Contractors’ perception of the use of costs of quality system in Malaysian building construction projects

Samiaah M. Hassen Al-Tmeemy a,⁎, Hamzah Abdul-Rahman b, Zakaria Harun a

a Faculty of Engineering, University of Malaya, 50603 Kuala Lumpur, Malaysia
b Research & Innovation, University of Malaya, 50603 Kuala Lumpur, Malaysia

Received 14 March 2011; received in revised form 1 December 2011; accepted 8 December 2011

Abstract

While conforming on the findings of prior researches regarding quality cost system in building companies, current research successfully illustrates the contractors’ perceptions on the importance of the quality cost system and the barriers that may constrain the implementation of the system for recording and collecting quality cost data. A postal and email surveys were undertaken on Malaysian building companies, focusing on the benefits and difficulties associated with the implementation of quality cost system. Statistical analyses based on Chi-Squared test and Relative Importance Index techniques were used to investigate the significance of the findings and determine the relative importance of the factors. The most important benefit of measuring quality costs is “getting management attention and increase quality awareness” as perceived by the sample of the study. The possible barriers that may affect the management’s decision to implement quality cost system are identified and grouped into three categories, which are culture and knowledge; system; and company. The study suggests that the level of the site staff’s knowledge should be as important as that of the management to successfully collect and record quality costs data. The findings of this research will raise the level of awareness and sensitize managers and those involved with building industry about the importance of quality cost system and collecting quality costs data.

© 2011 Elsevier Ltd. APM and IPMA. All rights reserved.

Keywords: Cost of quality; Quality cost system; Building construction; Quality management; Relative Importance Index

1. Introduction

The main purpose of project management is to address the stakeholder needs and expectations; thus, dissatisfactions of a project’s stakeholders lead to extra time and cost (Tam and Le, 2007). In addition, the successful companies must deliver projects on time and within budget, and meet specifications while managing project risk (Raymond and Bergeron, 2008). Achieving the stakeholder’s satisfaction and the completion of project within predefined time, cost and quality constraints is not an easy task in building construction (Al-Tmeemy et al., 2011). Likewise, the process of measuring quality costs is often difficult due largely to the complexity of construction processes (Aoieong et al., 2002). Hence, many economic and mathematical models have been developed to track quality costs; for example: Quality Performance Management System (CII, 1990); Quality Performed Tracking System (Davis et al., 1989); Quality Cost Matrix (Abdul-Rahman, 1995); Process Cost Model (Aoieong et al., 2002); and Construction Quality Costs Quantifying System (Low and Yeo, 1998). Unfortunately, these models have been of little use and many companies still do not have a quality cost system in place (Kazaz et al., 2005; Love and Irani, 2003; Miguel and Pontel, 2004).

The importance of quality management is quite noticeable in project management literature (Choi et al., 2009; Din et al., 2010). Also the need for companies to capture and assess quality costs data has been well-established in previously published literatures (Abdelsalam and Gad, 2009; Dale and Plunkett, 1999; Morse and Roth, 1987; Tam and Le, 2007). Several researchers (Miguel and Pontel, 2004; Schiffauerova and...
Thomson, 2006b; Sower and Quarles, 2003) stated that many companies appreciate the necessity of the quality cost system; however, they continue to lack one. As a result, the companies are not able to recognize how much they lose because of poor quality (Schiffauerova and Thomson, 2006b). This implies a gap between existing theory and practical application regarding quality management.

In Malaysia, the application of the cost of quality concept in the construction industry is a relatively new field of interest. Hence, the economics’ sense of improving quality is not well understood within the players of the building construction industry. It is no surprise therefore that some building contractors may avoid quality improvement processes believing that these processes add only time and cost to the process of construction. In the same time, less satisfactory performance in the construction industry has led to the belief that construction projects cannot be completed within budget and desired quality (Abdul-Rahman et al., 1996). This paper attempts to gain a deeper understanding of quality cost practices in the Malaysian building construction projects. Major issues that this study set out to establish were to study the perceptions of the contractors as to the benefits of collecting quality cost measurements and the barriers to adopt quality cost system. This study is very timely as CIDB of Malaysia has mandated ISO 9001 certification as a requirement for G7 contractors since first January 2009. It is therefore anticipated that registration with ISO 9000 will be increased and will become a norm rather than an exception. This implies that it is imperative for construction companies to adopt continuous improvement and change conventional management practices into a new paradigm to achieve high performance.

