

## Critical Success Factors of Project Quality Management System for Malaysian Construction Industry

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### Article history

Received :1 November 2014

Received in revised form :

31 March 2015

Accepted :30 April 2015

### Abstract

This study aims to explore the current implementation of Project Quality Management System and identify critical success factors of project quality management system associated with the indicators for each critical success factor identified. Hundreds of articles searched using keyword of “success factor”, “quality” and “construction” were gathered and analyzed using content analysis method. This research provides a comprehensive compilation of all previous study on the Critical Success Factors for Project Quality Management System implementation, through a clearly structured methodological approach. A total of six critical success factors for project quality management system in construction industry were identified. Each of the critical success factors is associated with three indicators that present evidences of implementation. The findings of this study provide guidance to the organization in implementing project quality management system effectively and efficiently.

*Keywords:* Critical success factors; quality; quality management system; project; construction

### Abstrak

Kajian ini bertujuan untuk meneroka pelaksanaan semasa Sistem Pengurusan Kualiti Projek dan mengenal pasti faktor-faktor kejayaan kritikal sistem pengurusan kualiti projek yang berkaitan dengan petunjuk bagi setiap faktor kejayaan kritikal yang dikenal pasti. Beratus-ratus artikel yang dicari menggunakan kata kunci "faktor kejayaan", "kualiti" dan "pembinaan" telah dikumpulkan dan dianalisis menggunakan kaedah analisis kandungan. Kajian ini menyediakan himpunan menyeluruh terhadap semua kajian sebelumnya mengenai faktor-faktor kejayaan kritikal sistem pengurusan kualiti projek, melalui pendekatan metodologi berstruktur yg jelas. Sebanyak enam faktor kejayaan kritikal untuk pelaksanaan sistem pengurusan kualiti projek dalam industri pembinaan telah dikenal pasti. Setiap satu daripada faktor-faktor kejayaan kritikal dikaitkan dengan tiga petunjuk yang menyediakan bukti-bukti pelaksanaan. Penemuan kajian ini menyediakan bimbingan kepada organisasi dalam melaksanakan sistem pengurusan kualiti projek yang berkesan dan cekap.

*Kata kunci:* Faktor-faktor kejayaan kritikal; kualiti; sistem pengurusan kualiti; pembinaan

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### 1.0 INTRODUCTION

Quality management system (QMS) is defined as “all activities of the overall management function that determine the quality policy, objectives and responsibilities, and implement them by means such as quality planning, quality control, quality assurance and quality improvement within the quality system” (1994). ISO 9000 is one of the QMS commonly apply in various industry including construction. According to Lin and Jang (2008), since the introduction of ISO 9000 till year 2005, there are total of 776,608 companies across 161 countries are ISO 9000 certified.

Evidences showed various advantages derived from adopting ISO 9000 QMS, these including but not limited to, improving the communications between stakeholders, minimizing the mistakes, rework and wastage, better control of sub-contractors and suppliers, and other benefits which are therefore, increasing productivity, profit, and market share as well meeting the clients requirements (Douglas, Coleman, & Oddy, 2003; Motwani, Kumar, & Cheng, 1996).

The construction industry had lived in the quality programme of inspection and quality control for years. Construction works and materials were accepted or rejected

based on the inspection and quality control. However, the introduction of BS 5750: Quality Systems in the UK in 1980's ISO 9000 in the same period had changed the perception of the construction industry's peoples in managing quality in construction environment (Giles, 1997). Local construction industry is also affected by the development and significant phenomenon of the ISO 9000 certification.

In Malaysia, the Construction Industry Development Board of Malaysia (CIDBM) has circulated a circular Bil.2/2006 to put a mandatory requirement for Grade 7 contractors, which is the highest level of contractor's registration to obtain ISO 9001 certification before 1<sup>st</sup> January 2009. Failure to do so will cause their registration be relegated or terminated. Besides, CIDBM also had taken a positive step by introducing a scheme namely Do-It-Yourself (DIY) scheme to all the contractors in Malaysia with the aims to facilitate the contractors to obtain ISO 9001. Introduction of DIY scheme has successfully increasing the numbers of contractors certified with ISO 9001. In year 2006, total of 375 contractors were certified with ISO 9001 (CIDB, 2007) and additional total of 180 contractors were certified in year 2009 (CIDB, 2009).

