claims that the parties in a process (supplier, processor, and customer) have a "triple role". Juran's "triple role" concept applied to construction. The designer is the customer of the owner

because the designer has to receive the project requirements from the owner in order to provide a feasible design. The designer supplies plans and specifications to the constructor; in this case the constructor is the designer's customer because the constructor uses the designer's plans and specifications, then conducts the construction process, and finally supplies the completed building to the owner. The owner is now the constructor's customer. Quality in each phase is affected by the quality in the preceding phases. Therefore customer service in each phase is important for the overall quality performance of the process.

Supplier involvement

The ability to produce a quality product largely depends on the relationship among the parties involved in the process; the supplier, the processor, and the customer. The quality of any stage in a process is contingent upon the quality of the previous stages. The quality of the project built by the constructor is directly related to the quality of the plans and the specifications prepared by the designer, the quality of the equipment and materials supplied by the vendors, and the quality of work performed by the subcontractors. Close and long-term relationships with these suppliers to the construction process are required if the constructor is to achieve the best economy and quality.l~ Traditionally, in the construction industry, contractors, subcontractors, and vendors are all pitted against one another to compete on the basis of low-bid contracts. Yet, the fourth of Deming's 26 14 recommendations for reaching a high level of quality stresses that companies must end the practice of awarding business on the basis of price tag alone. According to Peters, 27 successful projects in the future are likely to be decided based on quality, life-cycle costs (not initial cost), and supplier responsiveness, which can only be achieved through partnership relationships; these relationships will involve fewer suppliers, and they are expected to be based on mutual trust. This is already being proven true in certain areas of the industrial construction market. Long-term partnering agreements have been formed between a number of owners and contractors. Some owners are requiring their contractors to have formal TQM programs, and both owners and contractors are requiring their vendors to implement TQM if they wish to be considered for future work.

III. CONSTRUCTION INDUSTRY-SPECIFIC FACTORS

While the evolution of quality control in the construction industry is parallel to that of the manufacturing industry, many dissimilar characteristics distinguish the two industries. The following differences, some of them significant, must be considered when applying a quality program to construction.

- Almost all construction projects are unique. They are single-order, single-production products.
- Unlike other industries, which usually have a fixed site with similar conditions for production each construction production site always displays different conditions.
- The life-cycle of a construction project is much longer than the life-cycle of most manufactured products.
- There is no clear and uniform standard in evaluating overall construction quality as there is in manufactured items and materials; thus, construction projects usually are evaluated subjectively.
- Since construction projects are a single-order design project, the owner usually directly influences the production.
- The participants in the construction project--owner, designer, general contractor, subcontractor, material supplier, etc.--differ for each project. Because of these distinguishing characteristics, the construction industry has generally been considered to be quite different from manufacturing industries. That is why, quality control procedures that work effectively in a mass production industry have not been considered suitable for the construction industry. Consequently, quality control throughout the construction industry has not evolved to the level attained in manufacturing industries. According to Asakaoru, 3° project design and construction planning are carried out based upon a standard derived from relevant codes, owner requirements, and design company standard practice. Construction is then managed to conform to this composite standard as interpreted by the constructor. Quality assurance via owner, designer, or building authority, or a combination, occurs after completion, and in some cases, after partial compensation. This process results in the following trends.
- Quality is designed into and evaluated for each individual project each time. Except for some specialized areas of construction such as nuclear power plants and interstate road construction, there is no comprehensive quality policy employed to establish quality assurance for the entire industry or large segments of the industry.
- No feedback system exists for reexamining quality control work. Correction only occurs when the owner, designer, or building authority points out defects in the project. This makes quality evaluation difficult.
- It is difficult to establish a data collection system to build an information base that could lead to early identification of defects. Since post-completion correction of unacceptable work damaging to a company's or an individual's reputation, or both, the defect that occurs

during construction is usually corrected or concealed before top level management or the owner discovers it. Thus, lack of information means no change in procedures, and allows the defect to reoccur during the next project.

- No mechanism exists for practical implementation of standards. This is not only because too many standards exist, but also because there are no efficient means for inputting new information and, thus, maintaining relevant standards.
- No system exists to manage quality throughout the design/construction process. While a construction management' block appears in, it is only the execution of the construction plan, and does not contain a quality management component. According to ,the concept of quality control should be changed from "controlling quality" to "controlling management for quality". This would result in using an integrated quality standard, based upon current industry wide experience, to define policies and organization to manage quality. Policies are defined for the quality, for the control of quality, and for management of the quality control system.

