

PRACTICES FOR PROJECT QUALITY MANAGEMENT SYSTEMS (PQMS) IN CONSTRUCTION PROJECT

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Abstract

Due to the importance of the quality management system implementation in construction project, the current study was conducted to identify the set of Project Quality Management System (PQMS) practices for its successful implementation in construction field through a systematic review of literature. Critical success factor (CSF) to implement PQMS in construction project were stated as 'Client Commitment', 'Measurement and Improvement', 'Integration of quality Plan', 'Education and Training', 'Teamwork and Communication' and 'Use of ICT'. However, these CSF need to be explored more in terms of its practices and there is an urgent need. A research approach was carried out on the selected papers published between 2004 and 2014. An appropriate database was chosen and seven research papers were identified through a screening process and reviewed for this study. There are 20 important practices in PQMS were identified and has been categorized into six CSF namely; Client's Commitment (5 practices); Integration of Quality Plan (3 practices); Education and Training (3 practices); Measurement and Improvement (4 practices); Teamwork and Communication (3 practices) and the use of ICT (2 practices). This paper concluded with a numbers of recommendations for future researchers to discuss, develop, and work upon in order to achieve better precision and generalization.

Keywords: Construction industry, project, quality management system implementation, project quality management practice, best practices

Abstrak

Disebabkan oleh kepentingan pelaksanaan Sistem Pengurusan Kualiti dalam projek pembinaan, maka kajian ini adalah bertujuan bagi mengenalpasti satu set Amalan Sistem Pengurusan Kualiti Projek (SPKP) bagi menjayakan pelaksanaannya di dalam bidang pembinaan. Kajian ini dilakukan melalui kajian literatur yang sistematik. Faktor Kejayaan Kritisikal (FKK) bagi melaksanakan SPKP di dalam projek pembinaan telah dikenalpasti sebagai 'Komitmen Pelanggan, Penilaian dan Penambahbaikan', 'Integrasi Rancangan Berkualiti', 'Pembelajaran dan Latihan, Kerja Berpasukan dan Komunikasi' dan 'Penggunaan ICT'. Namun, FKK ini perlu diterokai lebih mendalam dari segi amalan dan terdapat keperluan bagi berbuat demikian. Satu pendekatan kajian telah dijalankan keatas kertas yang diterbitkan di antara tahun 2004 sehinggalah 2014. Satu pangkalan data yang sesuai telah dipilih dan tujuh kertas penyelidikan telah dikenalpasti melalui proses saringan dan akhirnya dianalisis bagi tujuan kajian ini. 20 amalan penting telah dikenalpasti dan dikategorikan pada enam FKK iaitu; Komitmen Pelanggan (5 amalan); Integrasi Rancangan Berkualiti (3 amalan); Pembelajaran dan Latihan (3 amalan); Penilaian dan Penambahbaikan (4 amalan); Kerja Berpasukan dan Komunikasi (3 amalan) dan Penggunaan ICT (2 amalan). Kertas kerja diakhiri dengan beberapa cadangan untuk pengkaji akan datang untuk berbincang, membangunkan, dan melakukan kajian bagi mencapai keputusan yang lebih baik dan menyeluruh.

Kata kunci: Industri pembinaan, projek, pelaksanaan sistem pengurusan kualiti, amalan pengurusan kualiti projek, amalan terbaik

1.0 INTRODUCTION

The main objective quality management implementation is to improve product quality and continuously improve the services. It would be defined as the ability to meet customer needs and be free from deficiencies, like reworks and errors [1]. At the early stages, quality management systems are more to manufacturing oriented which is to improve the quality through higher process control, better documentation, high commitment and involvement of management, and deeper improvement efforts [2]. However, after the successful implementation in the manufacturing industry, QMS has increasingly adopted in the construction industry.

In construction perspective, quality meet the requirement by the clients based on the contract specification [3]. Similarly as defined by Jha and Iyer [4] that quality project is "meeting the customer expectation" or "compliance with customer's satisfaction". Generally, quality of the construction projects is to meet the requirement of each parties that involved on the construction team such as architects, contractors, consultants as well as the project organizer [5].

Basically, the quality management defined as the measurement to achieve and maintain high-quality output to the needs and achieving customer satisfaction [6]. On the other hand, ISO 8402 defined the quality system as "the organization structures, responsibilities, procedures and resources needed to implement the quality management". Meanwhile, quality management involve overall management functions that determine the quality policy, objectives and responsibilities and implement them such as quality planning, quality assurance, quality control and quality improvement within quality system. Therefore, it can be concluded that QMS is the interaction between people, processes and documentation with the objective to meet the requirements and customers satisfaction [7] in a quality system.

