The major causes of quality failures in the Malaysian building construction industry

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Abstract

The paper aims to investigate the causes of quality failures in the construction of buildings. A survey was conducted to collect data from a random sample of building companies in Malaysia. Statistical analyses based on Chi-Square and on Relative Importance Index techniques were used to determine the significance of the findings and the relative importance of the failure causes. Among 15 causes of quality failures, the most frequent causes are “insufficient skill levels”, “inadequate reviews of the design and engineering drawings”, and “lack of site layout studies”. To overcome these failures, an influence diagram is developed, which attributes quality failures to the lack of implementation of cost of control activities. The outcome of this study clearly shows the importance of understanding the reasons of quality failures to employ remedial actions that can prevent recurrence of errors. Furthermore, this study provides managers with adequate justification to spend for cost of control activities and to launch various quality improvement initiatives.

Keywords: Cost of quality, quality failure, building construction, cost of control, Relative Important Index

1. Introduction

Successful companies must deliver projects on time and within budget; as well as meet specifications while managing project risks (Raymond and Bergeron 2008). Achieving project objectives and completing project within pre-defined time, cost and quality constraints is not an
easy task in the construction of buildings (Al-Tmeemy et al. 2011). During construction, contractors are often required to re-work portions of the project due to unacceptable quality (Kakitahi et al. 2011; Hwang et al. 2009). Quality is evident in the amount of re-work and in the overall expenditures of a project (Garrett and Teizer 2009). Quality failure can occur during any stage of the construction process (Ede 2011). These conditions have led studies and practitioners to rethink models and frameworks that consider the cost of quality failure as not only a performance measure in the manufacturing plant or for a specific process, but also for an entire supply chain (Castillo-Villar et al. 2012a 2012b).

Regardless of time occurrence, the impact of quality failure can erase the projected benefits of development programmes (Kakitahi et al. 2011; Ede 2011). However, many companies are not aware of the cost that quality failure can incur, and the real harm it can cause, because these costs are not properly assessed (Selles et al. 2008). Consequently, quality failures continue to occur during construction process, while some are repeated in several projects (Selles et al. 2008; Love et al. 2008; Mitropoulos and Nichita 2010). Therefore, understanding the underlying causes of these failures and developing strategies to eliminate or to mitigate their occurrence are important to increase the probability of achieving the project objectives.

The first step in reducing the occurrences of quality failure is to study its causes and to develop subsequent effective prevention strategies (Love et al. 2008; Yates and Lockley 2002). For this purpose, this paper provides a deeper understanding of the causes of quality failures in construction projects in Malaysia. A literature review was conducted to identify the possible causes of quality failures, which were then associated with the lack implementation of cost of control (COC) activities. The findings of this research significantly contribute to the understanding of the necessity of COC activities. This understanding particularly helps people
involved in the construction process to obtain a true picture of the impact of implementation of COC activities and directs efforts to mitigate quality failures.

2. Relationship Between Quality Failure and Cost of Control Activities

Improving quality in the construction industry is necessary (Tam et al. 2008). This need for an improved overall project quality drives the implementation of quality control programs (Love and Edwards 2004). Effective quality management is a critical factor in the successful management of construction projects (Achi et al. 2007). Prior literature reports that poor quality management system connotes that uncoordinated information gathering, reporting, and project management, thereby necessitating multiple processing of information (Love and Irani 2003). Ultimately, wasted time; unnecessary costs; increased errors; reworking and non-conformity become inevitable in the construction process (Love and Irani 2003; Abdul-Rahman 1995; Alwi et al. 2001; Smallwood and Rossouw 2008). Thus, investigating and gathering information on quality costs are essential (Selles et al. 2008). Unnecessary costs due to failures can be eliminated with a small investment in prevention and timely inspection (Kazaz et al. 2005). Controlling quality costs can lead to the reduction in building cost and time for error or failure correction. Higher savings can therefore be derived from reducing failure and minimizing defects. In other words, cost of quality (COQ) represents a powerful tool that translates the implications of poor quality, reflects activities of a quality program, and translates quality improvement efforts into a monetary language for managers (Castillo-Villar et al. 2012a).

