Identification of Attributes Based on TQM Principles Influencing Construction Quality in STP Project

[a*]Krishna B. Chavan, [b]Dr. N. A. Hedaoo

[a] M.Tech Student (Construction Management), College of Engineering, Pune, India
[b] Associate Professor, Civil Engineering Department, College of Engineering, Pune, India

*Corresponding author: chavankb18.civil@coep.ac.in

doi: https://doi.org/10.21467/proceedings.112.5

ABSTRACT

TQM is a management philosophy where every individual working in an ideal environment towards a common goal, continuously improving the processes and in turn improving the quality of product or process. An important factor for the success of an organization in implementing TQM is its ability to translate, integrate, and ultimately implement TQM behaviors into everyday practice on the job. This study was initially conducted by investigating the quality affecting factors (attributes) from different pieces of literature on quality performances and understanding the concept of total quality management. The questions in this questionnaire are distributed among the different phases that take place during the construction. Factor analysis involved identifying a total of 55 attributes that belonged to the different phases of construction, these factors were then distributed into critical success and failure attributes based on data analysis. These critical attributes affect the Quality performance in the construction of the STP project. The study included a questionnaire survey considering all the main attributes and it was sent out to all construction related project participants. Relative significance of success and failure attributes in the construction of STP projects as understood by the construction professionals, owners, and contractors was obtained. Data collection of this study involved the collection of the responses based on the 5 points Likert scale. The survey data has analyzed by using the Relative importance index (RII) method. The research finding assists the project participants to give the information about the critical attributes, this will help in improving the quality of construction of STP as well as the overall performance of the project.

Keywords: TQM, Construction Quality

1 Introduction

In this paper questionnaire survey is formed based on the total quality management principles. Questions are based on the different phases of the construction processes of the STP and are related to the TQM principles. As an example, effective "communication" is the important principles in the TQM practices therefore the questions in the survey like Developing and maintaining short and informal line communication between project participants, Commitment of all parties of the project are included in the questionnaire to give the relative importance of the failure and success attributes. The quality improvement in the construction is achieved from a management perspective rather than the perspective of improving material or construction process. Therefore, it becomes important to discuss about the construction quality, TQM and its principles from the management perspective to improve construction quality.

Definitions of Quality with respect to construction industry.

It is very difficult to pinpoint the exact definition of quality for the construction industry. Moreover, available empirical data on the quality of construction is very less. Few of the Definition of quality performance given

Proceedings DOI: 10.21467/proceedings.112; Series: AIJR Proceedings; ISSN: 2582-3922; ISBN: 978-81-947843-3-3

by researchers are 'meeting expectations of the customer' [Kiani and McKim (1995)]; 'reduced rework or defects' [Atkinson (1998), Kiani and McKim (1995)]; 'repeat business' [Sypsomos (1997)]; 'conformance to ISO 9000 criteria' [Bubshait & Al-Atiq (1999); Sun (1999)];'completion on-time and within budget' [Kiani and McKim (1995); Sypsomos (1997)].The results of the study by Peter Hoonakker, Pascale Carayon , Todd Loushine shows that there is a difficulty in defining the quality related to construction industry. Contractors mostly rely on 'looks good, feels good' attitude to measure the quality. And no extra effort is taken regarding defining or quantifying the quality in construction. And according to the interviews conducted in the study, most of the contractors thought the measure of quality performance to be Reputation or customer satisfaction, Getting continued business or new work or Formal quality programs. And few of them even replied that it is not possible to improve quality at all because construction industry still favors low bid.

1.1 Total Quality Management (TQM).

TQM is a management philosophy where every individual working in an ideal environment towards a common goal, continuously improving the processes and in turn improving the quality of product or process. TQM can be implemented on goals, organizations, processes, and people to ensure that the right things are done right the first time every time. TQM can be described as both a theory and a set of leading policies that outline the framework of a continuously developing organization. Total quality management is a process aiming at continuous improvement and involvement of the whole organization starting from the top managerial level and ending at the bottom level of employees. TQM is an integrated approach that emphasizes management commitment, teamwork, customer satisfaction, communication, continuous improvement, complete organizational involvement, standardization etc. Total quality management (TQM) is generally called a course, not a terminus.

1.1.1 Principles of TQM

Customer satisfaction: According to the TQM principles the true measure of the quality is the customer satisfaction or delight. Sometimes it means understanding clients needs better than himself and making every effort in order to deliver the expected quality. And no matter how many efforts have taken in training employees, improving process the ultimate test for the level of quality is given by the customer.

