DEVELOPMENT OF A WORKMANSHIP MANAGEMENT SYSTEM FOR PERFORMANCE APPRAISAL OF CONSTRUCTION PROJECTS

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One of the most important aspect of quality in a project is workmanship. Most contractors have failed in meeting stakeholders’ needs in the area of workmanship as it relates to the objectives of cost, quality and time. The lack of a workmanship management system in the construction process is one of the major problems facing the construction industry. In this regard, this study is aimed at developing an integrated benchmarking framework to measure workmanship performance of construction projects at any stage with focus on ensuring quality. To do so, the study undertakes a critical survey of literature and building professionals using mixed survey methods. It then uses the information gathered to develop an integrated workmanship benchmarking framework by integrating three major existing quality management techniques that include TQM, Six Sigma and SMS. This study successfully developed an integrated benchmarking framework with capability to measure the workmanship performance at both organization and project levels in any stage of construction projects. Also, the study identified a set of critical success factors for workmanship assessment and is expected to assist with and guide in the development of a workmanship performance assessment tool for the construction industry in developing counties including Trinidad and Tobago.

Keywords: Assessment, Technique, Framework, Defect, Factor and Benchmarking.

1 INTRODUCTION

Defective workmanship can bring about building defects at any stage of a building project, including during construction, operational or maintenance stage (Josephon and Hammarlund 1999). These include workmanship defects such as design errors, defective materials, and or improper installation of materials with lack of supervision. There are many problems affecting the quality of construction projects such as standard reduction, increased cost, project delay, unskilled workers and less qualified construction workers (Ali and Wen 2011). Other factors influencing the construction quality include poor specification of materials, workmanship and quality of technical elements and services (Husin et al. 2011). Rapid development in housing construction through government quality control efforts have seen the existence of widespread defects. This is a major public concern. According to a study conducted by Che-Ani et al. (2014), the quality of provided housing in most developing countries today is far below standard as most of the defects are related to structural and systemic workmanship problems. These defects were found to be strongly associated with poor workmanship quality (Chong and Low
The most important and re-occurring issue concerning building and construction projects’ quality assessment was found to be the lack of a comprehensive performance assessment framework at all phases of the project for construction workmanship. Hence, the need for this study to develop a holistic integrated workmanship performance benchmarking framework for construction processes.

2 WORKMANSHIP PERFORMANCE ASSESSMENT TECHNIQUE AND MODELS

Several models and procedures have been suggested for the evaluation of project performance on site and project level (Aziz and Hafez 2013). Some of these models focused on prediction of project performance, while other focused on measuring. However, these traditional models offered and used a limited set of measures for performance assessment. This is because most of these models limit their analyses to measures such as cost, schedule, labor and productivity. The major shortcomings of these traditional workmanship control systems are their inability or not using appropriate critical success factors to measure new performance elements. Consequently, Priyadarshani et al. (2013) and Aziz and Hafez (2013) suggested the need to utilize previous concepts in modelling the new performance for continuous improvement. Consequently, a conceptual integrated framework was developed workmanship performance benchmarking. An integrated and holistic approach developed to measure and assess the workmanship performance of construction processes at both organizational and project levels. This approach integrates principles and techniques from three existing quality assessment systems that include TQM, Six Sigma and SMS.

2.1 Development of a Workmanship Performance Benchmarking Framework

Several important quality management systems and programs have been developed since 1980s for quality management, such as ISO 9000, Total Quality Management (TQM), Six Sigma, re-engineering and lean programs among others. Most of these systems have been adopted by industries around the world. Among all quality management systems, TQM and Six Sigma are more widely adopted by global industries. In some cases, firms implement both systems simultaneously. To implement these effectively, it is usually necessary to integrate them with other quality and similar practices, especially those with element of safety, such as Safety Management Systems (SMS). Safety is considered an important component of quality management in construction project. According to Yang (2004), a holistic workmanship management model can be developed. This suggests that understanding customers’ needs, expectations and satisfactions can be combined through an integrated framework involving SMS, TQM and Six Sigma. The integration of practices between the three systems involves integrating their key critical success factors, such as employee participation, team work, quality management system, safety management system, human resource management, quality principles, objectives and strategies as the key enablers of TQM implementation. There are critical factors being used for business performance improvement and also required for the implementation of six sigma program. These include project management, role design, operations, statistical quality control (SQC) tools, leadership and motivation from the management. Most of these practice enablers and factors are also integrated to TQM and SMS implementation. In Figure 1, the three frameworks placed emphasis on employee education and training. Statistical tools and improvement methods such as Quality Control Circle (QCC) and Quality Improvement Team (QIT). Six Sigma five improvement phases: Define, Measure, Analysis, Improve and Control (DMAIC) and Deming “Plan, Do, Check, Act” PDCA cycle are the main ingredients of content for TQM, SMS and Six sigma integration. Apart from statistical tools, TQM, SMS and Six
Sigma have shared training imperatives. These include basic concepts, leadership and communication skills and project management as shown in Figure 1.