A literature search was used to generate the usefulness of collecting quality costs and the possible barriers for adopting quality cost system, which were administered to the building construction companies via a postal and e-mail surveys. The findings from this research significantly contributed towards enriching the boundary of existing knowledge to achieve a quality costs culture within building construction. Understanding the significance of quality costs system inspires the managers and contractors to effectively track and report the quality cost data. Indeed, this will alert all those involved with building industry to the extent to which quality costs can reduce the costs of construction. On the other hand, knowing the barriers that halted the adoption of the quality system will assist the contractors to overcome their struggle against these barriers.

2. Review of cost of quality models

Several models have been developed in previous literature. Schiffauerova and Thomson (2006b) classified COQ models into four groups of generic models, namely, prevention-appraisal-failure (PAF) or Crosby’s model; opportunity cost models; process cost models (PCM); and activity-based cost (ABC) models.

A most noticeable categorization model for quality costs is PAF, which was first simplified by Feigenbaum (1956). Prevention costs are incurred to prevent nonconforming units from being produced (Morse and Roth, 1987). The purpose of those costs is to keep defects from occurring in the first place by assuring that standards of organizational quality and customer satisfaction are met.

With appraisal costs come the costs of necessary activities to determine the actual level of quality achieved relative to the desired levels of customer satisfaction and organizational quality standards (Gilmore, 1990). Appraisal costs are incurred to identify nonconforming units before these are shipped to the customer (Morse and Roth, 1987).

Failure costs are incurred resulting from the existence of poor quality. These costs are typically classified as either internal or external. Internal failure costs occur when defective goods are identified before shipment to customers (Morse, 1993). Conversely external failure costs incur when nonconforming products are shipped to the customers (Morse and Roth, 1987).

Crosby (1979) divided quality costs into price of conformance (POC) and price of non-conformance (PONC). POC pertains to the price paid for doing things right, and examples include inspection and quality appraisal. PONC is the cost of poor quality caused by product and service failure, and examples are rework and returns. The opportunity and intangible cost model includes the cost of a missed opportunity, such as profits not earned because of lost customers and reduction in revenue owing to non-conformance (Schiffauerova and Thomson, 2006b). With the PCM, the focus is on the quality costs of a particular process rather than the total quality costs of an entire project (Tang et al., 2004). The last generic model is ABC, which provides data on how costs are actually consumed. The main idea behind ABC is that not all activities (and thus resource consumption rates) are proportional to the number of units produced (Raz and El Nathan, 1999).

To sum it up, COQ is the total of all resources spent by an organization to ensure that the established quality plan consistently achieves or exceeds standards (Bamford and Land, 2006). These resources are spent either for achieving quality or incurred due to lack of quality.

3. The significance of cost of quality

The quality costs are important because these costs can be extensive and could be 20% of the total sales turnover (Dale and Plunkett, 1999). Previous studies in North America have indicated that the costs of quality are typically at 20–30% of the total sales (Campenella, 1999; Hansen and Mowen, 1997; Krisham et al., 2000).

In construction, Lam (1994) has claimed that quality costs can make up from 8 to 15% of the total construction costs. In 1978, these costs were estimated by the UK Government to be 10% of the UK’s gross national product (Low and Yeo, 1998). Low and Yeo further stated that in the USA, direct costs incurred for rework alone have been estimated to be greater than 12% of any project costs. Hagan (1986) has warned that the lack of knowledge regarding quality costs will likely lead to unbalancing the inter-relationship of quality, schedule, and cost. This imbalance will continue to exist as long as the real cost of quality remains hidden among total costs.
The uses of quality costs data have been expounded by a number of scholars (Albright and Roth, 1992; Dale and Plunkett, 1999; Hagan, 1986; Lin and Johnson, 2004; Morse and Roth, 1987) and these are alerting management on the potential impact of poor quality on the financial performance of the company; helping management to determine the types of activities that are most beneficial in reducing quality costs and prioritizing quality improvement activities; establishing priorities for the corrective actions needed, promoting the concept that quality is everyone’s responsibility; allowing quality-related activities to be expressed in the language of management; establishing bases for budgets with a view to exercising budgetary control over the entire quality operation, assisting managers to comprehend the financial consequences of quality and arming them with information to formulate better strategic decisions in quality control and management; and reducing quality costs by altering the process in a particular project.