Complete organizational involvement: Every employee should be involved in developing the process, product to ensure the work towards company's common goal. Employees are considered as the internal customers of an organization. Involvement of every single individual in the company brings out the sense of belonging in the organization, every employee feels involved in organization and works towards the betterment of quality.

Process orientation: Process is systematic breakdown of the work that is being carried out in an organization. Process in an organization converts input into an output. Every single step involved in an organization is properly defined. Performance is continuously measured to improve the efficiency of the process.

Integration of the system: Every organization before applying TQM is divided into various departments based on their functions. Every organization has vertical hierarchy, and it is the job of TQM to interconnect all of this and make them work towards common goal. Every organization needs a standardized calibrated system to ensure process success. E.g. Implementation of ISO 9000 system to ensure the quality of the output product.

Proceedings DOI: 10.21467/proceedings.112
ISBN: 978-81-947843-3-3

Series: AIJR Proceedings
ISSN: 2582-3922

Systematic and strategic approach: Every organization should have clear vision or goals in order to achieve an approach working towards the quality improvement. Strategic approach must be made in order to formulate quality as the core vale of the organization.

Fact based decision making: Every organization needs to collect and analyze data based on performance measures in order to achieve accuracy in decision making, come to an agreement, and allow prediction based on previously collected data. Decision making within the organization must only be based on facts and not on opinions.

Communication: Effective communication is the key to successful implementation TQM. It plays key role avoiding conflicts, duplication of work, improves daily operations. An informal line of communication between different levels of organization better understanding of the problem by the upper-level management and simple and efficient solution can be achieved by addressing the problem together as a team.

Continuous improvement: With the help of different tools and creative thinking continuous improvement can be achieved in an organization. In present era where the acing the competition is the only way to survival. To excel in this 'survival of the fittest' world continuous improvement becomes the necessity in an organization. Continuous improvement involves improving techniques and processes in order to retaining or maintaining highest quality.

1.1.2 Evolution of TQM contains the following four stages

Stage 1:- Quality inspection:- In Inspection at the last stage examination is done, If it shows an accurate trend, the method is recommended. Else it is declined. In the modern era of quality, no one will be going to accept this philosophy.

Stage 2:- Quality control:- In this methodology, performance data were gathered and statistical techniques were used to keep the process under control. This method gives assurance to the employees working in companies.

Stage 3:-Quality assurance:- In the quality assurance importance was given utmost to documentation. Standard codes like ISO 9000 were prepared. In this methodology, the third-party audit was made mandatory which prevented many loopholes.

Stage 4:-Total quality management (TQM):- TQM is the most suitable approach for ensuring quality. TQM is a management theory where everyone in a company is inspired to working in a favorable atmosphere towards a common goal, continuously developing their performance, resulting in better business outcomes. TQM is the combination of all services and methods within an industry to achieve constant enhancement of the quality of goods and services.

2 Literature

In the paper "Factors affecting cost performance: evidence from Indian construction projects." written by Iyer, K. C., and K. N. Jha. factor analysis was done using literature review and personal interviews. Total of 55 success and failure attributes affecting the cost of the projects were identified. And by collection the response from industry practitioner and owners of different projects critical factors were identified by calculating the relative importance index (RII). Result of the study shows that project manager's competence or technical capability, positive attitude and coordinating ability with top management and other project participants, coordination between project participants, committed project participants, top managements support to be the critical success attributes; and labour strike, inadequate project planning at the beginning of project, conflicts

between project manager and top management, negative attitude by all the project participants are critical failure attributes. It was observed that it is not only important to maximize the effects caused by the critical positive success factors but also to minimize the effects caused by negative failure factors. Coordination among project participants found out to be the most critical factor of them all using regression analysis.