As stated by Barrett [8] and Yasamis et al. [9] there are two stages of QMS implementation which are at the company-based quality management system (CQMS) and project-based quality management system (PQMS). Although, the adoption of QMS had given positive impact on the company based, but there are still numbers of issues regarding the implementation of QMS at the project level. The previous research showed that construction team faces many difficulties to transfer the quality systems to the project level. As the study done by Barrett and Grover [10] on the effect of quality systems certifications and the impact at project level, the team indicates that the actual impact on the quality of services from the client view point has been slightly positive. Furthermore, the results obtained by Haupt and Whiteman [11] found that most of the construction company had successfully practices the Total Quality Management (TQM) approach, though only a few of them success in the practice into project level. A study by Abdullah [12] verified similar situation

faced by Malaysian construction team in implementing quality system in a large scale construction project.

Pheng and Wee [13] found that the obstacles in implementing QMS in project level because of some reasons i.e. lack of motivations by management of main contractors, lack control over subcontractors, too much paperwork and appeared too complex to be adopted, high foreign labours, lack of pride, lack of tolerances between main contractor, consultant and client; deficiency on quality culture, lack of contractual understanding and confusion over terms used. Parallel with the results, research by Haupt and Whiteman [11] also found that the hindrance of PQMS implementation is because of excessively paperwork, temporary workforce, resistance by the teams, difficulty in measuring the results, low bidding by sub-contracting and the construction project team not interested to implement the QMS. Mohamed A.H et al. [7] found that the incapability of the construction team to carry out the system is due to misconception and misunderstanding about the quality system. Furthermore, it become worse when the system was designed by consultant from non-construction background [7].

Some researcher concluded that the main obstacles to the successful quality management system implementation due the nature of the construction process itself [14, 15]. The construction industries diverse in many ways; from the range of end product through few types of method in the construction process. This diversity made this industry is so challenging and not an easy task to manage the overall of the construction process.

As suggested by Zeng and Tian [16] in their research regarding on overcoming the barriers to sustainable implementation of ISO 9001 system, the legal framework need to be improve to strengthen the supervision and control for effective auditing of ISO 9000 standards. Due to that, this research focusing on the measurements of the effectiveness ISO 9000 implementation on the various industries, not specifically on the construction industry. Concerning to the high cost of poor quality on many construction project, more research is necessary to present a framework for improvement of project quality outcomes [17].

Due to that, there are few expanded research focusing on the developments of PQMS frameworks for construction industry [18-22]. The rationale for developing framework is as step-by-step guidance and for launching excellence initiatives in planned method on how to proceed if a set of goals is to be achieved [20].

It is appeared much in the literature, however it is not concluded the main practices of PQMS that should be adopted in the construction process. Though, this paper present critical review on practices of Project Quality Management System (PQMS) for construction projects. In the following sections, the research objective and selected research methodology chosen to prepare the compilation will be explained. This will follow by a summary of the PQMS literature and categories as well as critical analysis of the PQMS practices.

2.0 RESEARCH OBJECTIVE AND METHODOLOGY

The purpose of the study is to identify a set of the best practice that can be used by researchers and practitioners in the field of PQMS in construction industry for successful implementation. Extensive literature reviews were selected as the methodology in order to identify the good and appropriate published research paper for this study. "Quality Management System Practices" and "Construction Project" are the expressing and phrases that used in this study as a search strategy. A comprehensive computer-aided search papers in the Scopus Search Database published from 2004 until 2014 was performed using these expression and phrases that resulted of 305 hits.

From the selected research papers, this study continued previous research that focuses on quality management system's best practices with the Scopus search filter into several criteria which are 'Subject Area', 'Document Type', 'Source Type', 'Source Title', 'Keyword', 'Source Type' and 'language'. After several filtering processes, a total of 52 abstracts were further reviewed and concerned on the identification of PQMS practices in construction industry. These 52 selected publications were then retrieved for the full text documents to evaluate their methodology of study, approaches, and findings. Then, there are several journals (construction based involved in this extensive literature and the journals are:

- International Journal of Quality and Reliability Management
- Journal of Construction Engineering and Management
- Construction Management and Economics
- Journal of Asian Architecture and Building Engineering
- Engineering, Construction and Architectural Management.

