

QUALITY MANAGEMENT SYSTEM IN CONSTRUCTION: A REVIEW

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Abstract

Generally, the quality management system is designed to ensure that the organizations make adequate effort to achieve the level of quality required by the customer. Achieving these quality levels will contribute to greater customer satisfaction, which is crucial to maintaining long-term success for construction firms. ISO 9001 Quality Management System is one of the ISO 9000 standards set that includes a collection of instructions on how to set up a quality management system for processes that impact their goods or services. Despite reports that construction organizations enjoyed the great benefits of being an ISO 9000 certification are literally proven, the main goal of Quality management system implementation, namely achieving customer satisfaction in project management, is still broad. Enhanced management & work efficiency of the organization as the most important benefit from system implementation while the most significant issue is lack of knowledge of the system among the employees. To solve these implementation challenges, preparation and audit (internal and external) need to be improved.

Keywords: Construction, Quality, Quality Management System, Quality Assurance, Quality Control, Total Quality Management

I. Introduction

Quality has a functional meaning in industry, engineering, and manufacturing as the non-inferiority or superiority of something; it's also characterized as suitable for its intended purpose (fitness for purpose) while meeting customer expectations. Performance is a perceptual, conditional, and rather subjective attribute and different people can interpret it differently. Consumers should concentrate on a product / service's performance consistency, or how it compares with marketplace competitors. Producers may calculate the quality of the conformance, or the degree to which the product / service was correctly created. Support staff may assess the quality of a product to the degree that it is effective, implementable or sustainable.

In a business sense, there are several levels of quality, but the idea that the company creates something is important, whether it is a tangible product or a specific service. Such products and/or services and how they are made include several types of processes, methods, machinery, staff and investments, all of which come under the umbrella of quality. The idea of quality management has its origins in key aspects of quality and how it is diffused in the sector.

Although quality management and its concepts are relatively recent trends, the notion of organizational quality is not new. In the early 1900s, pioneers like Frederick Winslow Taylor and Henry Ford noticed the shortcomings of the techniques used at the time of industrial manufacturing and the resulting varying quality of performance, the introduction of quality control, inspection and standardization procedures of their work. Later in the twentieth century, William Edwards Deming and Joseph M. Juran's likes helped to improve quality.

A. The Triple Constraints

The triple project constraints are:

- 1) Quality
- 2) Time
- 3) Cost

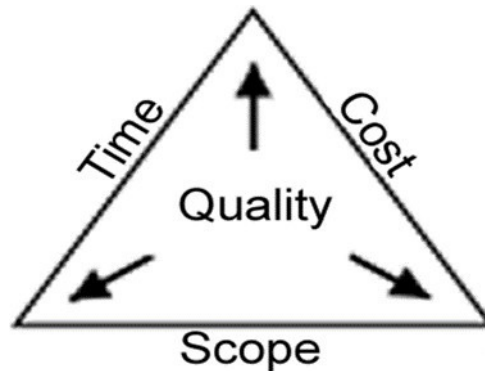


Figure 1: Project management triple constraints

One way of thinking about the golden triangle is to imagine a structure of linkages. Scope is in the center and link bars attach to the three standards, time and cost constraints. If the permissible cost is decreased, pressure will be added to one or more of the three other components. For example, schedule must be slipped, quality reduced and/or scope reduced. Project management does not provide free lunch. You can never alter one element of the triangle without changing at least one of the other three.

B. Quality Control (QC)

Quality control (QC) is a mechanism in which the consistency of all variables involved in output is evaluated by organizations. ISO 9000 describes quality control as "a section of quality management which is geared towards meeting quality requirements."

A company must first determine which basic requirements the product or service must follow to implement an effective QC system. Then you have to assess the magnitude of QC behavior — for example, the percentage of units to be checked from each lot.

This approach emphasizes three things (shined in standards like ISO 9001).