In the study conducted by Chua, D. K. H., Kog, Y. C., & Loh, P. K. (2001) on a model for construction project budget and schedule performances using fuzzy data. Different critical success factors were identified for meeting different project objectives. Instead of finding critical factors related to the general construction process they found the impact of these factors separately on the budget, schedule, and quality of construction. The relative importance of these success-related factors was established by the analytic hierarchy process (AHP). A total of 67 success-related factors were divided into four main groups or aspects of the projects. Those four groups were found to be project characteristics, contractual arrangements, project participants and interactive processes. A questionnaire survey was developed addressing all the important factors for data collection. Project participants were selected having 20 years or more experience in the field and their response was collected. Critical success factors affecting budget, schedule and quality performance in construction. The study shows that there are different critical success factors contributes towards the different performance measures. Project success is not dependents only on project manger's selection, monitoring and controlling, etc. Project characteristics and contractual agreements are also important in determining project success. In other words, project success can be achieved by properly understanding the project characteristics, contract made in good faith and mutual understanding between the parties, proper management team selection, controlling and monitoring by project manager.

The study conducted by Chan, A. P., Ho, D. C., & Tam, C. M. (2001) on Design and build project success factors: multivariate analysis. They found out different factors which affects the design and build projects and their effects on different performances. Factor analysis was conducted to find the critical factors and relative importance of these project attributes on project success. With the help of literature survey, empirical studies, and project participants interview various 31 factors were identified. Questionnaire survey was made taking all these 31 factors in consideration. From the response obtained by 53 project participants among 31 various factors, 6 project success factors were found to be critical. project team commitment, competency of the contractor, risk and liability assessment, competency of the client, end-users need, and constraints imposed by end-users are found to be those critical success factors in design and build projects. project team commitment, competency of the contractor and clients were found to be most critical among those six using regression analysis for overall success of design and build projects. It also helps in improving scheduling performance. Overall observation shows that commitment and efforts by all parties to be the most important factor for project success.

In the study conducted by Belassi, W., Kondra, A. Z., & Tukel, O. I. (2007) on New product development projects: The effects of organizational culture. A new technique was developed. Rather than identification of individual factors for any project or project in general, critical success factors were distributed in groups. These groups included individual factors which impacts the project performance. Different critical groups which affect the performance of the project found to be project managers' performance, top management support preliminary estimates, availability of resources factors related to team members and environmental factors. After applying the changes suggested by this group attributes it was found that overall performance in terms of Cost, time, quality, client satisfaction was seen to be improving.

Proceedings DOI: 10.21467/proceedings.112
ISBN: 978-81-947843-3-3

Series: AIJR Proceedings
ISSN: 2582-3922

3 Research and methodology

The relative importance of success and failure factors that affects the quality performance in the construction of sewage treatment plant was to be found by the study on data collected by the responses from industry professionals, contractors. The study only considers till the construction phase of the project life cycle. Impact of the different success and failure factors identified through the literature review and studying the TQM principles related to the quality of construction process, input materials and overall output of the construction is identified through this study. Due to the unavailability of the quality-related data on construction project other approaches for data collection had to be considered. In this study questionnaire, a survey study was implemented to collect data for analysis. With the help of these factors various outputs of the project were studied through different performance measures like scheduling (time), budget (cost), quality, project disputes, and customer satisfaction can be calculated. In this study it was contained or limited to quality of the construction only.

3.1 Data Collection

From the literature review and the studying the principles of TQM total of 55 success and failure attributes were identified and questionnaire survey was made. These attributes were divided into different groups based on the different phases of the construction. Among them 26 success factors were in general found to be Experience, training, availability of standards, quality assurance, quality control, inspection audits, inventory management, safety, coordination, cooperation and delegation of authority. And 22 failure factors were Conflicts, hostile political environment, negative attitude, improper tendering process, lack of standards are found to be the general critical failure factors. A questionnaire was sent to many peoples involved in Indian construction industry. Project participants included different industry professionals, contractors and consultants working on respective individual process in Indian construction industry. Questionnaire survey response was obtained from 18 different industry professionals which include design engineers, project managers and contractors having minimum of 3 or more years of experience.

3.2 Questionnaire survey

Questionnaire survey had total of 55 questions in total and response from the different project participants was recorded in the form of five-point scale. In this scale, 1 represents adversely affecting the quality of the project, 2 represents significantly affecting the quality, 3 represents marginally affecting the quality, 4 represents no effect on the quality, and 5 represents helps in improving the quality of the project. In this paper questionnaire survey is formed based on the total quality management principles. Questions are based on the different phases of the construction processes of the STP and are related to the TQM principles.

3.3 Data Analysis

After collecting the data from respondents, the mean score of every individual factor was calculated. Depending on these mean score factors were divided into three separate groups (Table 1). The first group has mean value less than 3.5, these factors are considered to be the failure attributes for the further calculation; second group has mean value between 3.5 to 4.5, factors belonging to this group was omitted from further calculations; and third and last group has the mean value greater than 4.5, factors belonging to this group considered for further calculation as the success attributes.