Finally, a total of seven research publications were reviewed extensively. Data from these seven studies were also extracted into structured summary as shown in Appendix 1 where the objectives, methodology, approach, and main findings have been explained. All the PQMS practices from these seven papers recorded and based on their frequency of occurrence; the results were obtained as shown in Table 1

Table 1 Major PQMS practices in construction project investigated in literature

Author's	CC	MI	IQP	ET	TC	ICT
Delgado-Hernandez and Aspinwall (2005)		•				•
Chan et al. (2006)	•	•		•		
Ezeldin and Abu-Ghazala (2007)		•	•		•	
Tang et al. (2009)		•			•	
Kwahk et al. (2011)		•				
Choudhry et al. (2012)			•			
Yean Yng Ling and Theng Ang (2013)		•		•	•	•

CC=Client's commitment, MI= Measurement and Improvement, IQP=Integrated Quality Plan, ET= Education and Training, TC= Teamwork and Communication, ICT= Information, Communication and Technology

3.0 RESULTS AND DISCUSSION

Different conclusion and practical suggestions could be determined from in depth study of six selected research publications with varying terms of their specific study approach, objectives, methodology, sampling type and size, setting and respondents as shown in table 1.

Overall, there are 41 practices in PQMS implementation identified from the literature review. These practices will be categorized according to the Abdullah [23] findings on Critical Success Factor (CSF) for PQMS implementation which are; client commitment, integration of quality plan, education and training, measurement and improvement, teamwork and communication and the use of information, communication and technology (ICT).

These practices were identified on the basis of their frequency of apparent in the literature review as shown in curly digressions. The following part of this paper will further explain each PQMS practices.

Client's Commitment

As founded by Abdullah [23], the top management of the project level is the client and their commitment in CSF towards PQMS. Numbers of researchers examined that the commitment of the client significant to drive the implementation of the PQMS [4,24,25]. As stated by Jha and Iyer [4], the competence of the owner plays a significant role in defining the expected level of quality from the contractor organization. There are several practice had be summarized from the research by Abdullah [23] and Chan et al. [25], which are:

- i) Client provide conditions in the contract for the preparation and implementation of project quality system by all parties involved in the construction projects;
- ii) Client organize campaigns and trainings in PQMS to all parties especially to the management level down to foreman level to generate quality awareness and comprehension on the PQMS process and procedures; and
- iii) Client offer adequate resources to support PQMS such as budgets, appointment of the

- right choice of quality consultant and incentives for quality achievement.
- iv) Client appoint the competent project team
- v) Client highlighting on quality, safety and environment.

Integration of Quality Plan

Integration of quality plan is one the factor that leads to the successful PQMS implementation [23]. This factor is the effort to equilibrium the requirements of the stakeholders such as the client, consultant and contractor which integrate the roles and responsibilities of the many parties; promote teamwork, and to connect the client quality prospects with specific aims and processes throughout design and production [26]. As highlighted by Pheng and Hwa [27], the integration produces good quality system that can avoid overlapping and overlooking the scope of the activities and conflicts quality. To ensure all these integrations are properly done, there are several practices listed by Abdullah [23], Ezeldin and Abu-Ghazala [28] and Choudhry, Hinze [29]:

- i) All construction main parties (client, consultant and contractor) prepare their project quality plans according to ISO 9000 and contract requirements.
- ii) The individual project quality plans are integrated by a competent quality consultant.
- iii) The integrated quality plan links all the relevant parts of the participants that own quality plan together around the needs of the project, balancing the needs of the stakeholders such as clients, consultants, and contractors, identifies and specifies the roles and responsibilities of the parties to prevent overlapping and overlooking of functions, and reconciles construction project management and contract conditions

Education and Training

The practitioners and researchers recognize the necessity of proper training and knowledge in delivering qualities for the construction project. It is because of the numbers of participants project may not have a clear concept about quality system. Therefore, proper training for all level of workers to make them known with the needed all the quality system requirements [30]. In Abdullah [23] studied, he had summarized that numbers of practices should be followed by the construction practitioner to conduct the education and training PQMS implementation:

- i) Continuous and regular training are conducted to make the construction team understand the needs of quality system, and enhance the quality awareness and basic of quality system;
- ii) Quality training are targeted at every level of the organization at least extended to the foreman level; and

- iii) Introduce quality control circles (QCC) to all levels in order to look for opportunities for improvement and to promote learning project organization.