Quality costs are associated with two categories of quality-related activities, namely, control and failure activities (Hansen and Mowen 2006). Control activities consist of prevention and appraisal activities. Prevention activities are performed to avoid production of nonconforming units (Morse and Poston 1987). Prevention activities eliminate the initial occurrence of defects by
assuring the meeting of the standards of organizational quality and customer satisfaction. Prevention investments seek to realize this purpose by supporting activities, such as quality program management; training and education; quality promotion; process capability studies; failure mode and effect analysis; quality function deployment; designing of experiments; designing for the manufacturing, market research; internal and external customer surveys; quality planning; supplier certification programs; preventive maintenance; and the creation of cross-functional design teams (Angel and Chandra 2001).

Appraisal activities determine the actual level of quality achieved, which is relative to the desired levels of customer satisfaction and to organizational quality standards (Gilmore 1990). Appraisal activities extract nonconforming units before reach the customer (Morse and Poston 1987). These activities include inspection, testing and supplier surveillance internal audits and review of completed work (Gray 1995). Appraisal activities are done after failures occur and not before.

Failure activities are performed because of poor quality existence (Juran and Gryna 1980; Juran 1951). Costs due to failure are either internal or external. Internal failure costs are incurred when defective goods are identified while still in the factory and before they are shipped to customers (Morse 1993). Examples of internal failure costs are associated with scraps, re-working, equipment downtime, re-testing, and the time spent in identifying the appropriate corrective action. External failure costs are incurred when nonconforming products are shipped to customers (Morse and Poston 1987). These costs cover include attending to complaints adjustment; receipt and replacement of defective product, warranty charges, and payments made to customers to compensate for the inconvenience. (Angel and Chandra 2001).

The combination of prevention and appraisal costs composes COC (Hansen and Mowen 2006). The Construction Industry Institute (CII) defines eight types of COC that cover COC activities
These activities include: quality systems; supplier qualification; personnel qualification, testing and training; Expediting; constructability review; operability, safety, and value review; examinations, internal; and examinations, external, as shown in Table 1.

Table 1: Cost of Control Activities

<table>
<thead>
<tr>
<th>Activities</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality System</td>
<td>Developing quality improvement programs, standards and goals, data collection, analysis and reporting, indoctrination, and training</td>
</tr>
<tr>
<td>Personnel Qualification, Testing, and Training</td>
<td>Testing personnel’s ability to perform work according to specified standards, craft certification, and training for quality assurance/control activities.</td>
</tr>
<tr>
<td>Supplier Qualification</td>
<td>Evaluating the ability of suppliers, vendors, contractors, and subcontractors to perform capably, as well as developing a certification system and compiling rating scores to measure supplier performance.</td>
</tr>
<tr>
<td>Expediting</td>
<td>Activities prior to delivery to ensure on-schedule delivery of all purchased materials, equipment, services, and third-party engineering information.</td>
</tr>
<tr>
<td>Operability, Safety, and Value Review</td>
<td>Determining if the design is in compliance with client, industry, and government requirements in terms of operability, safety, value engineering, safety analysis, process hazards, operability reviews, value engineering studies, and so on.</td>
</tr>
<tr>
<td>Constructability Review</td>
<td>Activities to ensure that the most efficient design and planned construction methods are used to maximize the chance of building perfect facilities, construction site layout studies, de-watering studies, prefabrication studies, and so on.</td>
</tr>
<tr>
<td>Examinations, Internal</td>
<td>Reviewing, checking, inspecting, testing and observing services/product internally in the organization; reviewing designs, drafting and documentation, soil testing, concrete testing, hydro-testing piping, and so on.</td>
</tr>
<tr>
<td>Examinations, External</td>
<td>Reviewing, checking, inspecting, testing and observing products/services produced externally by others; inspection of material/equipment received, vendor document reviews, and so on.</td>
</tr>
</tbody>
</table>

3. Causes of Quality Failures

Previous literature on construction management mentions various terms for quality failure. These terms include re-work (Love and Edwards 2004; Love et al. 2004), nonconform (Abdul-Rahman 1995), defects (Josephson and Hammarlund 1999; Sommerville 2007), quality lapses
(Sommerville 2007), snags (Sommerville and McCosh 2006); quality failures (Barber et al. 2000), quality indices (Apostolopoulos and Pasialis 2008), and failure incidents (Barber et al. 2000) that are often used but have a tendency to vary. Regardless of the term used, quality failures lead to re-working and additional time for the correction process. Otherwise, the quality of the project is affected (Mitropoulos and Nichita 2010; Imbeah and Guikema 2009).