Table 1. Distribution of attributes based on mean scores.

Project performance parameters.	Mean<3.5	3.5<Mean<4.5	Mean>4.5
Quality	Adversely affecting the quality.	Neither helps in improving or adversely affecting the quality.	Helps in improving the quality.
	Failure attributes.	Omitted from further calculations.	Success attributes.

To establish the further relative importance between the success and failure attributes only calculating the mean and standard deviation is not enough to establish their rankings. So, in order to establish relative importance, arranging the factors in order of their importance and finding the critical most factors relative importance index (RII) was found.

$$\text{Relative importance index (RII)} = \frac{\sum w}{\text{A} * \text{N}}$$

Where,

$\sum w$ is the summation of weightages for individual factors assigned by the respondents.

A is the highest weightage allotted for a factor. (Here=5)

N is the total number of respondents.

Attributes belonging to the first group having mean value less than 3.5 are arranged in the ascending order depending on their individual RII values. In this way the attribute having rank 1 will be the most critical failure attribute and the final ranking attribute will be the least critical attribute. Similarly, attributes having mean more than 4.5 are arranged in descending order of their RII values. And the attribute having rank 1 was most critical in improving quality. And as rank of the attribute increased their importance decreased.

4 Result and Discussion

Among the total of 55 attributes 26 factors has a mean score greater than 4.5 are found to be the critical success factors (Figure 1) further the relative importance index values (RII) are calculated and arranged in the descending order of the RII values (Table2).

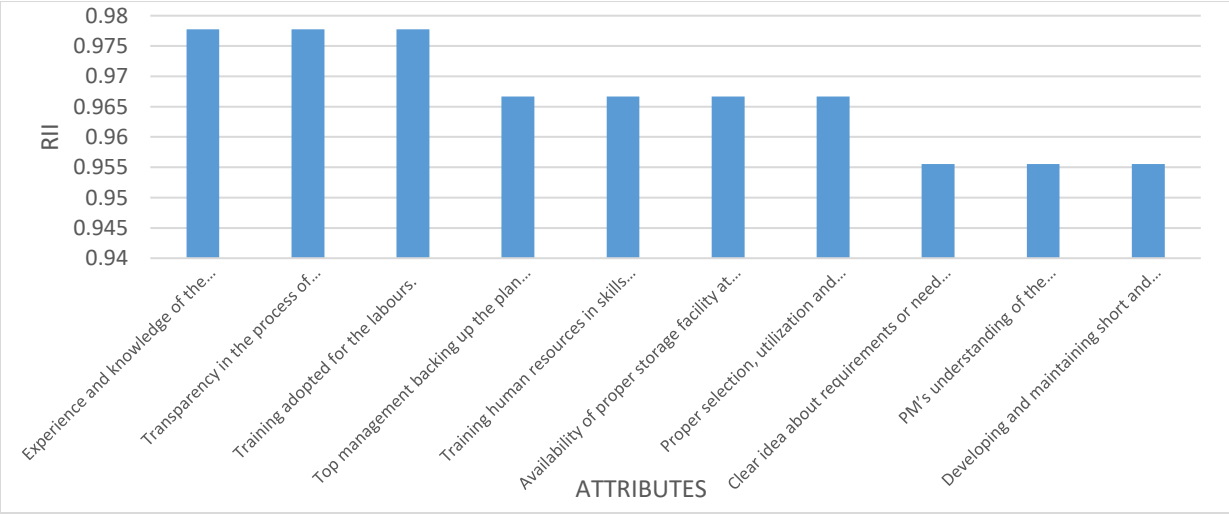

Fig. 1. Critical success factors against their RII values.

Proceedings DOI: 10.21467/proceedings.112
ISBN: 978-81-947843-3-3

Series: AIJR Proceedings
ISSN: 2582-3922

Table 2. Success attributes and their RII values.