Measurement and Improvement

The measurement and improvement are one of the critical factors for the successful PQMS implementation and it has been shown by several previous studies [11, 23,31]. Based on the table 2 above, it shows that measurement and improvement are the practices that always mentioned on papers that been analyzed. Performance measurement is the common practice in the construction industry [32] that involves gathering data, facts and figures and analyzing them in reasonable manner and presentation. This factor is needed to make an improvement in the PQMS implementation. There are several practice that had be summarized from Abdullah (2012), Delgado-Hernandez and Aspinwall [32], Chan, Wong [25], Ezeldin and Abu-Ghazala [28], Tang, Aoieong [33], Kwahk, Park [34], Yean Yng Ling and Theng Ang [35], which are:

- i) Planned internal and external audit are conducted to measure the performance of construction parties' quality system implementation and to identify areas for improvement;
- ii) The quality committee conduct management reviews as planned to determine the areas for improvement based on the records and report listed by the ISO 9000 standard such as the audit report and complaints; and
- iii) Client takes into account the construction parties' quality system performance when judging the interim payment and incentives contribution.
- iv) Higher the competent personnel to measure the performance.

Teamwork and Communication

In ISO 9001, there are two clause related to communication which are clause 5.5.3 internal communication and Clause 7.2.3 Customer Communication (SIRIM, 2008). While the requirement of communication has been mentioned in ISO 9000, there is no single clause mentioning about teamwork. However, in the actual fact, teamwork also plays an important part in ensuring PQMS implementation. Moreover, the term of "teamwork and communication" are frequently used in many studies [31, 36]. Therefore, in Abdullah [23] research, both of the terms are combined as CSF for PQMS implementation. The key practices for strong teamwork and effective communication are as follows [23, 28,35]:

- i) Establish steering committee consisting of all parties involved such as client, consultant and contractor to create a common goal, togetherness and integration;

- ii) Quality training and briefing are conducted through a well-planned team structure to ensure cohesiveness; and
- iii) Strong informal relationships between the parties with informal line of communication.

Information, Communication and Technology (ICT).

With the rapid growth of information and communication technology (ICT), many researcher suggested the uses of centralized electronic quality document management system [16, 23, 36,37]. Among the advantage of using ICT are; it could be optimized and minimized the documentation requirements [37], fast availability of records, simultaneous document sharing and better adherence to ISO 9000 standards [38]. There are some suggestions from various authors regarding the use of project specific website that integrated the internet, electronic information management system and the quality system [16, 39]. The key practices for the use of ICT in PQMS implementation are as follow [23, 32,35]:

- i) Establishment of electronic-based document control center that make use of electronic quality document management system and web-based;
- ii) Integration between the information technology requirement and quality systems requirement; and Management of change in the use of ICT through training and workshop.

4.0 CONCLUSION

In conclusion, from the present literature review, there are 20 important PQMS practices were investigated. These practices has been categorized into six CSF namely; client's commitment (5 practices); Integration of Quality Plan (3 practices); Education and Training (3 practices); Measurement and Improvement (4 practices); Teamwork and Communication (3 practices) and the use of ICT (2 practices). However, these findings are different from previous studies which related to the identification of PQMS practices. A number of different practices have been identified in other studies as well as other practices which are not identified in the present study outcome. This happened due to several reasons:

- Only use Scopus in searching database
- Limitation of published paper involved in this study
- This study only based on secondary data

Analyzing these reasons, it was found that all quantitative analysis of empirical studies except for few studies have been utilized interview and literature review (qualitative) as methodology. Besides, size and sampling types also found to be varying in each study and it will affect the findings of the present study.

Through all six research studies, it was found that two studies were conducted in Hong Kong and one each in United Kingdom, Middle East, Korea, Pakistan and Singapore. Another reason for the variation is related to the construction that has been used. Most of the selected research studies utilized different approach, such as Quality Management, improvement tools, quality culture auditing, and quality control. Hence this approach also affects the results of the current study.

Implications

For the successful implementation of PQMS in the construction project, the implications of the current study are:

- The practitioners in the construction industry can use the practices for each CSF as a guideline for achieving desirable result such as customer satisfactions, improved performance and improved quality of product.