- 1) Elements such as monitors, task management, and procedures identified and well controlled performance and integrity standards, and record identification.
- 2) Competencies, such as information, expertise, experience and skills.
- 3) Soft elements such as employees, honesty, confidence, culture of organization, inspiration, team spirit and quality relationships.

Inspection is a significant component of quality assurance, where the actual product is physically inspected (or an examination of the end results of a service). Lists and explanations of unacceptable product defects such as cracks or surface blemishes will be given to quality inspectors.

C. Quality Assurance (QA)

Quality assurance (QA) is a way of eliminating errors and failures in manufacturing goods and of eliminating problems when producing goods or services to customers; which ISO 9000 describes as 'part of quality control based on ensuring that quality standards are met. This quality assurance defect avoidance varies slightly from identification of defects and rejection in quality management, and is described to as a left shift because it focuses on consistency earlier in the cycle (i.e., left to right of a linear process structure attempting to read).

The terms "quality assurance" and "quality control" are generally used interchangeably to respond to objective of ensuring the quality of the service or product. For example, the word "assurance" is often used as follows: Philips Semiconductors explains the introduction of evaluation and systematic inspection as a quality assurance method in a projection screen software system. Furthermore, the term "control" is used to describe the fifth step of the system Defining, Measuring, Analyzing, Improving, Control (DMAIC). DMAIC is a quality approach which is guided by data and used to enhance processes.

Quality assurance involves logistical and operational tasks carried out in a production system to meet the specifications and targets for a product, service or operation. This is the systematic assessment, comparative analysis with a norm, process control and a related feedback loop that confers reduction of errors. This can be correlated with quality control which focuses on the performance of the process.

Quality control comprises two main principles: "fit for purpose" (the result should match the expected intent); and "made for first time" (mistakes should be eliminated). QA covers quality control of raw materials, parts, goods and components, production and management support services, manufacturing processes, and inspection processes. In the history of designing (engineering) a novel technological product, the two concepts often manifest: The task of project management is to make it happen once, while the task of quality assurance is to making it work every time.

D. Total Quality Management (TQM)

William Deming, a professor of management whose work had a significant influence on Japanese industry, developed TQM. Although TQM shares the Six Sigma improvement method much in general, this is not the same as Six Sigma. TQM focuses on ensuring that mistakes are minimized by standards and guidelines and process requirements while Six Sigma seeks to minimize defects.

Total Quality Management (TQM) is the ongoing process of identifying and minimizing or removing production defects, streamlining supply chain operations, improving customer service, and ensuring that staff are trained to pace. Full quality control seeks to keep responsible for the overall quality of the finished product or service to all parties involved in the manufacturing process.

Total Quality Management (TQM) is a holistic approach to optimal management of the organizations. The method focuses on enhancing the quality of the products of an company, including services and products, by continually improving the internal operations. When part of the TQM process, the specifications set will represent both internal expectations and any technical standards currently in place. Industry requirements can be set at different rates and may require adherence to particular laws and regulations governing the company's operation in question. Fig.2. shows the main difference between QC, QA, and TQM.



Figure 2: Difference between QC, QA and TQM

II. Literature Review

The review paper which contains the work done by various authors and the results of different research paper. Paper published in numerous national and foreign journals, Ph.D. thesis, studies and books have been studied and at the end of this chapter the main findings are described and reported..

The following are the previous research review based on quality management system in construction industry.

Abdul Hakim Muhammad et al. (2006) summarized the definition of the Quality Management System (QMS) and its implementation in the construction sector. A disagreement on the QMS definition among develop players has become the major roadblock for its system execution. Either at company level or at project level, QMS may be applied. They work on the company-based QMS in manufacturing can be described as extensive given the various areas of the project. While several researches on the company-based QMS have been completed, the QMS project-based analysis lags behind. While reports that construction organizations enjoyed the benefits and advantages to become an ISO 9000 certification are literally proven, the prime target of QMS implementation, namely achieving client satisfaction in projects, remains large. At the project stage, QMS as part of the framework needs a Project Quality Plan (PQP). The market players still don't understand PQP well and therefore the implementation of PQP faces a lot of problems. The important information to remember in designing, implementing and managing the PQP is the strategy and goals of the project, the mechanism, the leadership teams and the work methods. PQP may be created separately for each project member, or as an interactive document for all project team members. [2]