Several researchers have investigated the causes of quality failures. Feld and Carper (1997) claimed that either technical or procedural causes trigger failures. Feld and Carper (1997) classified the causes of failure into seven categories, which are: fundamental concept; site selection and development; programming; design; construction; materials; and operation. Similarly, Imbeah and Guikema (2009) referred to failures as results of technical and managerial inadequacies.

A survey carried out by Yates and Lockley (2002) exposed 29 causes of construction failures. These causes are summarized as follows: unqualified labour, poor review of on drawings, financial pressures, inadequate inspection methods, improper safety and value review, poor constructability review, poor reviewing, checking, inspecting, testing and observation, ineffective communication, and poor decision making.

Love and Edwards (2004) identified a number of factors impede the construction quality of buildings, which leads to reworking, as lack of understanding of end-user requirements, poor contract documentation and low consultant fees, incompetent standard of workmanship, lack of focus on quality and inadequate supervision and inspection. Josephson and Hammarlund (1999) attributed these factors to knowledge, information, motivation, stress, and risk. Willis and Willis (1996) observed that the causes of major deviations are designer error, vendor error, and change of designer.
The above literature clearly reveals that most causes can be attributed to the poor implementation of COC activities (Table 1). Several researchers claimed that the implementation of COC activities, such as design reviews; inspection; and training is the first step to minimize the potential impact of quality failures (Love et al. 2008; Yates and Lockley 2002; Love and Li 2000). In addition, the proper implementation of a quality management system assures the logical and progressive sequence of work, which prevents or mitigates delays during construction (Abdul-Rahman et al. 2006).

4. Methodology

To investigate the perception of the contractors and managers about the causes of quality failures, a cross sectional survey was conducted to collect data from a random sample of building companies in Kuala Lumpur. The targeted respondents for this study were drawn from the Construction Industry Development Board Malaysia (CIDB) (2008) registered list of contractors categorized under Class G6 (tendering capacity of 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 and G6 contractors.

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 more 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 (2008) 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.

**Table 2: Sampling Frame**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Population</th>
<th>Percentage</th>
<th>Sample size</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>G6</td>
<td>193</td>
<td>16%</td>
<td>95</td>
<td>2</td>
</tr>
<tr>
<td>G7</td>
<td>1003</td>
<td>84%</td>
<td>499</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>1196</td>
<td>1005</td>
<td>594</td>
<td></td>
</tr>
</tbody>
</table>

The sample size was 594 contractors of grade G6 and G7 operating in Kuala Lumpur. 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 2. 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 2.

The collected data was analyzed using the Relative Importance Index (RII), which is successfully used in the previous researches (Alwi and Hampson 2003; Assaf and Al-Hejji 2006; Chan and Kumaraswamy 1997; Kometa et al. 1994). The relative importance index (RII) and Chi-Squared test ($\chi^2$) were computed using the following equations:

$$RII = \frac{\sum a_i x_i}{A * N}$$  \hspace{2cm} (1)

$$\chi^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$$  \hspace{2cm} (2)
RII was used to determine the relative importance of the factors, where $a_i$ = constant expressing the weight of the $i^{th}$ 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. In order to examine the significance of the findings, the equation 4 was used, where $O_i$ = an observed frequency, $E_i$ = an expected (theoretical) frequency, asserted by the null hypothesis, $i$ = response category index, $n$ = number of response category index.

5. Questionnaire Development

A survey is conducted to obtain maximum information at minimal cost (Ader et al. 2008). The questionnaire has a range of structured questions and can be self-administered. Moreover, the questionnaire can be sent to a large number of respondents at a relatively lower cost. However, the success of the survey depends on the cooperation of the respondents (Adams and Brace 2006). To achieve a high success rate of the survey, prior meetings were held with a group of experts to evaluate and to enhance the quality of the survey items and contents of the survey. According to Ader et al. (2008), four to five experts can adequately assess the survey items. The questionnaire in the present study was vetted by experts, who consisted of two academicians and three project managers with more than 20 years of working experience in the building construction industry.