Recommendation for Future Research

Other than that, the scope and suggested direction for further research in regards of this area are:

- To test these practices into the construction project
- A comparative study with another developing country may be carried out to find the similarities and dissimilarities regarding PQMS implementation in construction projects.
- Further studies need to be undertaken concerning the best practice for PQMS implementation and its impact towards project performance.

Finally, the results of this study will help the managers and practitioners to adopt PQMS program successfully in their organization and highlight a new dimension for other researchers in this area, contributing to the knowledge as well as enhancing the implementation of PQMS philosophy.

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Appendix

Appendix 1: Review of the main literature on PQMS practices

Author(s)	Objective	Methodology and approach	Number of PQMS practices	Main Findings	Practices
Delgado-Hernandez, D.J. and E.M. Aspinwall[32]	Assessment of improvement tools on the perceived importance and the current of use.	Construct: Improvement Tools Method: literature review and survey Approach: factor analysis and descriptive analysis Sample type: UK construction industry Sample size: 72 respondents	8	The common practices in the industry are; quality control, technology and performance measurement.	<ul style="list-style-type: none"> - Gathering customer needs - Organizing customer needs - Formal methods - Planning tools - Programming tools - Quality control - Performance measures - Technology
Chan, A.P.C., F.K.W. Wong, and P.T.I. Lam[25]	Affecting factor on quality outcomes of the public housing projects.	Construct: QM Method: survey Approach: factor analysis and multiple regression analysis Sample type: public housing project Sample size: 54 cases	6	The identified factors show a strong relationship to good quality and found how these factors affect the PASS (performance assessing scoring system) scores of public housing projects.	<ul style="list-style-type: none"> - Appoint competent project manager - Proactive quality culture - Increasing usage of direct skilled workers - Adopting comprehensive inspection system - Increase competency of site labour - The client's emphasis on quality, safety and environment.
Ezeldin, A. and H. Abu-Ghazala[28]	Development and implementations of QMS model	Construct: QMS Method: interview Approach: statistical analysis Sample type: design consultant in Middle East Sample size: 20 projects	9	The QMS model applications has improved the design and the productivity	<ul style="list-style-type: none"> - Management responsibility - Resources management - Quality planning - Design and developments - Customer requirements - Purchasing - Measurement of customer satisfaction - Audits - Improvement
Tang, S.L., R.T.M. Aoieong, and C.S.L. Tsui[33]	Quality culture auditing through a scoring system	Construct: Quality Culture Auditing Method: survey Approach: one-way ANOVA Sample type: consultants in Hong Kong Sample size: 30 consultants	7	From the analysis, it is show that the three working level (high, middle and low) groups show significant difference opinions.	<ul style="list-style-type: none"> - Communication between management - Mutual understanding among staffs - Teamwork spirit - Commitment and involvement of staffs

					<ul style="list-style-type: none"> - Customer relationship and satisfaction - Continual improvement - Industry specific factor
Kwahk, K.J., et al.[34]	This paper present the integrated practice between progress management and quality inspection process for nuclear power plant construction project in Korea	Construct: QM Method: literature review Approach: IDEF0 Sample type: nuclear power plant construction project Sample size: N/A	1	Conflicts in progress determination between contractor and clients were reducing.	<ul style="list-style-type: none"> - Inspection
Choudhry, R.M., et al.[29]	Quality assessment and the ways to improve quality service provided by subcontractors.	Construct: QM Method: survey and interview Approach: mean scores, one way ANOVA or Kruskal-Wallis tests. Sample type: clients, consultants and contractor/subcontractors Sample size: 69	3	The result shows that poor constructions still exist. To improve the existing subcontracting practices, collaborative efforts of all the stakeholders are essential.	<ul style="list-style-type: none"> - Client adopt [ISO 9000 (ISO 19870)] - Contractor adopt [ISO 9000 (ISO 19870)] - More quality-control engineers
Yean Yng Ling, F. and W. ThengAng[35]	Using control systems to improve construction project outcomes.	Construct: Quality control Method: survey Approach: t-test and pearson's correlation analysis, and multiple linear regressions (MLR). Sample type: Singapore-based construction firm Sample size: 51	7	Competency of quality manager was significantly affected to quality outcome.	<ul style="list-style-type: none"> - Inspection record - Competency of quality manager - Information system - Project team's contribution to record system - Understanding of quality control process - Adequacy of time spent to resolve quality problems - Emphasis placed on developing feasibility studies for quality problems - Usage of material laboratory technology