To summarize the concept and significances of COQ, Fig. 1 illustrates the objectives; targets; associated activities; and the expected output of each COQ category. This summary demonstrates how COQ can be an effective tool for evaluating the success of a quality management program and clearly points out the importance of knowing how and where quality costs are incurred so that remedial actions may be taken to prevent the recurrence of errors.

4. Barriers to cost of quality system implementation

Quality costs in the construction industry as a whole are considered high in terms of percentage of total project costs (Aoieong et al., 2002). Therefore, developing and assessing of quality costs are extremely beneficial for construction companies especially at the onset of their quality journey (Tatikonda and Tatikonda, 1996). Realizing the importance of quality costs is insufficient (Low and Yeo, 1998) as quality costs data must be collected. Achieving conformance to requirements consists of a series of quality management activities during the various phases of a project (Battikha, 2003). In this sense, companies need to implement a strategy to track quality failure costs, measure quality performance, and thus achieve continuous improvement in construction. Such a strategy requires a system that reports, monitors, and controls quality costs. This system does not only report quality costs, but likewise determines the level of quality that minimizes total cost of quality (Schiffauerova and Thomson, 2006a).

Miguel and Pontel (2004) posted similar view that many companies did not have a quality cost system despite their acknowledgement of its necessity. Previous survey studies showed that only 39% of companies certified with ISO 9000 adopted a quality cost system (Kumar and Brittain, 1995; Mattos and Toledo, 1997). The reason for the deficiency in adopting the COQ system has much to do with the onerous task of implementing such a system. Many quality experts have become aware of this issue and therefore have attempted to write about the installation process of the quality costs system (Low and Yeo, 1998).

Several authors documented the barriers and difficulties in COQ system implementation. According to Chen and Tang (1992), these barriers include: an extensive mathematical complexity; a lack of documentation to accompany the analytical derivation; and incompatibility with the existing corporate cost structures. Rodchua (2006) identified similar factors affecting its implementation such as, management support, effective application and system, cooperation from other departments and understanding of the concepts of the cost of quality. Serpell (1999) stated the most important barriers to implementation quality system that faced the contractors include: lack of knowledge of the concepts and tools of quality cost systems, deficient communication, lack of coordination between the main office and site, improper organization, lack interest of top management and site personnel, and problems regarding quality cost system definition.

In construction projects, measuring quality costs is often difficult due to the complexity of construction processes (Aoieong et al., 2002). Love and Irani (2003) found that measuring and analyzing quality costs is complex and problematic because of the large number of activities and organizations involved with procurement. Low and Yeo (1998) stated that the implementation of COQ system involves the efforts of many site personnel and needs further administrative work. Therefore, it is likely to be met with resistance from those involved and affected by it.

5. COQ as a quality improvement tool

The need for construction industry to improve quality performance has been well established in the previous literature (Tam and Le, 2008; Tam et al., 2008). Hence, quality management philosophy has gained prominence in research area (Zhao, 2000). Therefore, various approaches have been used for quality management such as Total Quality Management, Lean Construction; Supply Chain Management; Continuous Quality Improvement; Just in Time; and Total Quality Control. To provide problem-solving and facility for these approaches, several techniques and tools have been used such as seven tools of quality (histograms, cause and effect diagrams, checklists, Pareto analysis, control charts, flowcharts, and scatter diagrams); Six Sigma programs (Parast, 2011; Tam et al., 2008); Cost of Quality (Abdel-salam and Gad, 2009; Tam and Le, 2007); failure mode and effects analysis (Hawkins and Woollons, 1998; Yang and Peng, 2008); Quality Function Deployment (Dikmen et al., 2005); and value-added analysis (East and Love, 2011). To achieve the objective of total quality management that accomplish customer satisfaction at the lowest cost possible, it is necessary to do things correctly the first time. This is only possible if the cost of quality is measured and analyzed (Selles et al., 2008).

The quality performance of the construction industry is still unsatisfactory and serious problems continue to happen in the industry (Miguel and Pontel, 2004; Tam and Le, 2008). The main reason behind the failure of several companies in implementation of total quality programs is the lack of effective quality costs methods (Miguel and Pontel, 2004). According to Chang (2005), the ambiguity of the relationship between quality and quality cost influences managers’ decisions on quality improvement efforts. On the other hand, due to great complexity of construction, the possibilities and interrelations become so
fuzzy that they entail access to a decision-making aid model based on relevant performance evaluation (Marques et al., 2010). Ultimately, construction managers need to direct toward quantitative approaches for clear and accurate decision-making. COQ can be leveraged to support this strategy (Walker and Tobias, 2006).