A.R. Rezaei et al. (2011) was developed a web-based bureau automation system. Using a web-based automation program for offices, called the performance measurement Support System (PMSS), managers will be immediately supplied with reliable business details. PMSS eliminates paperwork by correct IT usage, eliminates reporting issues through the use of data centers, overcomes connectivity issues through the use of Internet and cell phone facilities, and ultimately allows the organization to achieve Certification as part of its quality management program. PMSS considered only practical OBS and efficiency measurements require three measures for time, cost and price. [4]

Bubshait Abdulaziz et al. (2014) measured the efficiency of 15 building contractors' programs. He claimed that the sophistication of the quality system ranges from an irregular audit program system to a quality system compliant with ISO 9002. Senior management interest in enhancing project efficiency and existing or anticipated demand from clients are the most compelling factors for registration. The most commonly associated with ISO 9000 clauses are: (1) audit and check status; (2) examination and testing; (3) non-compliance quality control; and (4) handling, storage, and protection. Misunderstandings have been found about documentation of the quality program, method of implementation, and the discrepancy between non-conformity behavior and corrective

acts. Putting up development goals would be another area that firms are struggling to deliver. [1]

AnupW S et al. (2015) was conducted exploratory work to provide insight into quality processes, methods, strategies and the dedication of management to quality implementation in construction projects. They also discussed the problems facing Quality Control Systems during deployment. They use a qualitative questionnaire approach to collect data, and a case study is performed using content review tool to validate the questionnaire. They concluded by interviewing the professionals through an interview process based on the findings of the review and the case study data and providing reasonable advice on how to solve QMS issues arising. They have established there is a belief that implementation of QMS increases paper work. Certain significant factors experienced during QMS implementation are the staff's inability to follow QMS and poor technological know-how. In the local context, the majority of the quality problems encountered elsewhere are important. In the case of management variables, the association levels are higher for naming members and performing evaluations. Subcontractors operate and there is stronger connection between insufficient professional experiences in QMS implementation issues. [3]

Keng Tan Chin et al. (2016) identified the importance of implementing ISO 9001 Quality Management System in Malaysian construction firms, solving the problem faced by construction firms in adopting ISO 9001 Quality Management System and identifying approaches followed by ISO-certified construction firms to solve or mitigate problems and challenges. They carried out case study and picked approach to collecting data for this research. Five construction companies were chosen to be interviewed for case study purpose. That organization is consulted with one representative form to gain more details from their viewpoint on the advantages, challenges and methods for implementing ISO 9001 QMS. The research findings concluded that the most important benefit from introducing the program is improved management & work quality of the organization while the most serious problem is lack of knowledge on the program among workers. To solve these implementation challenges, preparation and audit (internal and external) needs to be enhanced. [12]

Mohammed ALI Ahmed et al. (2017) established and eliminated barriers to the effective implementation of quality management system in the construction projects created either before or during implementation of such systems. Putting these defined obstacles into seven main categories: managerial, organizational, communicational, financial, cultural, educational, and auditing. CSFs should be defined for more efficient implementation of these systems, taking into account, in particular, the impact of external factors. In this study, 'External Factors' refer to those found in the atmosphere of the construction industry that are produced primarily by external influences that, unlike internal factors, may not be primarily accounted for organizational disruptions such as influences of economic, financial, political, cultural and industrial relations. Using and modeling the final collection of all the current and defined variables (internal and external) should establish a structure for successful QMS implementation in the construction firm. [10]

Pascal Bacoup et al. (2017) they was approach used based on a synergistic synthesis of both ISO (Quality Management System) principles and core Lean Management concepts. Each article begins with a description of a company's performance, and draws some meaningful results. Organizations have the option of gaining certification in conjunction with a Lean Quality Management System: a one-page Quality Guide, just ten documents, no significant non-conformities and no consumer concerns for a period of two years. [11]