The initial copy $v$ of the questionnaire was used in a pilot study prior to the main conduct of the survey. This pilot study is important in evaluating the questionnaire in terms of its clarity and its comprehensibility as well as its suitability for the chosen sector. According to Ader et al. (2008), a pilot survey provides feedback on errors, identifies problems that may arise, and measures the, willingness of the respondents to participate in the survey. In addition, a pilot questionnaire is a commonly used and successful approach in situations when the subject of the survey is not
widely known (Wong and Aspinwall 2005). Twenty (20) construction companies that are listed under Classes G6 and G7 of the CIDB database were selected for this purpose. The results of the pilot survey provided information that enhanced the final version of the questionnaire; hence some questions were revised or rephrased based on the feedback. Specific issues that were raised prompted some changes to the sentence structure and word usage for more clarity on the intended purpose of the questions being asked.

The questionnaire was divided into two parts. The first part was to gather general respondent's demographics characteristics (e.g. educational level, age, experience, and occupation) of the participating companies. The second part was to investigate the benefits and barriers of adopting quality cost system to measure and track quality costs data.

6. Research Findings and Discussion

6.1 Response Rate

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

6.2 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 3. The General Respondents’ Demographics (GRD) revealed that the majority of the respondents (90.2%) were holding a Bachelor's degree as shown in Table 3. The highest frequency of respondents (40.5%) was
registered by the age group between (40 – 49) years, whereas the least percentage (6.5%) corresponded to the age group between (50- 60+) years. Where respondents are divided according to occupation, managers form the largest number of respondents (55.6%). And of which 96.1% had more than (10) years experience. However, the majority of the total respondents (39.2%) fell into the group having working experience between 20-24 years.

### Table 3: Descriptive Statistics of some General Respondent Demographic (GRD)

<table>
<thead>
<tr>
<th>GRD</th>
<th>Groups</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational</td>
<td>Diploma</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Bachelor</td>
<td>138</td>
<td>90.2</td>
<td>90.2</td>
</tr>
<tr>
<td></td>
<td>Master</td>
<td>13</td>
<td>8.5</td>
<td>98.7</td>
</tr>
<tr>
<td></td>
<td>PhD</td>
<td>2</td>
<td>1.3</td>
<td>100</td>
</tr>
<tr>
<td>Age</td>
<td>20-29 yrs</td>
<td>12</td>
<td>7.8</td>
<td>7.8</td>
</tr>
<tr>
<td></td>
<td>30-39 yrs</td>
<td>59</td>
<td>38.6</td>
<td>46.4</td>
</tr>
<tr>
<td></td>
<td>40-49 yrs</td>
<td>62</td>
<td>40.5</td>
<td>86.9</td>
</tr>
<tr>
<td></td>
<td>50-59 yrs</td>
<td>10</td>
<td>6.5</td>
<td>93.5</td>
</tr>
<tr>
<td></td>
<td>60 + yrs</td>
<td>10</td>
<td>6.5</td>
<td>100</td>
</tr>
<tr>
<td>Occupation</td>
<td>Quantity Survey</td>
<td>5</td>
<td>3.3</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>Project(construction) Engineer</td>
<td>5</td>
<td>3.3</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td>Quality Assurance/Quality Control</td>
<td>7</td>
<td>4.6</td>
<td>11.1</td>
</tr>
<tr>
<td></td>
<td>Resident/ site Engineer</td>
<td>41</td>
<td>26.8</td>
<td>37.9</td>
</tr>
<tr>
<td></td>
<td>Manager</td>
<td>85</td>
<td>55.6</td>
<td>93.5</td>
</tr>
<tr>
<td></td>
<td>Director</td>
<td>10</td>
<td>6.5</td>
<td>100</td>
</tr>
<tr>
<td>Experience</td>
<td>5 - 9 yrs</td>
<td>6</td>
<td>3.9</td>
<td>3.9</td>
</tr>
<tr>
<td></td>
<td>10 - 14 yrs</td>
<td>37</td>
<td>24.2</td>
<td>28.1</td>
</tr>
<tr>
<td></td>
<td>15 - 19 yrs</td>
<td>25</td>
<td>16.3</td>
<td>44.4</td>
</tr>
<tr>
<td></td>
<td>20 - 24 yrs</td>
<td>60</td>
<td>39.2</td>
<td>83.7</td>
</tr>
<tr>
<td></td>
<td>25 + yrs</td>
<td>25</td>
<td>16.3</td>
<td>100</td>
</tr>
</tbody>
</table>