SUCCESS ATTRIBUTES	RII	RANK
Experience and knowledge of the designer.	0.977777778	1
Transparency in the process of allotment of the work.	0.977777778	2
Training adopted for the labours.	0.977777778	3
Top management backing up the plan and identifying the critical activities.	0.966666667	4
Training human resources in skills demanded in the construction of STP.	0.966666667	5
Availability of proper storage facility at the location of STP.	0.966666667	6
Proper selection, utilization and maintenance of equipments.	0.966666667	7
Clear idea about requirements or need of the STP project.	0.955555556	8
PM's understanding of the responsibilities of various project participants.	0.955555556	9
Developing and maintaining short and informal line communication between project participants.	0.955555556	10
Quality assurance(QA) and quality control(QC) processes implemented for construction processes.	0.955555556	11
Conducting basic survey at the proposed location of STP.	0.944444444	12
Government(owners) enthusiastic support in giving administrative approval for STP project.	0.944444444	13
PM's coordinating and leadership skills.	0.944444444	14
Commitment of all parties of the project.	0.944444444	15
Inspection of the construction process for pre decided quality standards(Eg. ISO 9000)	0.944444444	16
Proper floor plans, structural plan and good for construction drawings of STP.	0.933333333	17
PM's technical capability and experience.	0.933333333	18
Experienced or skill labors involved in the construction of STP.	0.933333333	19
Auditing the site for specifications and standards mentioned in design and quality standards.	0.933333333	20
Innovative or experimental approach in construction of STP.	0.922222222	21
Perfect drawings to achieve technical sanction and final approval.	0.922222222	22
Cooperation between parties(govt. and contractor) involved.	0.922222222	23
Importance of security deposit till defect liability period.(to ensure quality)	0.922222222	24
Safety system installed at the site to take preventive measures.	0.922222222	25
Clarity of constraints at the initiation phase of project.	0.911111111	26

Among the total of 55 attributes 22 factors has a mean score less than 3.5 are found to be the critical failure factors (Figure 2) further the relative importance index values (RII) are calculated and arranged in the ascending order of the RII values (Table 3).

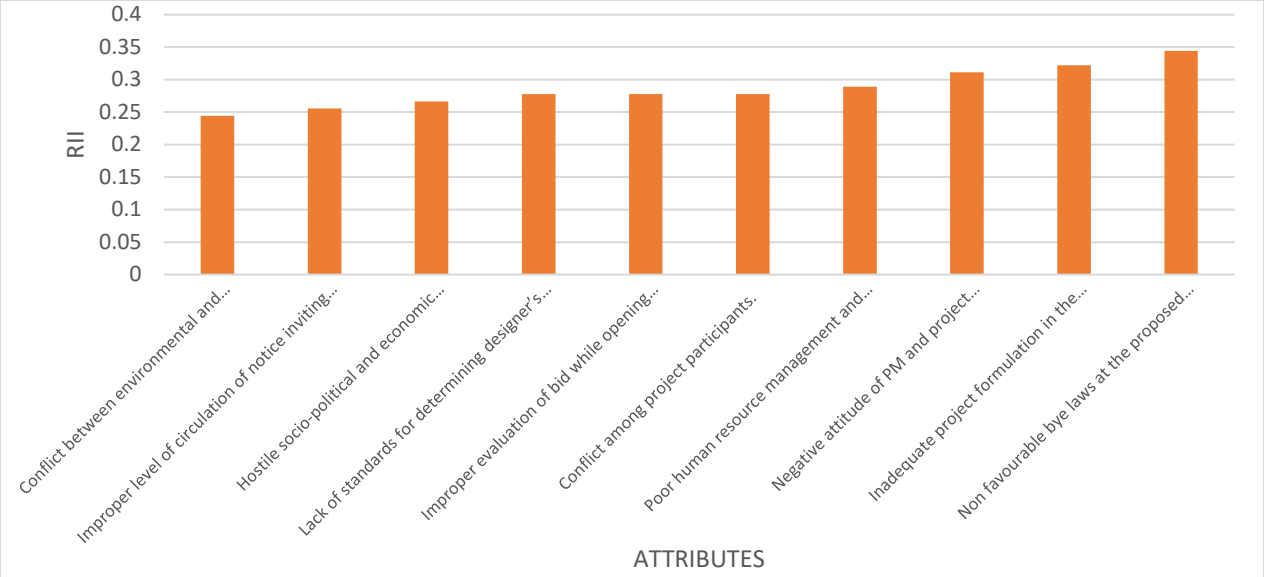

Fig. 2. Critical failure factors against their RII values.