The reporting of COQ with detailed information on the three categories of quality costs (i.e. prevention, appraisal and failure) outlines a clear picture of the relative distribution of quality costs incurred within a given period (Lin and Johnson, 2004). This information serves three purposes (Willis and Willis, 1996). First, it helps to track quality problems by identifying the nature of these problems. Second, it shows the effectiveness of control efforts and highlights where improvements must be focused. Third, it provides a baseline measure for evaluating quality improvement efforts in future projects.

The previous studies showed the implication of COQ for construction projects and how can use it to improve the quality performance of projects. For example, Love and Irani (2003) reviewed the quality costing systems and developed a prototype project management quality cost system to determine quality costs in construction projects. They used the system to determine the various causes of rework that occurred to monitor the progress of client change requirements.

According to Dale and Plunkett (1999), quality costs can be reduced by a third when a cost-effective quality management system is implemented. Similarly, Crosby (1979) has found that a well-planned and suitably implemented cost of quality program can reduce quality costs to 2.5% of total revenue. Implementing an effective quality cost program allows most companies to reduce scraps/rework and poor quality costs. Moreover, it leads to the development of a strategic quality improvement plan consistent with overall organizational goals (Rodchua, 2006).

### 6. Methodology

In order to investigate the perceptions of the contractors and managers of construction building about the benefits and the constraints of implementation of quality cost system, a cross sectional survey involving building contractors in Kuala Lumpur, Malaysia was used. The targeted respondents for this study were drawn from Construction Industry Development Board Malaysia (CIDB, 2008b) registered list of contractors categorized under Class G6 (tendering capacity 10 million Ringgit Malaysia) and Class G7 (tendering capacity of more than 10 million Ringgit Malaysia). Kuala Lumpur was chosen as the sampling city since it comprises the largest number of registered Class G7 contractors.

### Fig. 1. Mechanism of quality cost system.

<table>
<thead>
<tr>
<th>Category</th>
<th>Failure Cost</th>
<th>Appraisal Cost</th>
<th>Prevention Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Dealing with Non-conformances</td>
<td>Appraising the level of quality</td>
<td>Keep defects from occurring</td>
</tr>
<tr>
<td>Target</td>
<td>Identifying quality failure in products or services</td>
<td>Assuring quality &amp; Customer satisfaction</td>
<td>Preventing poor quality</td>
</tr>
<tr>
<td>Activities</td>
<td>Analysis root causes of failure, Ranking quality problems, etc.</td>
<td>Inspection, Testing, Review, etc.</td>
<td>Quality Planning, Process improvements, Training Managing quality system, supplier surveys, etc.</td>
</tr>
<tr>
<td>Output</td>
<td>- Deviation corrections - Rework and scrap - Processing complaints</td>
<td>- Faster identification of problems - Reduced rework and external failures</td>
<td>- Right first time - Fast and efficient work - Elimination of error, waste, total COQ</td>
</tr>
</tbody>
</table>
and G6 contractors. The percentage of registered contractors in this area is around 31.25% of the total number distributed within the 15 Malaysian states (CIDB, 2008a), postal and email surveys were used.

6.1. Sample size

To choose the sample for this research, the stratified sampling method was used to divide the sampling frame into two groups; G6 and G7 contractors. This method yields precise estimation and more accurate than those produced by simple random sampling; particularly, when the sampling frame is available in the form of a list (Kothari, 2004). Furthermore it is simple and convenient (Pedhazur and Schmelkin, 1991).

According to CIDB statistics, there were 1329 active contractors of grade G6 and G7 in Kuala Lumpur. Of this total, 1196 contractors are involved in building construction, which represented the population of this study. This population comprises 193 (16%) contractors of G6, and 1003 (84%) contractors of G7. In order to determine a suitable sample size, the following equation from Czaja and Blair (2005) was applied:

\[
ss = \frac{z^2 \times p(1-p)}{c^2} \tag{1}
\]

where \(ss\) = sample size, \(z\) = standardized variable, \(p\) = percentage picking a choice, expressed as a decimal, \(c\) = confidence interval, expressed as a decimal.