Construction is a project based industry which the definition of quality in the construction is meeting the customer's expectation (Jha and Iyer, 2006), for that reason, the success of QMS should be measured at project level rather at company level. As according to Barrett (2000), quality implementation in the construction industry can be categorized into two levels: company-based quality system and project-based quality system. However, most of the studies were done at company-based, limited number of studies focused on project-based. Implementation of PQMS at project level is challenging. In the past two decades, quality level of the construction industry is claimed still poor despite the introduction of various new technologies and management system (Sullivan, 2010). Among the major challenges always remains on the overall quality of the project. Construction projects often undergo project delays, cost overruns and non-conformance to quality, leading to poor performance and dissatisfied parties (Senaratne & Sexton, 2009). While the benefits of implementing quality system at company level are obvious as quoted earlier, the construction team faced difficulties to transfer them to the project level. An interesting study on the effect of quality system certification had been done by Barrett & Grover (1998) in which they concluded that for those companies that have achieved certification, the actual impact on the quality of the service from the client's viewpoint has been only slightly positive. Ng (2005) also reported the dissatisfaction of client on their expected quality level contributed by the engineering consultants in ISO 9000-based construction project. Research by Abdullah (2005) confirmed the similar situation faced by the local construction team in implementing quality system in a large scale construction project. As pointed by Tam *et al.* (2000b), "with all the quality programmes, quality appears far better on paper than it does on site".

Whilst studies are abound on the barriers and solutions, benefits and costs, and perceptions of the construction team on the quality system (Abdul-Aziz, 2002; Au & Yu, 1999; A. A. Bubshait & Al-Atiq, 1999; Chini & Valdez, 2003; Haupt & Whiteman, 2004; Hoonakker, Carayon, & Loushine, 2010; Huang, 2010; S. Y. W. Lam & Tang, 2002; Lindahl & Ryd, 2007; McAdam & Canning, 2001; Nycyk, 2008; L. S. Pheng & Hwa, 1994; L. S. Pheng & Teo, 2004; Alfredo Serpell & Ferrada, 2007; Shammass-Toma, Seymour, & Clark, 1998; Tang & Kam, 1999), only a few research on the critical success factors (CSF) in implementing the quality system in the construction industry especially at project level is observed. According to Rockart

(1979) CSFs are the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization.

The CSFs for the project success are different from the CSFs for the quality system implementation depending on the nature of study. Previous studies mainly focused on the CSF for the project success. For instance, Lam *et al.* (2007) identified eleven CSFs for the Design and Build-based project success i.e. time, cost, quality, functionality, low accident rate, minimal claims and disputes, environmental consciousness, aesthetic purpose, learning value, expectations of project participants and professional image. Whereas Haupt and Whiteman (2004) identified nine CSFs for implementing TQM on construction sites i.e. top management commitment, top management involvement, primary customer focus, well developed planning, participative management style, continuous improvement measurements, rewards for TQM contributions, TQM applied to all fields' operations, and workers trained in TQM. Both CSFs are apparently diverse with each other because they are meant for different purposes. The project success is meant for the product-oriented while the quality system is meant for the processes-oriented (Huang, 2010).

Identification of critical success factors and its indicators for PQMS implementation is the seed to success, which considered as the first approach towards the PQMS. The review shows that most of the research of CSF for the quality system irrespective of the type of the industry also focused on the identifying the CSF, ranking the level of criticality and finding the indicators for each CSF (Ab Wahid & Corner, 2009; Achanga, Shehab, Roy, & Nelder, 2006; Ahmad, Francis, & Zairi, 2007; Baidoun, 2004; Chin & Choi, 2003; Fotopoulos & Psomas, 2010; Khanna, Sharma, & Laroia, 2011; Kim, Kumar, & Kumar, 2011; Love, Edwards, & Sohal, 2004; Psomas, Fotopoulos, & Kafetzopoulos, 2010; Salaheldin, 2009a, 2009b; Singh, 2011; Singh, Garg, Deshmukh, & Kumar, 2007). For that, this paper aims to explore on the current implementation of Project Quality Management System (PQMS) and to identify the critical success factors for PQMS implementation in Malaysian construction industry. The following sections details in-depth study that explores the CSF for ISO 9000-based PQMS and their indicators.

## ■ 2.0 THE CSF FOR ISO 9000 BASED PQMS

To the best of author knowledge, previous literatures mainly focused on the success factors of TQM implementation in construction and limited research documented on the ISO 9000-based PQMS. For instance, Arditi and Gunaydin (1997) recognized that the importance factors affected quality in construction are corresponded to the TQM elements; Haupt and Whiteman (2004) studied success factors in transferring the TQM to the construction site; Pheng and Teo (2004) attempted to prove that the TQM could be successfully implemented in the construction industry; and Bryde and Robinson (2007) studied the application of TQM to the construction project management. Others specify the quality system in general as quality management system in their researches such as Jha and Iyer (2006) who determined the critical factors affecting the quality performance in construction project and Ries *et al.* (2010) who analyzed the best practice in leadership and third party certification for QMS in construction. Research in ISO 9000-based PQMS success factors is scarce and centered to the single party of the construction team. For instance, Chin and Choi (2003) who determined the success factors for ISO 9000 implementation by the contractor in Hong Kong construction industry. Other research in ISO 9000-based PQMS are not related to the success

factors of implementation such as the study on the performance of the engineering consultants in ISO 9000-based PQMS (Ng, 2005; Tang & Kam, 1999) and the effect of ISO 9000-based PQMS to the performance of the construction project (Din, Abd-Hamid, & Bryde, 2010).