Table 3. Failure attributes and their RII values

FAILURE ATTRIBUTES	RII	RANK
Conflict between environmental and structural engineer.	0.244444444	1
Improper level of circulation of notice inviting tenders(NIT) for construction of STP.	0.255555556	2
Hostile socio-political and economic environment at the proposed location of STP.	0.266666667	3
Lack of standards for determining designer's responsibility.	0.277777778	4
Improper evaluation of bid while opening tender.	0.277777778	5
Conflict among project participants.	0.277777778	6
Poor human resource management and labour strikes.	0.288888889	7
Negative attitude of PM and project participants.	0.311111111	8
Inadequate project formulation in the beginning of the STP project.	0.322222222	9
Non favorable bye laws at the proposed location of STP.	0.344444444	10
Ignorance of proper planning tools techniques by project manager(PM) of STP project.	0.344444444	11
Lack of understanding of operating procedures by the PM.	0.355555556	12
Clients unclear ideas for design of STP.	0.366666667	13
Aggressive competition at the tender stage.	0.366666667	14
Harsh climatic condition at the site.	0.4	15
size and value of the STP project being large.	0.433333333	16
Delay in procurement of material.	0.433333333	17
Absence of proper material management system.	0.455555556	18
Urgency emphasized by the owner while issuing the tender.	0.477777778	19
Tendency to pass on the blame to others.	0.477777778	20
Project completion date not planned by the owner.	0.511111111	21
Uniqueness of the project requiring the higher technical knowledge.	0.511111111	22

Proceedings DOI: 10.21467/proceedings.112
ISBN: 978-81-947843-3-3

Series: AIJR Proceedings
ISSN: 2582-3922

5 Conclusion

Questionnaire survey on an extensive project attributes that affect the quality performance of project has revealed the important success and failure attributes. In general Experience, training, availability of standards, quality assurance, quality control, inspection audits, inventory management, safety, coordination, cooperation and delegation of authority are found to be the critical management factors helps in improvement of quality of STP construction and Conflicts, hostile political environment, negative attitude, improper tendering process, lack of standards are found to be the critical failure factors. Out of all the success and failure attributes the critical factors are found to be mostly from the execution / construction phase of the project after that contract / tender phase and at last concept phase of the construction of sewage treatment plant.

In general, the P.M.'s competence, leadership, coordinating, decision making capabilities; transparent, fair tendering process, communication, positive attitude, training, avoiding conflicts, inspection, auditing, standardization, proper planning and designing are found to be the TQM principles which are necessary in improving the quality of sewage treatment plant. It was found that it is not only enough to increase the effect caused by the success factors but also important to limit the negative impact caused by the failure attributes.

In this paper questionnaire survey was formed based on the total quality management principles. Questions were based on the different phases of the construction processes of the STP and are related to the TQM principles. Based on Different management principles affecting the quality of construction process of STP different critical attributes were identified. In future based on the important critical success and failure attributes a standardized management practice can be designed for the construction of sewage treatment plant. This standardized practice will help in improving the construction quality.

How to Cite this Article:

Chavan, K. B., & Hedaoo, N. A. (2021). Identification of Attributes Based on TQM Principles Influencing Construction Quality in STP Project. *AIJR Proceedings*, 37-45.

References

Iyer, K. C., and K. N. Jha. "Factors affecting cost performance: evidence from Indian construction projects." International journal of project management 23, no. 4 (2005): 283-295

Chua, D. K. H., Kog, Y. C., & Loh, P. K. (2001). A model for construction project budget and schedule performances using fuzzy data. CIVIL ENGINEERING SYSTEMS, 18(4), 303-329.

Chan, A. P., Ho, D. C., & Tam, C. M. (2001). Design and build project success factors: multivariate analysis. Journal of construction engineering and management, 127(2), 93-100.

Belassi, W., Kondra, A. Z., & Tukel, O. I. (2007). New product development projects: The effects of organizational culture. Project Management Journal, 38(4), 12-24.

Hoonakker, P., Carayon, P., & Loushine, T. (2010). Barriers and benefits of quality management in the construction industry: An empirical study. Total quality management, 21(9), 953-969.

McKim, R. A., & Kiani, H. (1995). Applying total quality management to the North American cons. Cost Engineering, 37(3), 24.

Sypsomos, M. G. (1997). Beyond project controls--the quality improvement approach. AACE International Transactions, 262.

Chan, D. W., & Kumaraswamy, M. M. (1997). A comparative study of causes of time overruns in Hong Kong construction projects. International Journal of project management, 15(1), 55-63.