Jayden Smith et al. (2018) developed the principle of benchmarking and the philosophy of creating a method that businesses can use to continuously improve their total quality management. They announced survey findings showed that on average, Oil and Gas companies had more mature

QMS than construction and mining firms. The findings also showed that firms operating in wider geographic areas (i.e. internationally) usually had more mature QMS than firms running only regional level (i.e., Perth or Western Australia). Certain findings needing further study include the fact that there was no scientific proof that businesses with higher sales had more advanced QMS. A bigger pool of respondents should be pursued in future iterations of this study so that objective statistical analysis can be used to validate patterns in the survey responses. [7]

Yosep Hernawan et al. (2018) defined the degree to which the implementation of ISO 9001:2015 as a Quality Management System is implemented in a business, what benefits a business can reap by adopting the ISO 9001:2015 Quality Management System, finding challenges and solutions and what steps organizations need to take to incorporate the ISO 9001:2015 Quality Management System. The technique used is a descriptive tool which is qualitative. Outcomes represented in the form of a reinterpretation of the implementation of ISO 9001:2015 in the organization in the context of constraints and barriers, assessment and benefits obtained after the application of ISO 9001:2015 Quality Management System, like the division of authority and obligations in each group which is simpler, quicker contact and response to customers, ongoing. [13]

III. Quality Management System

I. General

A Quality Management System (QMS) is a collection of business processes that are based on fulfilling customer expectations reliably and increasing their fulfillment. It is in line with the intent and strategic direction of an organization (ISO9001:2015). It is described as the organizational objectives and expectations, strategies, procedures, recorded information and resources required for its implementation and maintenance. Early quality control methods, using basic statistics and random sampling, stressed predictable results in a manufacturing product category. Through the 20th century, labor inputs were usually the most complicated and expensive imports in most developed societies, so emphasis shifted to team cooperation and coordination, particularly through a continuous improvement process, early signaling of problems. QMS has continued to align with efficiency and transparency campaigns in the 21st century, as both investor loyalty and c Many QMS, such as Natural Phase, emphasis on environmental concerns and believe other quality problems would be minimized as a result of systemic thought, accountability, reporting, and diagnostic discipline, consumer satisfaction and perceived quality are strongly tied to these factors. Of the QMS regimes, the ISO 9000 standard family is perhaps the most commonly adopted worldwide – both are regulated by the ISO 19011 audit regime, and deals with consistency and consistency and their incorporation.

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Figure 3: Quality management system

QMS Guidelines series are:

- ISO 9000 Quality Management Systems-Principles and Vocabulary, applied in all ISO 9000 Standards.
- ISO 9001 Quality Management Systems – Provides criteria that and company must meet in order to be accredited as ISO 9001.
- ISO 9002-Instructions for ISO 9001:2015 use.
- ISO 9004 – Managing an organization's consistent success, offers guidance for maintaining QMS progress through assessment and enhancement of results.
- The latest edition of ISO 9001:2015 is an ISO 9001 standard.

II. Benefits of QMS

Implementing a quality control system has an impact on each and every aspect of the success of an organization. A recorded quality control program has the benefits of:

- Following the expectations of the client, this helps to install confidence in the company, which in turn leads to more clients, more sales and more customer retention.
- Meeting the organization's criteria, this guarantees the most cost-effective and resource-efficient compliance with the regulations and the delivery of products and services, creating space for development, growth and benefit.

Such systems provide more advantages, including:

- Description, development and processes;
- Cutting waste
- Fixing errors
- Rising costs
- Fostering and recognizing opportunities for training
- Recruiting workers
- Setting course through organizations

IV. ISO 9001 Requirements for QMS

I. General

The standard has eight clauses: Scope, Common Attributes, Definitions, Management Accountability, Quality Management Systems, Inventory Control, Product and/or Service Realization, and Measurement, Evaluation and Development. The first three provisions are for details and the last five are conditions that must be fulfilled by an agency. This section follows the numbering scheme used in the normal.