While there have been several studies on the CSF for ISO 9000 implementation, they are mainly focus at the company level and some are referred to non-construction industry. For instance, Kim *et al.* (2011) developed the performance realization framework based on the motivations; critical success factors; and impacts of ISO 9000 implementation, but their research were for general industries. Work by others (Ab Wahid & Corner, 2011; Chin & Choi, 2003) were focus on the CSF for ISO 9000 implementation at construction related company-based QMS. As a matter of fact, there are many researches in implementing quality system at construction project level that have touched modestly on the several success factors. To encompass all CSF for PQMS, the disjointed success factors cited in the articles are scrutinised and categorised. Accordingly, 40 articles are considered to contain “success factors” applicable for PQMS implementation regardless of the type of quality system.

Hundreds of articles are reviewed after searching through the online database libraries including Emerald, Pro-Quest, Scopus and Web of Science. Among the keywords used are “success” and “quality system” and “construction”. Successive rounds of abstract reviews resulted in only fifty three articles are considered related to CSF for quality system regardless of the type of industry and CSF for construction per se. To identify the CSF through the articles involves two stages. The first stage is categorizing the like concepts into like category. Success factors that appeared to refer to same phenomenon are grouped together. At this stage, the proposed relationship is still provisional. After completion of this stage, 9 possible success factor categories are identified. The second stage involves close reviewing of the 9 possible success factors categories and finally, by collapsing several categories, 6 CSF are identified for the implementation of PQMS. Considering the definition by Rockart (1979) that the CSF is a “limited areas” the management should focus to flourish the business, this stage also produces the indicators for each CSF (area) comprising of the activities or signs that the CSF has been practiced. Table 1 shows the final 6 CSF for PQMS implementation and the references. The frequencies of references are stated for arranging the CSF in ascendant order. The subsequent sections explain each CSF in detail.

**Table 1** CSF for PQMS implementation

No	Success factors	Previous Study
1.	Client's commitment	Pheng and Hwa (1994), Bubshait (1994), Pheng and Ke-Wei (1996), Giles(1997), Arditi and Gunaydin (1997), Tang and Kam (1999), Serpell (1999), Chan and Tam (2000), Santos and Powell (2001), Antony <i>et al.</i> (2002), Chin and Choi (2003), Pheng and Teo (2004), Haupt and Whiteman (2004), Love <i>et al.</i> (2004), Pheng and Hong (2005), Chan <i>et al.</i> (2006), Jha and Iyer (2006), Zwikael (2008), Ab Wahid and Corner (2009), Kim <i>et al.</i> (2011), McCabe (1996), Huang (2010), Faulkner <i>et al.</i> (2000), Hoonakker <i>et al.</i> (2010)
2.	Integration of quality plan	Pheng and Hwa (1994), Sjiholt (1995), Pheng and Ke-Wei (1996), McCabe (1996), Giles (1997), Barrett (2000), Lam and Tang (2002), Battikha (2003), Toakley and Marosszeky (2003), Arditi and Gunaydin (1997), Tang and Kam

		(1999), Netto <i>et al.</i> (1997), Hodgson (1999), Serpell (1999), Haupt and Whiteman (2004), Love <i>et al.</i> (2004), Hoonakker <i>et al.</i> (2010), Kim <i>et al.</i> (2011)
3.	Measurement and improvement	Pheng and Ke-Wei (1996), Willis (1996), Arditi and Gunaydin (1997), Hodgson (1999), Au and Yu (1999), Faulkner <i>et al.</i> (2000), Tam <i>et al.</i> (2000), Santos <i>et al.</i> (2000), Antony <i>et al.</i> (2002), Chin and Choi (2003), Pheng and Teo (2004), Haupt and Whiteman (2004), Love <i>et al.</i> (2004), Chan <i>et al.</i> (2006), Jha and Iyer (2006), Ab Wahid and Corner (2009), Kim <i>et al.</i> (2011)
4.	Education and training	Pheng and Hwa (1994), Abdul-Rahman (1996), Giles (1997), Arditi and Gunaydin (1997), Tang and Kam (1999), Serpell (1999), Antony <i>et al.</i> (2002), Antony <i>et al.</i> (2002), Chin and Choi (2003), Love <i>et al.</i> (2004), Pheng and Hong (2005), Chan <i>et al.</i> (2006), Ab Wahid and Corner (2009), Kim <i>et al.</i> (2011)
5.	Teamwork and communication	Arditi and Gunaydin (1997), Barrett (2000), Santos and Powell (2001), Serpell (1999), Chin and Choi (2003), Antony <i>et al.</i> (2002), Pheng and Hong (2005), Jha and Iyer (2006), Ab Wahid and Corner (2009), Kim <i>et al.</i> (2011), Pheng and Teo (2004), Hoonakker <i>et al.</i> (2010)
6.	Use of ICT	Au and Yu (1999), Hajjar and AbouRizk (2000), Antony <i>et al.</i> (2002), Chini and Valdez (2003), Chin and Choi (2003), Love <i>et al.</i> (2004), Zeng <i>et al.</i> (2007), Nycyk (2008)