6.3 The Causes of the Quality Failures

The respondents were asked to provide their opinions toward the listed causes on a 5-point Likert scale where 1 = never, 2 = rarely, 3 = sometimes, 4= often, 5= always. Table 4 shows that the most frequent causes of quality failure was “Insufficient skill levels” with RII=0.79.
The respondents declared that the most frequent cause of quality failure is “insufficient skill levels” with RII=0.79. This result indicates that the Malaysian construction industry often faces the problem of inadequate skill levels among its workers. The lack of labor skills can be attributed to two possible reasons. First, contractors mostly consider ethical practices rather than education and training. Ethical practices are not easy to perform, while the development of skills in the construction sector takes a long time. Construction work encompasses a diverse range of specialized skills to perform a number of functions, which leads to the difficulty. Second, contractors do not fully understand the implications of a shortage of skilled labor to the ability of the company to compete in the global market.

Table 4: The causes of the quality failures

<table>
<thead>
<tr>
<th>Questions</th>
<th>Choices</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
<th>RII</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor quality improvements programs</td>
<td>never</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.70</td>
<td>P=0.000</td>
</tr>
<tr>
<td></td>
<td>rarely</td>
<td>4</td>
<td>2.6</td>
<td>2.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>sometimes</td>
<td>84</td>
<td>54.9</td>
<td>57.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>often</td>
<td>52</td>
<td>34</td>
<td>91.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Always</td>
<td>13</td>
<td>8.5</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor document control</td>
<td>never</td>
<td>1</td>
<td>0.7</td>
<td>0.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>rarely</td>
<td>23</td>
<td>15</td>
<td>15.7</td>
<td>0.60</td>
<td>P=0.000</td>
</tr>
<tr>
<td></td>
<td>sometimes</td>
<td>110</td>
<td>71.9</td>
<td>87.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>often</td>
<td>16</td>
<td>10.5</td>
<td>98</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Always</td>
<td>3</td>
<td>2</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of training</td>
<td>never</td>
<td>1</td>
<td>0.7</td>
<td>0.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>rarely</td>
<td>12</td>
<td>7.8</td>
<td>8.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>sometimes</td>
<td>63</td>
<td>41.2</td>
<td>49.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>often</td>
<td>69</td>
<td>54.1</td>
<td>94.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Always</td>
<td>8</td>
<td>5.2</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor selection of suppliers, vendors and sub-contractors</td>
<td>never</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.67</td>
<td>P=0.000</td>
</tr>
<tr>
<td></td>
<td>rarely</td>
<td>13</td>
<td>8.5</td>
<td>8.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>sometimes</td>
<td>72</td>
<td>47.1</td>
<td>55.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>often</td>
<td>68</td>
<td>44.4</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Always</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insufficient skill levels</td>
<td>never</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.79</td>
<td>P=0.000</td>
</tr>
<tr>
<td></td>
<td>rarely</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>sometimes</td>
<td>22</td>
<td>14.4</td>
<td>14.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>often</td>
<td>117</td>
<td>76.5</td>
<td>90.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Always</td>
<td>14</td>
<td>9.2</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delayed purchased material</td>
<td>never</td>
<td>28</td>
<td>18.3</td>
<td>18.3</td>
<td>0.47</td>
<td>P=0.000</td>
</tr>
<tr>
<td></td>
<td>rarely</td>
<td>65</td>
<td>42.5</td>
<td>60.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>sometimes</td>
<td>44</td>
<td>28.8</td>
<td>89.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>often</td>
<td>13</td>
<td>8.5</td>
<td>98</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Always</td>
<td>3</td>
<td>2</td>
<td>100</td>
<td></td>
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</tr>
</tbody>
</table>
The second identified cause of quality problems is “inadequate reviews of the design and engineering drawings” with RII of 0.74. The review of design is an important step in the lifecycle of a project because it evaluates the adequacy of design requirements to identify problems. The
problems discovered during construction are usually more costly to correct and more likely to cause delay. However, several contractors conduct inadequate reviews because they either feel they already know enough to prohibit any design review or because of limited time. Moreover, the client rarely requires the contractor to provide a comprehensive design review.