For this research, a value of 95% was established for confidence level (i.e. significance level of \(\alpha = 0.05\), \(z = 1.96\)), and a confidence interval (c) of ±10% was assumed. The value of 0.5 was chosen for (p) to assume the worst case percentage picking a choice (Czaja and Blair, 2005). Based on these assumptions, the required sample size for the questionnaire survey is 96 contractors. However, this figure requires a further correction for the finite population correction. The equation for this is given in Czaja and Blair (2005) as follows:

\[
Newss = ss / [1 + (ss - 1/pop)] \tag{2}
\]

Therefore, the required sample size for the questionnaire survey is 89 contractors. Construction industry is well-known for the poor response to questionnaire surveys; (20–30%) is believed to be the norm (Akintoye, 2000; Dulaimi et al., 2003). For this reason, it was necessary to adjust the sample size to account for non-response. Assuming a response rate of 15%, the appropriate sample size is derived from the following calculation:

\[
Surveyss = Newss / response rate \tag{3}
\]

Therefore, the sample size is duly adjusted whereby 594 contractors are targeted for the questionnaire survey. The sampling frame was structured in such a way that it represents the population and included all companies that have a chance to be selected. As shown in Table 1, the sample was selected according to the proportion of each group in the population (Adams and Brace, 2006; Czaja and Blair, 2005). Therefore, the sample contained 95 contractors G6 and 499 contractors G7, as shown in Table 1.

Systematic sampling consists of picking one company every certain interval from a complete list of population (Czaja and Blair, 2005; Vaus, 2002). First step, the names of companies for both G6 and G7 contractors were randomly listed in separate lists. The next step, the sampling interval was calculated by dividing the population size by required sample size. The sampling interval was 193/95 = 2 for G6 contractors. Likewise, the sampling interval for G7 contractors was 1003/499 = 2, as shown in Table 1. The starting point was randomly chosen based on either the first or second company in the list. Then, the sampling was conducted by choosing every second company in each list and added to the sample to obtain of 95 of G6 contractors and 499 of G7 contractors.

6.2. Questionnaire development

The questionnaire survey has been drawn up to get maximum information for minimum cost (Ader et al., 2008). The questionnaire is self-completing/sufficient and contained a range of structure questions. The self-completion questionnaire can be sent to a large number of respondents with a relatively lower cost. However, its success depends on the cooperation of the respondents (Adams and Brace, 2006). To attain an increased success rate of the survey, prior meetings were held with a group of experts to judge and assess the quality of survey items and its content. According to Ader et al. (2008), four to five experts are adequate to judge the survey items. Therefore, experts consisting of two academics and three project managers with more than 20 years work experience in the building construction field have vetted this survey questionnaire.

To ensure that respondents accurately able to answer the questions and receive the same stimuli, the questionnaire included clear definitions of the terms that related to quality cost. In addition, the initial paper/hard copy version of the questionnaire was used to conduct a pilot study prior to the full distribution of the questionnaires. According to Ader et al. (2008), the pilot survey provides feedback on errors, unexpected problems, and respondents’ willingness to participate in the survey. A total of twenty building construction companies listed under Classes G6 and G7 of the CIDB database were selected for this purpose. The results of the pilot survey provided information that was used to further improve the final version of the survey questionnaire where some questions were revised. Specific ideas were gained prompting some changes to the sentence structures and wording in order to provide more clarity to the intended original purpose of the questions.

The questionnaire survey was conducted in 2008 (March–October). It was divided into two parts. The first part was designed to gather general respondent’s demographics characteristics (e.g. educational level, age, experience, and occupation) of the participating companies. The second part investigated the benefits and barriers of adopting quality cost system to measure and track quality costs data.

6.3. Data analysis

The chi-square (\(\chi^2\)) test was performed on the significance of findings. Chi-squared test is used to examine the difference...
between observed and expected frequency’s distribution according to randomness outcome assumption (Field, 2009) using the following formula:

\[ X^2 = \sum \frac{(O_i - E_i)^2}{E_i} \]  

(4)

where \( O_i = \) an observed frequency, \( E_i = \) an expected (theoretical) frequency, \( i = \) response category index.