The organization created to implement quality control policies must have well-defined responsibilities and authority. In construction, failure can result from malfunction on the part of constructor, designer, or even owner. In most cases however, it is the result of a combination of actions by several or all of these parties. The quality management organization must, therefore, have the ability to deal effectively with all parties involved. A quality flow chart demonstrates the following characteristics for a properly organized quality control program in the construction industry.

IV. QUALITY OF CODES AND STANDARDS

According to the ASCE manual, the primary purpose of codes and standards is to protect the public's health and safety. Compliance with codes and standards should be an issue addressed early in the design phase. Without early identification of the appropriate codes and standards, reworking plans and specifications can result in considerable cost and delay. The design professional must be knowledgeable about the provisions of codes and standards before starting the design process because the building codes directly control the minimum standards of many components of a building project, and are responsible for much of the controlling the construction process are much more restrictive than in most manufacturing and service industries.

Stasiowski and Burstein underline that quality design begins with sound engineering and scientific principles, must satisfy the criteria of applicable codes and standards, but also the owner's project requirements. Codes and standards refer to the minimum criteria. Owners, however, may have particular requirements.

V. SIX SIGMA

Organizations commonly use Six Sigma DMAIC program. The use of the five-phase improvement cycle DMAIC, within Six Sigma companies, has become increasingly common. DAMIC acronym refers to the terms: define, measure, analyze, improve, and control. It is an improvement methodology for current processes that are not meeting required specifications, but only need incremental improvement. DMAIC consists of the following 5 steps:

- Define customer need, requirements, and what needs to be improved.
- Measure current processes.
- Analyze the data, process, root cause, and develop a plan to improve existing processes.
- Improve existing processes and methods of measuring success.
- Control gains and repeat the process.

Six Sigma differs from other quality approaches used in organizations because it emphasizes the definition of measures of customer satisfaction and employs teams to continually lessen the DPMO for each measure. The Six Sigma figure of 3.4 DPMO is so minute that it is viewed as perfection. The fact that it is not actually zero permits individuals to believe in the Six Sigma approach. Organizations implementing Six Sigma reveal product and service quality improvement, cost reduction, and significant savings due to Six Sigma projects focus on bottom line results. The success of six Sigma projects is also due to its results orientation, data driven and ability to align the goals with objectives across the organizations.

The aim of Six Sigma is to improve the quality near perfection which means 3.4 defects per million opportunities (DPMO), to maximize the customer satisfaction and business benefits. This goal will occur when the sigma level is 6. For instance, at 3 sigma level 93.3% of items meet requirements and are without any defects (yield) where 66,800 defects occur per million opportunities (DPMO), but improving the performance to 5 sigma level reduces the number of defects to 320 items per million opportunities. Therefore, any companies work on Six Sigma should strive for the goal 6 sigma level performances.

In order to obtain high quality of 6 sigma level at the low price, Six Sigma uses the statistical metrics and techniques to measure the processes performance and rate the defects, and teaches involved people appropriate tools to analyze their performance and improve the way of business. Moreover Six Sigma systematic strategy leads the employees and processes to maintain and control the achieved high performance.

Six Sigma for Construction

"Lean Construction" based on the basic Principles of management and special tools and techniques to achieve those desired goals of better productivity and better profit margins. Application of Lean and Six sigma methodology will provide a guideline in making the process more effective and profitable. Lean and Six sigma have both management and technical components: On management side it focuses on getting the right process and goals. The right projects and right people to work on the projects .On Technical side it focuses on enhancing process performance using process data, statical thinking and methods. Lean and six sigma methodology can be used to gain deeper understanding of construction and explore new knowledge of contemporary practices can help extend the theory of lean and six sigma to provide a deeper understanding and improvement in construction process. Lean has produced remarkable result in continuous organizations several leading companies in India have implemented consents related to lean to improve competitiveness on many organizations and factors they get benefited.

VI. CONCLUSION

Lean & Six sigma which has been successfully developed to improve productivity and cut cost can be effectively apply to construction organization. In immerging scenario urgent need for scaling up and adaptation and implementation of Lean & Six Sigma Methodology in construction organization by taking help from Lean leaders and professional in India. The construction organization needs positive thinking and top management (i.e. Owner) supposes to start on the Lean & Six Sigma implementation journey. They have to make fundamental changes in their strategic of production, quality improvement and adaptation of new technology.

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