The process approach is referred to as the implementation of a series of processes within an entity, combined with their definition and interactions, and the management of those processes. The method highlights the value of:

- 1) Comprise and satisfy the criteria
- 2) The need to consider Value Added Processes
- 3) Achieving process success and productivity outcomes
- 4) Continuous process enhancement, based on objective test

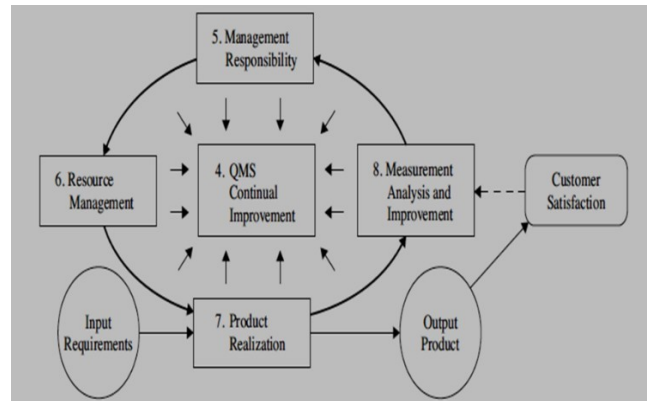


Figure 5: Model of a process-based Quality Management system

II. Eight Clauses of ISO 9001

1. Scope

The aim of the standard is to explain the company's ability to produce a product that meets consumer and regulatory requirements, and to increase customer satisfaction. Its aim is achieved by assessment and continuous improvement of the method, rather than the product. The standard's specifications are supposed to extend to all forms and sizes of organizations. It is possible to remove specifications in Clause 7, Product Awareness which are not suitable for the company.

2. Normative Reference

ISO 9000:2005 Quality Control Systems – Fundamentals and terminology is a standard guide that offers the principles and meanings which mostly apply.

3. Terms and Definitions

The terminology and definitions laid down in ISO 9000:2000 utilize for the objectives of this standard. The word "Good" also means "Service" in the entire text of this standard.

4. Quality Management System

The company shall create, log, enforce, and maintain a QMS and enhance its effectiveness continuously. The organization shall (a) evaluate the processes that need for QMS and its implementations within the organization, (b) define their sequencing and interaction, (c) determine requirements and approaches for the successful operation and control of those methods, (d) ensure the provision of resources and knowledge required to support and track these processes, (e) track and evaluate wherever necessary, And (f) introduce steps aimed at achieving expected outcomes and continuous improvement of those processes. Outsourced processes which effect the service quality must be defined that is included in the program.

Documentation:

Common Documentation shall involve (a) explanations of a Quality Policy and Quality Priorities, (b) A quality Report, (c) recorded techniques and records usually needed, (d) documents necessary to ensure efficient process and record preparation, activity, and control. A process or job instruction is needed if its absence may adversely affect the quality of the product. The scope of the reporting would depend on the size and nature of operations of the organization; the sophistication of the procedures and their interactions; and the employees' competencies. For example: a small enterprise may orally inform a manager of an upcoming meeting, whereas a big organization will need a written notice. The standard should meet contractual, legislative, and regulatory criteria as well as the needs and desires of consumers and other stakeholders. Documentation may be in any format or style.

System document contains:

- The Manual of Quality
- Monitor and control of documents
- Record Control

5. Management Responsibilities

Management Commitment:

Top Organization shall demonstrate its commitment to the success, implementation and continuous improvement of the QMS by (a) discussing the need to satisfy customer, legislative requirements, (b) implementing a quality policy, (c) ensuring that quality targets are set, (d) performing management audit, and (e) maintaining that resources are available. Top management is characterized as the person or group of individuals who direct and regulate an enterprise.