To further investigate the data, a relative importance is determined to quantify the contributions of individual explanatory variables to a response variable (Soofi et al., 2000). Several methods have been used to determine the relative importance. For example, the statistical significance has been used as an indicator of importance (Al-Harbi, 2001; Chan et al., 2011a,b). The interpretation of statistical significance is unfounded; therefore this method is inappropriate to assess relative importance (Soofi et al., 2000).

Other researchers used AHP (Analytic Hierarchy Process) to prioritize attributes, decision alternatives, and factors of a complex problem (Tsai et al., 2006). However AHP is a powerful and widely-used technique for eliciting the importance of factors, it is useful in circumstances which necessitate the identification of a preferred alternative from a set of alternatives (Saaty, 1980).

In this study the Relative Importance Index (RII) was used to assess the relative importance of each factor based on the numerical scores from the questionnaire responses. RII was defined as “the average percentage of total explained variance contributed by each variable across all possible subsets” (Baltes et al., 2004, p. 330). It can be performed for individual variables as well as for groups (Carpio et al., 2007). Moreover, RII was successfully used in the previous researches to determine the relative importance (Alwi and Hampson, 2003; Assaf and Al-Hejji, 2006; Chan and Kumaraswamy, 1997; Kometa et al., 1994; Le and Tam, 2008; Zeng et al., 2005) using the following equations:

\[ \text{RII} = \sum a_i x_i / A * N \]  

(5)

where \( a_i = \) constant expressing the weight of the ith response, \( x_i = \) level of the response given as a percentage of the total responses for each factor, \( A = \) highest weight, \( N = \) total number of respondents. The value of RII ranges from 0 to 1; a higher RII indicates that a particular factor is more significant than those with relatively lower RII. The RII for groups was determined by averaging the RII’s of all individual factors within the same category (Aibinu and Jagboro, 2002; Chan and Kumaraswamy, 2002; Soofi et al., 2000).

7. Research findings

7.1. Response rate

Of the 594 questionnaires dispatched to the selected sample, 153 were satisfactorily completed, pegging the total response rate at 25.7%. This figure is acceptable according to Akintoye (2000) and Dulaimi et al. (2003). Both of who have stated that normal response rate in the construction industry for postal questionnaires is within the range of 20–30%.

7.2. General respondents’ demographics characteristics

Frequency distribution is conducted to show four main profiles namely: educational level, age, occupation, and period of experience as shown in Table 2. The General Respondents’ Demographics (GRD) revealed that the majority of (90.2%) held a Bachelor’s degree as shown in Table 2. The highest frequency of respondents (40.5%) was aged between (40 and 49) years. Regarding the occupation of respondents, manager occupation accounted for the largest percentage (55.6%). Majority of respondents (96.1%) had more than 10 years of experience.

7.3. The benefits of quality cost measurements

The first question addressed the issues of surrounding benefits of quality cost system implementation and quality costs measurement. A scale of 1–4 (1 = disagree, 4 = strongly agree) was provided for the respondents to rate their choices. Table 3 provides a visual breakdown of the answers to this survey question (depicted in percentage).

The highest rank with RII of 0.99 was accorded to the benefit of “getting management attention and increase quality awareness”. This was based on the finding that the majority of respondents (92.8%) strongly agreed that quality cost measurement is a useful tool for gaining management attention. The remaining benefits listed according to their downward ranks are as follows: “changing the way the employees think about errors” (RII = 0.96); “providing means to measure the true impact of corrective action” (RII = 0.96); “Quality cost measurement is an effective tool for the implementation of TQM” (RII = 0.96); and “helps in identifying problem areas” (RII = 0.90). Other benefits of implementation of quality cost system are less significant, which are duly given low ranking as shown in Table 3. A highly significant difference was recorded at P<0.01 between observed and expected frequency distribution according to randomness outcomes assumption.

7.4. The barriers to adopt quality system in building projects

The second question was used to explore the viewpoint of respondents on the barriers that prevent adoption of the quality system. Respondents were asked to provide their opinions pertaining to the barriers listed in the questionnaire based on a four point Likert scale (1 = most unlikely, 2 = unlikely, 3 = likely, 4 = most likely).
Seven barriers were listed in the questionnaire form. Survey results indicate that the barrier that ranked the highest (RII = 0.96) was “lack of knowledge.” As shown in Table 4, majority of respondents (83%) agreed that this barrier is the most likely to prevent the adoption of the quality system. The barrier with the second highest ranking (RII = 0.95) was “lack of cooperation of contractor and sub-contractor”, where more than three-quarters of respondents (77.8%) believed the...
contractor and sub-contractor would most likely not provide such data. Meanwhile, 72.5% of respondents confirmed that design for such a system is most likely difficult to achieve, making “System design constrain” the third highest ranked (RII = 0.93). The remaining barriers that were ranked fourth to seventh were “lack of management interest”, “lack of resources”, “troublesome”, and “least important”. As shown in Table 4, the significant difference at P < 0.01 was recorded. This implies that the observed frequencies did not differ from their expected values.