## 2.0 THE CSF FOR ISO 9000 BASED PQMS

### 2.1 Client's Commitment

Clause 5.1 Management Commitment in ISO 9001:2008 specifies the requirements for the “top management” commitment in driving the implementation of the quality system. The use of “top management” is a major amendment from previous edition where “a supplier’s management with executive responsibility” was used to describe the position required to steer the quality system. This is to show the important role of top management after major deficiency observed in implementing the ISO 9000 by managerial level who do not have the authority to make strategic decisions. This clause also is an explicit requirement that the top management also will be audited. According to the clause 5.1, as a minimum, top management should:

- communicate to the organization the importance of meeting customer as well as statutory and regulatory requirements;
- establish a quality policy and objectives;
- conduct management reviews; and
- ensure the availability of resources.

Top management commitment to quality is also the most widely cited CSF. This CSF referred to the need to have a committed leadership at the top management level. Most of the authors of the articles stressed the importance of the top management commitment in various forms. Pheng & Hwa (1994) highlighted the importance of the commitment from the construction parties’ top management in implementing the PQMS especially at the infancy stage of implementation. Similarly

Bubshait (1994) stressed the significant positive impact on quality system implementation if the owner involves actively in his project. Pheng and Ke-Wei (1996) indicated that commitment from top management will ensure regular training in quality is carried out, resulted to staff participation and contribution through quality control circles; and positive change of attitudes. Giles (1997), Haupt and Whiteman (2004) and Serpell (1999), on the other hand, looked at the reward given in the form of commercial incentives for the quality performance achievement as the indicator of management commitment.

Other investigators indicated that the commitment from top management on quality can be seen from the emphasis on training in quality (Jha & Iyer, 2006; L. S. Pheng & Ke-Wei, 1996; Zwikael, 2008); change management and quality culture (Chin & Choi, 2003; Love *et al.*, 2004; L. S. Pheng & Ke-Wei, 1996; L. S. Pheng & Teo, 2004; Low Sui Pheng & Hong, 2005); performance measurement (L. S. Pheng & Teo, 2004; Zwikael, 2008); continuous improvement (Chin & Choi, 2003; Haupt & Whiteman, 2004); and resources allocation (Jha & Iyer, 2006; L. S. Pheng & Ke-Wei, 1996; L. S. Pheng & Teo, 2004; Low Sui Pheng & Hong, 2005). Chin and Choi (2003) suggested a management review to be conducted periodically to look for improvement opportunities.

Some authors suggested that the top management becoming the champion in the quality programmes by upgrading their competency level in quality (Jha & Iyer, 2006); having thorough understanding of quality system (Arditi & Gunaydin, 1997); and preparing the first few important documents on quality system and deliver these to all staff members (Low Sui Pheng & Hong, 2005). All these will play a prominent role in manifesting the leadership (Chin & Choi, 2003; Kim *et al.*, 2011) and top management deeply involvement will drive the need for commitment from all staff members (Low Sui Pheng & Hong, 2005).

Quality culture and change management are not explicitly mentioned in the ISO 9001 standard as they are considered as the results of top management commitment (Chin & Choi, 2003; Love *et al.*, 2004; L. S. Pheng & Ke-Wei, 1996; L. S. Pheng & Teo, 2004; Low Sui Pheng & Hong, 2005). However, many previous researches highlighted the positive impact in nurturing the quality culture and promoting the change management. Kim *et al.* (2011) selected the quality-oriented culture as one of the CSF for implementing ISO 9001 at company level. Whereas, in assessing the quality relationships in the public housing in Hong Kong, Chan *et al.* (2006) revealed that fostering a proactive quality culture is paramount in the construction industry as to confront the negative and trifling attitudes of the contractors towards quality. Likewise, the promotion of quality culture is also pertinent to the consultants and other professionals in the construction industry (Faulkner *et al.*, 2000).

All the efforts to cultivate the quality culture begins with the change management (Tang and Kam, 1999). The change management can occur by the top management commitment; constructive contribution from quality manager to convince and change employees' attitude; and involve people's in procedures writing (McCabe, 1996). It also should be done at all levels: the organizational changes, cultural changes and the structural changes (Chin and Choi, 2003). Pheng and Hwa (1994) emphasised the quality culture begins when everybody accepts quality as priority and customer satisfaction orientation (Antony *et al.*, 2002). It is the results of training and education conducted for all levels of staffs to familiarize them with the quality concept.

