Improvement of Quality of Construction using Six Sigma Strategies

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Abstract:
Construction industry plays a major role in developing and achieving the goals of the society. Construction is one of the largest industries contributing about 10% of the Gross National Product in industrialized countries and also it consumes more resources & money with high rate of wastages. Hence there is a need for process enhancement strategy to control and improve. Each type of construction project requires a unique team to plan, design, execute and maintain the project. But in contracted construction, only execution and maintenance team are present. Six Sigma is a set of techniques and tools for process improvement. This research applied Six-Sigma, in a systematic approach. Number of new projects/year, Financial difficulties of owner, Absenteeism rate through project are identified as the major factors (CTB) which influencing in construction process performance by using statistical mean and RII value. Using six sigma tools like Pareto and cause & effect diagram we found the root of problems followed by control plan we have evaded the problems and enhanced quality.

Keyword: Six sigma, DMAIC, Pareto analysis, GEMBA, Cause and Effect diagram.

1. INTRODUCTION
Six Sigma is a set of techniques and tools for process improvement. It was developed by Jack Welch in 1986 and he made it central to his business strategy at General Electric in 1995. Six Sigma seeks to improve the quality of process outputs by identifying and removing the causes of defects (errors) and minimizing variability in manufacturing and business processes. It uses a set of quality management methods, including statistical methods, and creates a special infrastructure of people within the organization ("Champions", "Black Belts", "Green Belts", "Yellow Belts", etc.) who are experts in these methods. Each Six Sigma project carried out within an organization follows a defined sequence of steps and has quantified value targets. For example, to reduce process cycle time, to reduce pollution, to reduce costs, to increase customer satisfaction and to increase profits. The term Six Sigma originated from terminology associated with manufacturing, specifically terms associated with statistical modeling of manufacturing processes.

2. OBJECTIVES
This study has two parts and progressed through Define, Measure Analysis, Improve and Control (DMAIC) Phases.

3. PROACTIVE PART:
The study aims to develop a six sigma - based framework to enhance quality and performance in the contracted construction process using DMAIC methodology. Factors affecting quality and performance of contracted construction are identified from literatures and a questionnaire is made. Gemba analysis is carried out to provide control measures as a consequence a systematic way with transparency in contracted construction process using six sigma principles and tools to improve quality and performance is created.

4. REACTIVE PART:
To develop a procedure to enhance quality of architectural works in contracted multi-storied residential construction project, Project charter is prepared to define the existing problem, DMAIC methodology and DPMO tools are to be used to identify the root of CTQ, List of CTQ’s is attained from SIPOC and VOC analysis. A checklist is formed to measure the CTQ’s and DPMO tool is used to give Sigma rating to the contracted work. A case study of a residential building is taken in which the architectural works are contracted, the Six Sigma methodology have been applied to improve the quality and was checked against the sigma level. Recommendations were made to improve

1. Cost factors
2. Duration factors
3. Quality factors
4. Productivity factors
5. Client satisfaction factors
6. Environmental factors
7. Health and safety factors
8. Any other factors
9. Suggestion on improving contracted construction process

Cause and Effect diagram helps us to visualize in a graphical manner the outcome and various factors that influence that outcome. It graphically illustrates the relationship between a given outcome and all the factors that influence the outcome. This type of diagram is sometimes called a "fishbone diagram" because of the way it looks.
2.1 NARRATIVE OF THE DATA ACQUIRED (MEASURE)
Out of a total of 20 questionnaires sent, 16 responded (9 Contractors, 7 Sub Contractors) to the questionnaire. In this case, it represents the participation of 80 percent. The target group in this study are Project Manager/ Deputy, Quality Manager/ Deputy, Safety Officer, Site Engineer/Others, working in contracted and sub contracted projects tag on with proper quality system like OSHAS, ISO, etc., to acquire sense and trustable information for consistent results performance as well as to reduce the defects and control measures were also applied for standardization of contracted construction process.

3. ANALYSIS AND RESULTS
A questionnaire survey was carried out to gather information from technical professionals who are involved in the construction industry. It is to get the opinion and understanding from the experienced respondents about the factors affecting quality and performance in contracted construction process. The questionnaires are all categorized as below: Figure 3.1 and Table 3.1 illustrates the various type of organization responded to the questionnaire survey completed.

<table>
<thead>
<tr>
<th>Type of Organization</th>
<th>Number of Respondents</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract</td>
<td>9</td>
<td>56</td>
</tr>
<tr>
<td>Sub Contract</td>
<td>7</td>
<td>44</td>
</tr>
<tr>
<td>Total</td>
<td>16</td>
<td>100</td>
</tr>
</tbody>
</table>

3.1 PARETO ANALYSIS (MEASURE)
Each construction activity is a set of various dependent activities. Pareto chart helps to identify the most significant factors, shows where to focus efforts and allows better use of limited resources. Figure 3.2 below shows us the Pareto Analysis for categorized factors by weighted score of responded questionnaire.

4. CONCLUSION
Interview and questionnaire is the first source in order to achieve the objectives. Besides, literature review also helps to achieve the objectives.

Overall, the objectives of the study were achieved. The following are the objectives that have been achieved:
1. To identify the major factors which influence quality and performance in the contracted construction.
2. To create Six sigma Based framework to enhance quality and performance in contracted construction process and review 3. relative issues of the construction with DMAIC sequence which being the standard methodology of Six Sigma.
4. To Implement six sigma strategy to enhance quality of architectural works in contracted multi-storied residential construction.

The study on implement of six sigma strategies in construction was achieved by literature review, questionnaire survey and a case study. The factors which influence quality and performance in the contracted construction were achieved using the questionnaires.

5. REFERENCES