8. Discussion

8.1. Benefits of quality costs measurement

Based on the results of the present research, quality cost measurement is needed to get the attention of the management and increase quality awareness. These results are consistent to some extent to previous management studies (Chong and Low, 2006; Hagan, 1986; Low and Yeo, 1998; Morse and Roth, 1987; Schiffauerova and Thomson, 2006a). No matter how these studies identified the role of quality cost in alerting the management on the potential impact of poor quality on the company’s financial performance, the quality improvements are still difficult for managers to justify and accept. This difficulty is mainly ascribed to the benefits, which are not always apparent from a strategic and economic perspective (Czuchry et al., 1999). In addition, the potential cost of quality failure may be — and probably is — considerably higher than indicated (Abdul-Rahman et al., 1996) because the records of most construction companies only show a limited amount of rework (failure), which is less than the actual incurred failure (Barber et al., 2000). Therefore, the quality cost system is necessary to get the attention of the management by separating quality cost from conventional accounts for cost assessment.

The results substantiated the usefulness of quality cost measurement in changing the way the employees think about errors by displaying the cost of rework. This measurement allows the employees to understand the cost of the errors they make. This understanding will never eliminate the errors completely, but it would help in preventing or reducing the future occurrence of the errors. The information on quality cost provides an adequate visual of the potential for improvement, as well as the impact of the corrective action. This information demonstrates that savings through quality management depreciate with time. In other words, the cost and time required to overcome a building failure are considerably less when the failure is detected earlier. Thus, the cost of failure data during the construction must be collected as soon as it occurs, or at least on a weekly basis (Abdul-Rahman, 1997).

The measurement of quality cost is also perceived as an effective tool for the successful implementation of a TQM. The TQM is mainly focused on the continuous improvement of the products and services. Construction managers must link the achievement of quality with cost to achieve the objectives of continuous improvement programs (Abdelsalam and Gad, 2009; Schiffauerova and Thomson, 2006b). Quality must be managed. One of the effective tools in managing quality is COQ, which associates the

<table>
<thead>
<tr>
<th>Table 4</th>
<th>The barriers to adopt quality system.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barriers</td>
<td>Choices</td>
</tr>
<tr>
<td>Lack of resources</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Lack of knowledge</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Least Important</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>System design constrain</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Lack of management interest</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Luck of cooperation of contractor and sub-contractor</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Troublesome</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>
achievement of the quality target with the economics of the company.

8.2. Barriers to the adoption of quality cost system in building construction companies

The results seem contradictory as a majority of the respondents acknowledged the importance of collecting quality cost data; however, the “lack of knowledge” was the most significant barrier. The logical premise is that the person who has answered the questionnaire does not work on site. To collect quality cost data, a company needs to implement a system (Oliver and Qu, 1999) and understand the elements and principles of quality cost (Sower and Quarles, 2003). Therefore, this process requires skilled labor to understand the collection and classification of quality cost. The importance of the skills of the laborer has been acknowledged in several previous researches (Abdul-Rahman et al., 1996; Azim et al., 2010; Hiyassat, 2000; Low and Goh, 1994; Tabassi and Bakar, 2009). Abdul-Rahman et al. (1996) claimed that most of the nonconformances could be prevented either by appropriate inspections or by the employment of skilled employees. In the same line, Low and Goh (1994) claimed that in the shortage of skilled labor, a large number of semi-skilled and poorly trained laborers are employed in the project, which creates barriers to the implementation of a quality system during the construction. However, the low level of skills among laborers is still one of the factors affecting the low productivity in the Malaysian construction industry (Ibrahim et al., 2010).