It is undeniable that education and training will initiate the process of developing the quality culture development and change management but Huang (2010) argued that since the

quality process is dynamic the approach also must dynamic. He suggested adoption of the system dynamic modelling techniques to simulate and monitor the quality managing process and learning organization. Softer and long-termed process approach suggested by Hoonakker *et al.* (2010) is to adopt the clan culture. Clan culture, most common in family-type organisations, characterised by teamwork, employee-involvement programmes, and corporate commitment to employees can change the culture in the construction industry Organisations characterised by a clan culture treat their customers as partners and its employees as family.

In reviewing the above discussion, two issues are of interest: 1. who is the "top management" at the project level?; 2. how to bind the commitment between the parties? Most of the researches are mainly focussed on the involvement of individual party at project or company level, hence the use of "top management commitment" phrase is substantiated. However, a few researchers examined the management commitment at project level emphasised the commitment of the client for driving the quality system (Bubshait, 1994; Chan and Tam, 2000; Chan *et al.*, 2006; and Jha and Iyer, 2006). For instances, work by Bubshait (1994) showed that owner involvement is the key for the quality system implementation at project level, while Jha and Iyer (2006) stated that competence of the owner plays a prominent role in defining the expected level of quality from the contractor organization. Since the client has to play the prominent role in driving the implementation of quality by other parties, the best method is to bind it as a contract conditions (Pheng and Hwa, 1994; Netto *et al.*, 1997; Barrett, 2000). However, the implementation should be participative (Haupt and Whiteman, 2004) and contractual arrangement based on partnership should be introduced (Hoonakker, 2010).

## 2.2 Integration of Quality Plan

The requirement of providing quality plan is stipulated in clause 7.1 "product realization" of the ISO 9001:2008. The detail discussion on the quality plan can be referred in Section 2.2.2. Sjiholt (1995) popularised the idea of integrating the individual quality plan. No other explicit citation on the integrating the quality plan except Sjiholt (1995). However, the essence of integration of the quality system is supported by many authors (Pheng and Hwa, 1994, Barrett, 2000, Lam and Tang, 2002, Battikha, 2003). Pheng and Ke-Wei (1996) even insisted a non-bureaucratic project quality plans for all levels of work which is seen as not practical. Perhaps suggestion by Battikha (2003) to apply the multilevel management scheme to the different organizational structures in quality management is preferable. Similarly, Barrett (2000) stressed the need to have a sound formal system that link all relevant parts of all of the participant's own quality systems together around the needs of the project. However, a balance with an informal relationship among the parties should be developed (Barrett, 2000).

Integrating the quality plan involves the effort to balance the needs of the stakeholders such as client, developer, user and community; integrate the roles and responsibilities of the many parties; and link the customer quality expectations with specific goals and processes throughout design and construction (Toakley & Marosszeky, 2003). Insisting all parties to submit the individual quality plan is already a pre-requisite in the ISO 9000, but more importantly is the integration is done by a right choice of quality consultant (McCabe, 1996, Giles, 1997) in order to produce good quality system and to avoid overlapping and overlooking of scope of quality activities and conflicts (Pheng and Hwa, 1994).

Clause 1.2 Application of the ISO 9001:2008 claims that the requirements of the standard are generic and are intended to be applicable to all organizations, regardless of type, size and product provided. This clause also stated two key points i.e. first, an organization can exclude requirements within clause 7 Product Realization that are not required in order to meet customer requirements or are not required by the nature of the product or service provided, and second, an organization cannot exclude requirement that affect the ability to produce and provide conforming product or service (Cianfrani, Tsiakals, & West, 2009).

In practice there are many instances where the ISO 9001 requirements need to be reconciled with the nature of the construction project and any specific factors of the construction practices, otherwise it will be implemented improperly and create frustration in attempting to fit the practice to the requirements of the standard. For example, the conditions of the contracts. Netto *et al.* (1997) concluded after comparing the requirements of the ISO 9000 standard and the condition of contracts, that there is a need to consider the compatibility of the quality system and the standard forms of building contracts. Pheng and Ke-Wei (1996) emphasised the need to consider the implications of the range of contractual forms available as well as the effect of these on the quality systems. They even urged consideration to be made to the various contractual situations at various stages of the overall construction process. However, the main thing is both, the clause of contracts or quality system need to be changed to suit to best practice and support the quality activities at the strategic level as well as the operational (Netto *et al.*, 1997; A. Serpell, 1999).