Surprisingly, the “lack of site layout studies” ranks third with RII of 0.74. Previous studies mentioned that site layout studies focused on space management and on the manner in which construction plans are formed, safety is ensured, and resources are utilized (Hendrickson 2000; Ning et al. 2011; Osman et al. 2003; Tam et al. 2002). These studies acknowledged the role of construction site planning in improving both efficiency and safety during the construction process. Hence site layout planning has a higher impact on quality than other reasons, such as improvement programs; training; selection of suppliers; and so on. This result indicates the importance of site layout management in the large building projects, which are crowded and chaotic job sites.

Table 4 shows the ranking of the other identified causes from fourth to fifteenth based on their RII. The rankings are: poor quality improvement programs (RII = 0.70); lack of training (RII= 0.69); inadequate operability review and value engineering studies (RII= 0.68); poor selection of suppliers, vendors and sub-contractors (RII= 0.67); constructability problems (RII= 0.66); poor checking, inspecting, and testing internally (RII=0.65); unclear or incompleteness construction drawings and specifications (RII= 0.61); improper soil analysis (RII= 0.60); poor document control (RII= 0.60); delayed purchased (RII= 0.47); poor safety program (RII= 0.42); and poor checking, inspecting and testing externally (RII= 0.39). The result shows a strong correlation value at 0.01 level of significance. This finding suggests that the sample is truly random and the population had no observed differences.
The above causes of quality failures can be attributed to the lack of implementation of COC activities. The implementation of eight activities of COC, as shown in Figure 1, can ultimately, reduce or prevent quality failures. For example, to deal with the problem of insufficient skills, the contractor should test the ability of the personnel to perform work according to specified standards, ensure personnel qualifications, and conduct trainings for quality assurance/control activities. Almost all instances of nonconformity can be avoided either by timely inspections or by the use of more experienced and skilled employees (Abdul-Rahman et al., 1996).

To overcome the problem of “inadequate reviews of the design and engineering drawings”, a design review must be planned and performed during the early stages of a project. The early review can determine if the design complies with the client requests, industry standards, and government requirements in terms of operability, safety, value engineering, process hazards, and so on. These activities provide managers with visibility to empower effectively employees. In addition, managers can immediately recognize existing or emerging problems, make corrections, and adjust resource allocations. Besides, these activities can prevent or reduce other quality failures such as poor safety program, inadequate operability, and improper site analysis, as shown in Figure 1.

The constructability review copes with the problems of “lack of site layout studies”, “unclear or incomplete construction drawings and specifications”, and “constructability problems”. The constructability review comprises all activities that necessary to ensure the efficiency of the design and the accuracy of studies on construction site layout, dewatering studies, pre-fabrication, and so on.
7. Conclusion

The present study aimed at identifying the possible causes of quality failures experienced by managers and contractors of building projects in Malaysia. Results show that the most frequent
cause of quality failures is “insufficient skill levels”. Additional evidence from this study suggests that the conduct of training programs improves knowledge and skills of employees. Quality assurance/control activities, such as training programs, can mitigate the skill shortages among the existing workforce and ultimately reduce quality failures. Therefore, the management of quality costs and implementation of COC activities can prevent or eliminate all quality failures.

Findings indicate that failure costs and the causes of failures should essentially be monitored. The level of awareness and sensitivity on the importance of COQ among managers and those involved in the construction process should be increased. As a result, managers potentially become more confident in implementing COC activities to minimize quality failures.

The limitation of this research is that the sample consisted only of Classes G6 and G7 contractors in Kuala Lumpur. Therefore, the results obtained may not be representative of the Malaysian construction population or of the situation worldwide. However, the findings from this study can be considered as acceptable indicators and a fair representation of the situation in the Malaysian construction industry.

For further studies, the sequences of quality failures may be examined more deeply based on time and cost overrun. This investigation will raise awareness regarding the significance of quality costs and equip managers with knowledge and confidence on where to best utilize their resources.

8. References