Another significant barrier in reporting quality cost data is the reluctance of contractors and subcontractors to provide data, probably because the contractual arrangement does not incite the contractor and subcontractors to announce the true extent of the problems (Barber et al., 2000). Another possible reason is their lack of awareness of the real significance of quality costs and to what extent these costs can affect the project performance (Selles et al., 2008). Apart from this factor, there is the issue of inaccurate reporting within companies, where the failure cost recorded is not a true reflection of the actual scenario. For example, reporting of defective works on site is sometimes skipped for fear of being held responsible for the rectification costs. Too often, site engineers promise to rectify the problem immediately to prevent the formal recording of the defect and halt the issuance of a nonconformance report by consultants. These engineers would then hide the cost of the rectification by other unauthorized cost-saving measures, such as cutting corners. Thus, the instances where the project appears to have been completed within the cost and with minimal wastage due to rework may not be entirely true.

The results indicated that the process of designing and implementing a quality cost system is not an easy task. However, most respondents denied viewing such a system with reduced importance. This acknowledgement indicates that the Malaysian building construction fraternity is on the right track toward understanding and realizing the importance and usefulness of managing quality cost. In general, the quality cost system implementation is met with resistance from the affected working level personnel because of the additional workload it entailed. To further exacerbate the situation, the top management is often unconvincing of its usefulness (Low and Yeo, 1998). However, huge expenditures on materials, money, and time are wasted yearly because of inefficient or nonexistent quality management procedures (Arditi and Gunaydin, 1997). Despite the similarity of reasons cited in previous literature for not adopting a quality cost system, an additional investigation within contractors would give a clearer view of the COQ awareness in Malaysian building and construction companies.

To provide framework and better understanding for expressing the barriers to the implementation of a quality cost system, according to their interpretation, the barriers can be linked up to three groups or categories, namely, “culture and knowledge”, “system”, and “company” as shown in Fig. 2. Culture has been considered as an indicator of how things get done within an organization (Garrett and Teizer, 2009). Culture comprises teamwork, loyalty, commitment, participation of employees (Fong and Kwok, 2009), behavior, and attitude (Abdul-Rahman et al., 1996). To some researchers, culture is an integrated product of social interaction and organizational life (Harvey and Stensaker, 2008), and is associated with knowledge (Cetina, 2007; Fong and Kwok, 2009). Therefore, the barriers of “lack of knowledge” and “lack of cooperation” can be placed under the first category (i.e., culture and knowledge). This category obtained the highest RII of 0.96.

The second group includes the barriers related to the system, which include “system design constrain”, “troublesome”, and “least important”. This group is ranked lowest, with an RII of 0.60. The third group, which refers to the barriers related to the company, has an RII of 0.7. This group includes “lack of management interest” and “lack of resources”.

9. Conclusion

The present study is concerned with the assessment of the awareness of the Malaysian building construction industry regarding quality costs and investigating the barriers that may constrain the implementation of the system for recording and collecting quality cost data. However, the majority of the respondents acknowledged the importance of collecting quality cost data, the level of quality cost knowledge among the site staff was relatively low. The present study suggests that the level of the site staff’s knowledge should be as important as that of the management to successfully collect and record quality cost data. Therefore, there is a high demand on quality cost training to enhance the site staff’s knowledge and skill.

The necessity of establishing a quality cost system stems from the fact that the implication of COQ cannot be realized without reporting and establishing all the true quality costs. However, the implementation of such a system is not an easy task and it is normally met with barriers. The barriers are not known, so overcoming them is difficult. The current research provided managers and participants a more informed sense to weigh the benefits against the barriers in the process of eliminating or removing them.

To obtain a quantum leap with regard to achieving the resultant gain from the benefits of collecting quality cost data, it is
important that the management enhance its awareness, take the right initiatives, and provide its utmost support while eliciting cooperation and instilling enthusiasm among all its departments to successfully implement the quality cost system.

The sample of the current study comprised G6 and G7 contractors in Kuala Lumpur; therefore, the transferability may be limited. In addition, we did not consider the use of COQ for cost reduction and quality improvements, but merely provided insight into the perceptions of managers and contractors on the benefits of implementing a quality cost system and the most significant barriers that limit or prevent its implementation. Consequently, further research is needed to show how quality cost data can be used to improve the performance of construction projects. More research is also needed to delve deeper into the causes and consequences of quality failures in terms of time and cost overrun. Such will raise awareness on the significance of quality costs and will equip managers with knowledge and confidence as to where it is best to spend money.

References