There are other areas that challenge the construction industry to customize the ISO requirements such as with the processes of construction project management, roles and responsibilities of various parties, practice at field operations and site management level (Arditi & Gunaydin, 1997; Haupt & Whiteman, 2004; A. Serpell, 1999). Tang and Kam (1999) stressed the compatibility between the ISO 9001 requirements and design process, whereas Hodgson (1999) added the construction process as well. Love *et al.* (2004) generalised all the exercises as the customization of the quality system to the business strategy. However, Hoonakker *et al.* (2010) have different radical stands. He stressed that since the ISO 9000 emphasises on the standardisation, the contractors and designers should focus on the similarities and make more use of standardisation, prefabrication and system-building. The main effect to the construction industry by using these systems is the changes in the construction processes towards the manufacturing processes of building elements. The success implementation of the quality system in the manufacturing industry can be achieved by the construction industry as half of the processes are carried out at the factories.

### 2.3 Performance Measurement and Improvement

Clause 8 Measurement, Analysis and Improvement of the ISO 9001:2008 details the requirements for an organization to conduct the measurement, analysis and improvement activities. The requirement is important for measuring the strength and weakness of the system and to evaluate whether the system is effectively maintained and meets the requirements of the standards. The standard requires measurement and analysis to be conducted on the customer satisfaction, process and product. Internal audit also is stated as part of the main requirements. All the results will be reviewed in a series of management review session that is described in Clause 5.6 Management Review. The output of the management review should be specific improvement activities. The clause also stated the aims for

conducting management review i.e. to evaluate the effectiveness of the system, define opportunities for improvement and the need for changes.

The performance measurement and improvement is also considered imperative by the previous studies (Ab Wahid, 2010; Antony *et al.*, 2002; Haupt & Whiteman, 2004; Santos *et al.*, 2000). Pheng and Teo (2004) listed three main benefits of conducting the exercise i.e. adding value to processes, increasing quality levels, and raising productivity. Love *et al.* (2004) added that the quality improvement system has a role in improving the morale of employees while quality control and feedback by project participants will help in improving the workmanship (Jha & Iyer, 2006). Some of the performance measurement activities mentioned in the articles are internal audit (Chin & Choi, 2003; Kim *et al.*, 2011; L. S. Pheng & Ke-Wei, 1996), external audit where the audit is conducted to measure the ability and performance of outside parties such as consultant, contractor, suppliers and subcontractor ((Au & Yu, 1999; Chan *et al.*, 2006; Faulkner *et al.*, 2000; Hodgson, 1999; Jha & Iyer, 2006; Tam *et al.*, 2000; Willis, 1996).

To reinforce the commitment in implementing, maintaining and improving the quality system, Au and Yu (1999) suggested to link the design and inspection process review, and the quality performance achievement with the interim payment Giving incentives (Tam *et al.*, 2000) and using “stretch targets” or key performance indicator (KPI) (Santos *et al.*, 2000) are among other approaches to stimulate continuous improvement.

The performance measurement involves gathering the data, facts and figures and analysing them in an understandable manner and presentation. Thus, the competency of the auditor, inspectors, and reviewers should be continuously assessed and upgraded with advanced learning and training. Among the quality trainings related to measurement, analysis and improvement are statistical methods, standard problem solving techniques and cost of quality (Arditi & Gunaydin, 1997). Another approach to measure the performance in quality especially the workmanship is by using the established measurement scoring system such as PASS or CONQUAS to measure contractor’s quality performance (Tam *et al.*, 2000). In the context of Malaysian construction industry, the Quality Assessment System In Construction (QLASSIC) has been implemented by the Construction Industry Development Board of Malaysia for several years that benchmark the quality of workmanship of the project at the national level.

### 2.4 Education and Training in Quality Management

The lack of education and training in quality will grow negative attitudes of the construction parties due to misconception of the quality programmes and system (Pheng and Hwa, 1994). To improve the situation at the infancy stage of the quality system implementation in Singapore construction industry, they suggested a nationwide quality training for all players in the construction industry. The need for education and training in quality is unavoidable and cited by many reserachers (Tam and Kam, 1999, Antony *et al.*, 2002, Ab Wahid and Corner, 2009, and Kim *et al.* (2011).

There are many benefits of conducting the learning and training and among the benefits are: it will enhance the construction team understanding the needs of quality system (Giles, 1997), promote quality awareness and basics (Arditi and Gunaydin, 1997), and develop the skills and abilities of the employees to ultimately bring about improvement (Pheng and Hong, 2005). The education and training in quality is also required at the management level and in fact, it should be done at all level and at least extended to the foreman level (Abdul-Rahman, 1996, Arditi and Gunaydin, 1997). According to Jaafari

(1996) at project level, project specific training is needed to form work-area teams and empower the workforce. Beside training, learning can also happen during the quality control circles (Santos & Powell, 2001). However, to improve the understanding and commitment, a follow up training is suggested (Arditi & Gunaydin, 1997) and to drive the education and training in quality, continued commitment to encourage them is demanded (Love *et al.*, 2004).