![Integrated benchmarking framework of TQM, Six Sigma and SMS](image)

Figure 1. Integrated benchmarking framework of TQM, Six Sigma and SMS.

Apart from these common elements, in developing an integrated framework it is necessary to integrate those elements that are not shared in common as well. The implementation of TQM, Six Sigma and SMS as an integrated system brings about cultural changes in the organization. These cultural features are critical factors in pursuing excellence in performance and in raising competitiveness. Cultural change features include: speed, quality concepts, innovation and performance-orientation. In the integrated model presented, these cultural features will enhance performance effects of workmanship assessment.

3 METHODOLOGY

To achieve the research aim and objectives, the researcher developed a set of main factors relevant to the implementation of the integrated workmanship performance benchmarking framework through questionnaire survey. The primary main factors used for this study were identified from literatures such as (Toor and Ogunlana 2009, Saurin and Ahuja 2014, Yiu et al. 2018 etc). Consequently, the participants were required to rank the importance of 21 main factors identified for organizational workmanship performance and another set of 23 main factors for project workmanship performance. The ranking was based on a scale of 1 (very important) to 21(least important) for organizational related factors and 1 (very important) to 23 (least important) for project related factors. The data was collected from building and construction professionals in Trinidad and Tobago. These professionals worked in different building and
construction firms. Out of 320 questionnaires administered to the professionals, 190 questionnaires were returned of which 95% were usable. The total number of usable questionnaires returned after checking was 181 representing an overall response rate of about 57%. Although the response rate was lower than hoped, the total number of responses is statistically significant as it satisfies the Centre Limit Theorem (Sample size > 30). A total number of 190 questionnaires were returned because the delivery some addresses could not be located by the Postal Agency used. Hence, Figure 2 below, shows that the highest number of questionnaires was received from contractor professional category.

![Figure 2](image)

**Figure 2.** Distribution of respondent by professional category.

### 4 DATA ANALYSIS

The findings from the survey as displayed in Figure 3 shows that top management commitment is considered as the main determinant of TQM practices in organisations. Besides, top management commitment is described as the fundamental factor to TQM implementation at both organisational and project levels (Toor and Ogunlana 2009, Saurin and Ahuja (2014). In addition, according to Figure 3 the respondents believed that “Safety Leadership” “Performance Measurement System”, “Continuous Improvement”, “Quality Culture”, “Customer Satisfaction”, “Safety Training”, “Process Planning”, ‘Employee Empowerment”, “Information and Communication”, “Strategic Quality Management”, “Training and Education”, and “Supply Chain Management” were the main factors and most important for workmanship performance assessment at organisational level. These factors recorded higher rankings compared to other factors assessed. However, in contrast, “Quality Initiative to Business” was considered the least important to organisational workmanship performance assessment. This is followed by “Quality Initiative to Customer, Employee and Supplier”. Also considered least important included “Project Selection”, “Environmental and Society Impact”. Besides, majority of the identified factors were in agreement with past studies and consistent with main factors recommended in the literature, such as Toor and Ogunlana (2009), Yiu et al. (2018), thus suggesting a new set of main factors for organisational workmanship performance assessment. On the project related WPA main factors shown in Figure 3, project nature, economic investment, customer satisfaction, performance measurement system, competency profile, process planning and top management
commitment were ranked and considered the most important main factors for project workmanship performance assessment.

![Organizational and project workmanship main factor ranking](image)

Figure 3. Organizational and project workmanship main factor ranking.

Overall, the findings from this study established a set of new main factors for project workmanship performance assessment and framework development. Thereby establishes the leading factors with lower ranking number and higher relative important Index as shown in Figure 3 for the integrated framework development and workmanship performance assessment. These factors include top management commitment, quality culture, safety leadership, performance management system, project nature, employee empowerment and involvement framework.

5 CONCLUSION AND RECOMMENDATION

The study has successfully developed an integrated approach for construction workmanship performance assessment at both organization and project levels. This study establishes main principal factors for workmanship performance assessment within the construction industry. This approach combines the methodological frameworks from TQM, SMS and Six Sigma techniques into an integrated performance benchmarking framework. This benchmarking framework provides a holistic and comprehensive analysis approach at both organization and project levels for workmanship performance assessment. Besides, the benchmarking system could be applied at tendering stage for project evaluation and award. It can also help contractors and others make informed decisions on matters of construction workmanship performance. Additionally, potential defects and safety hazards could be identified at early and progressive stages of construction projects to ensure necessary measures are taken to minimize financial losses and or failures.

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