- Focus on Consumers
- Policies of standard
- Arranging:

Objective on standard

Planning of the Quality Control Process

- Competency, Authority and Communication: Responsibility and Power
- Executive Member Inside Cooperation
- Testing the management

6. Resource Management

- Arrangement of Resources
- Human Resources:

General: Upon the basis of adequate schooling, training, expertise and experience, staff conducting work that affect adherence to product requirements shall be qualified. Compliance with quality specifications can be directly or indirectly influenced by staff conducting certain duties within the QMS.

Competence, awareness and training: The company shall

(a) define the required skills for personnel conducting work that affect compliance with product requirements, (b) help in providing instruction or take other steps, where appropriate, to achieve the required skills, (c) assess the efficacy of the actions taken, (d) ensure that its staff are conscious of the significance and value of these actions, and (e) Maintain proper records of schooling, employment, credentials and knowledge. Competence can be defined as the capacity demonstrated to apply knowledge and skills. It may be provided by role, party, or unique place in the job description. Effectiveness of training can be measured by assessments, results, or turnover before and after.11 ISO 10015 Training Guidelines can help companies achieve this requirement.

1) Infrastructure:

The company shall define, provide and maintain the infrastructure required to comply with the specifications of the goods. Infrastructure includes (a) offices, office, and related facilities as appropriate, (b) production equipment (both hardware and software), and (c) support services (such as transportation connectivity or operations management).

2) Work Atmosphere:

The company shall establish and maintain the work environment needed to meet the specifications of the product. Creation of an acceptable work environment can have a positive impact on morale, happiness and success of the employees. The word "work climate" refers to working environments, including physical, climate and other factors (such as noise, temperature, humidity, visibility, and weather).

7. Product Realization

- Market realization preparation
- Processes related to customers: Determination of Product Specifications
Revision of Material Specifications Customer care
- Development and Evolution:
Project and Development Planning Input in the design and production of
Excellence in design and production Technology and technology analysis
Verification of concept and development; Validation of design and development
Command over changes in design and development
- For tend to purchase:
Phase Purchase Buying Data
Verification of the Goods Purchased
- Manufacture and service provision: Sales and Service Inspection
Validation of the production and service delivery processes
Traceability and Identification Customer Ownership
Product preservation
- Testing and testing devices

8. Measurement, Evaluation and Improvements

- General:

The company shall prepare and execute the processes of tracking, testing, evaluating and enhancing required (a) to demonstrate conformity to product specifications (b) to ensure QMS compliance, and (c) to continually enhance the QMS effectiveness. This shall include the determination and scope of their use of relevant tools, including statistical techniques.

- Management and computation of: Service quality
Inside Compliance
Monitoring and process assessment
Surveillance and product and service assessment
- Material nonconformity test
- Information Analysis
- enhancements:
Improvements
Corrective and preventative measures

V. Conclusion

Following conclusions are made based on literature. There are many advantages of registering with ISO 9000. These specifications are also used as the fundamental structure for ISO 9000 criteria. The rule is common in nature and can be customized to fit the needs of any organization.

The general aims of ISO 9001:2015 based on literature are:

- To be standardized enough, but still applicable to all forms and sizes of organizations, regardless of their industry or field.
- Considering improvements in practice and technology in TQM.
- The implementation of the standard framework, core texts and meanings set out in the annex to the ISO Directive.
- To simplify operational performance and efficient compliance checks.

From literature benefits of ISO registration and implementation of QMS are:

- Increased management and job efficiency: Both organizations accepted that the introduction of ISO 9001 QMS in their organization would make work management more systematic.
- Improved communication: As job management has become more formal, companies A, C, D and E have found that contact between workers has improved considerably.
- Improved documentation control: Companies B, C, D and E submitted that the structured filing system was one of the significant advantages of implementing ISO.
- Increase customer trust and satisfaction, and thus improve the brand image of the organization.
- Heightened number of projects undertaken.
- Increased efficiency of the on-site jobs.

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