Education and training is normally an element of the resource management (Chin and Choi, 2003). ISO 9001:2008 also places this element under the Clause 6 Resource Management. To be specific the clause that describes the training is Clause 6.2.2 Competence, Training and Awareness. The clause clearly focuses on the competency level required in performing work to the satisfaction of the clients (Cianfrani *et al.*, 2009). One of the approaches is through training. The clause also emphasises the requirements for conducting the training needs analysis and training feedback to identify the competency gaps and the effectiveness of quality system.

### 2.5 Teamwork and Communication

There are two clauses of the ISO 9001:2008 related to communication i.e. Clause 5.5.3 Internal Communication and Clause 7.2.3 Customer Communication. Both clauses require an effective communication process to be established. The clauses do not specify the form of communication, thus implied the use of any means and forms as long as the message or information is effectively conveyed (Cianfrani *et al.* 2009). Hoyle (2009) emphasised the importance of effective communication which is the key to successful quality system implementation or otherwise the wrong information will be transmitted, the right information will fail to be transmitted, the right information will go to the wrong people, the right information will reach the right people before they have been prepared for it, the right information will reach the right people too late to be effective, the communication will not be understood, and the communication will cause undesirable result.

While the requirement for communication has been described in detail in the ISO 9001:2008, there is no single clause mentioned about the teamwork. In fact, teamwork also plays an important role in ensuring successful implementation of PQMS. Team, not individuals, are the organizational units that are accountable for performance (Pheng and Hong, 2005) and willing to work together towards achieving common goals (Arditi & Gunaydin, 1997). In addition, “teamwork and communication” are used simultaneously in many researches (Ab Wahid & Corner, 2011; Chin & Choi, 2003; Kim *et al.*, 2011; Santos & Powell, 2001). In view of the common usage, both are combined as one CSF for PQMS implementation.

There are many ways to cultivate the effective teamwork and communication. Arditi and Gunaydin (1994) suggested the establishment of steering committee consists of all parties involved such as client, consultant and contractor to create common goal, togetherness and integration. They also added that quality training and the continuous improvement process are executed through a well-planned team structure. This training will help the parties to have common understanding and use clear quality concepts and terms, resulted in the avoidance of conflicts and promote team cohesiveness (Antony *et al.*, 2002; A. Serpell, 1999). Santos and Powell(2001) proposed quality control circles (QCC) to be practiced in order to promote teamwork, communication and continuous improvement. However, to realise the QCC, support from management is essential (Santos & Powell, 2001) and request change in the management attitude (Chin & Choi, 2003).

According to Barrett (2000), strong informal relationships between the parties is the key for project success and PQMS implementation. Jha and Iyer(2006) detailed the meaning of strong informal relationship as active and positive interaction among project participants; proper understanding of the needs of the others; the coordinating ability and positive attitude of project participants; a short and informal line of communication as well as regular construction control meetings among project teams further support the achievement of the desired quality level. Finally, others (Hoonakker *et al.*, 2010; L. S. Pheng & Teo, 2004; A. Serpell, 1999) brought forward an innovative contractual relationship that based on partnering where according to Hoonakker *et al.* (2010), “the principle is that the parties try to work as much as possible as if they were a single organisation”.

### 2.6 Use of Information and Communication Technology

Managing information is one of the main problems in the construction project (Zeng *et al.*, 2007) as there are many parties involved with various non-standardised techniques in handling the information contains in the records and documents. ISO 9001:2008 Clause 4.2.2 Control of Document and 4.2.3 Control of Record stress the importance of controlling the documents and records where they require a documented procedure for approving, circulating, storing and retrieving is to be established. Therefore, establish filing index, associated procedures, document log and data storage in managing the information especially in large projects where voluminous records are generated is significant (Antony *et al.*, 2002; Au & Yu, 1999). However, Au and Yu (1999) suggestion on having a decentralised document control functions probably suits manual approach of handling the records.

With the advance and rapid development of information and communication technology (ICT), many authors suggested the use of electronic quality document management system (Chin & Choi, 2003; Chini & Valdez, 2003; Hajjar & AbouRizk, 2000; Love *et al.*, 2004; Nycyk, 2008; Zeng *et al.*, 2007). Among the benefits are ICT could minimize and optimised the documentation requirements (Chini & Valdez, 2003), quick accessibility of records, simultaneous document sharing and better adherence to ISO 9000 standards (Nycyk, 2008). Some authors suggested the use of project-specific website that integrates the internet, electronic information management system and the quality system (Love *et al.*, 2004; Zeng *et al.*, 2007). With all the efforts to manage the information through ICT and electronic document control system, they are subject to the willingness, knowledge and skills of the participants in handling the ICT, hence, requires for management of change in the use of ICT and specific training and hands-on experience (Nycyk, 2008).

## 3.0 THE CONSTRUCTS OF CSF AND ITS INDICATOR FOR PQMS

The discussion on the CSF above derived six CSF for the implementation of PQMS. At the same time, eighteen indicators have been identified. Table 2 summarised the CSF and their indicators.

**Table 2** CSF and indicators for PQMS implementation

Constructs	Indicators
<b>1. Client's commitment</b>  <i>Concept:</i> The top management of the CR, Consultant and Contractor should play the active roles to promote, implement and maintain the quality activities, otherwise the PQMS will be seen as secondary.	1.1 Client provides conditions in the contracts for the preparation and implementation of project quality system by all parties involved in the construction projects.
	1.2 Client provides 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.
	1.3 Client provides adequate resources to support PQMS such as budgets, appointment of the right choice of quality consultant and incentives for quality achievement.
<b>2. Integration of quality plan</b>  <i>Concept:</i> The PQP of all parties involved especially the CR, Consultant and Contractor is critical to be integrated in order to avoid duplication and redundancy of activities, process, procedures and forms.	2.1 All construction main parties (client, consultant and contractor) prepare their project quality plans according to ISO 9000 and contract requirements.
	2.2 The individual party's project quality plans are integrated by a competent quality consultant.
	2.3 The integrated quality plan links all relevant parts of all of the participant's own quality plan together around the needs of the project, balances the needs of the stakeholders such as clients, consultants, and contractors, identifies, specifies the roles and responsibilities of the parties to prevent overlapping and overlooking of functions, and reconciles with construction project management and contract conditions
<b>3. Measurement and improvement</b>  <i>Concept:</i> The performance measurement of the parties in implementing the PQMS is a critical activity because without regular assessment the standardisation cannot be achieved, without which improvement activities cannot be introduced.	3.1 Planned internal and external audits are conducted to measure the performance of construction parties' quality system implementation and to identify areas for improvement.
	3.2 The quality committee conducts management reviews as planned to determine the areas for improvement based on the records and reports listed by the ISO 9000 standard such as the audit report and complaints.
	3.3 Client takes into account the construction parties' quality system performance when judging for the interim payment and incentives contribution.

Constructs	Indicators
<b>4. Education &amp; trainings in quality management</b>  <i>Concept:</i> All projects are unique and the quality system is designed peculiar to the contract requirements. With the temporary set up of project organization structure and workers, training on the quality requirements and activities is critical.	4.1 Continuous and regular trainings are conducted to make the construction team to understand the needs of quality system, enhance the quality awareness and basics of quality system
	4.2 Quality trainings are targeted at every level of the organization especially at least extended to the foreman level
	4.3 Introduce quality control circles (QCC) to all levels in order to look for opportunities for improvement and to promote learning project organisation.
<b>5. Teamwork and communication</b>  <i>Concept:</i> Many important discussion and decision related to quality in construction project are done impromptu and informal due to spontaneous incidents demanding the parties' strong teamwork attitude and contributing communication.	5.1 Establish steering committee consists of all parties involved such as client, consultant and contractor to create common goal, togetherness and integration
	5.2 Quality training and briefing are conducted through a well-planned team structure to ensure cohesiveness.
	5.3 Strong informal relationships between the parties with informal line of communication
<b>6. The use of ICT application for managing information</b>  <i>Concept:</i> Any quality system requires some evidences in the form of hardcopies of records and papers. The more activities involved the more the paperwork will be. Thus, computer application for managing information is critical in PQMS implementation as the quality activities can generate enormous copies of quality documents and records such as test records.	6.1 Establish electronic-based document control centre that make use of electronic quality document management system and web-based.
	6.2 Integration between the information technology requirements and quality systems requirements
	6.3 Management of change in the use of ICT through trainings and workshops.

### ■ 3.0 CONCLUSION AND RECOMMENDATION

Research in PQMS implementation and the CSF for its implementation can be a valuable step in enhancing the understanding and practical approaches for ensuring successful and effective implementation. A review on the previous literature reveals that there are limited study that has been done to the PQMS implementation. Further, the disjointed success factors mentioned in scattered articles recommends the future study to

focus on the comprehensive CSF and its indicators for the PQMS implementation. Overall, there are 6 CSF for PQMS where each CSF has 3 indicators that present evidences of implementations. The literature review also reveals that there is no study that encompasses all key stakeholders of the construction project. Therefore, future research should consider the key stakeholders in construction project namely the client, consultant and contractor views of the CSF for the PQMS implementation in order to have a valid finding.

### Acknowledgement

The authors would like to extend their sincere gratitude to the Ministry of Higher Education Malaysia (MOHE) for the financial supports received under University Grant.

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