



Quality Management in a Residential Building Using Six Sigma Construction Techniques

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ABSTRACT

Construction plays an important role in the economic growth of a nation. The projects are lagging due to poor management in execution and implementation. The objective is to complete the project in time and within the scheduled costs and budget. The aim is to improve the quality of the building and customer satisfaction. Six Sigma is a continuous improvement methodology which uses DMAIC (define, measure, analyze, improve, control) to enhance the efficiency of the existing processes and increase customer satisfaction. The result of Six Sigma will be an increased efficiency, performance improvement and control of performance problems thus minimizing defects, risks and deviation. In this paper efforts are made to establish complete analysis of 20 papers published related to six sigma in construction. This paper discusses different research papers, articles, case studies that have been published in this field. There is great scope for six sigma in the construction field in future.

KEYWORDS: construction defects, quality management, six sigma, DMAIC.

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I. INTRODUCTION

Quality management is used to achieve and sustain the quality with considering the requirements to meet the customer satisfaction. The term quality refers to the fitness of the product to the customer's satisfaction. It uses quality assurance and control of processes as well as products to achieve more consistent quality. What a customer wants and willing to pay for it determines quality. Six sigma is a quantitative approach for improvement with the goal of eliminating defects from any process, a goal of 3.4 defects per million opportunities. Six sigma is reportedly easier to apply than other quality management programs because it provides

information about the change needed and the programs to execute the change. The strategy it uses is a five-step improvement process: define, measure, analyze, improve and control (DMAIC). Six sigma is more intense, focused and detailed than any other quality improvement techniques. Management aims at quality from the beginning and at each stage of the process. Here, quality is made everyone's responsibility and each person must contribute to the improvement of quality of the product or service offered.

II. SIX SIGMA TOOL

The Six Sigma technique, a subset of TQM, is a problem solving methodology that relies on statistical methods to reduce variations. It can also

be considered as a process improvement methodology. This concept aims at reducing the defects down to 3.4 per million, or in other terms, it aims at achieving 99.993% success. Limits of three times the standard deviation (3σ) is said to cover 99.993% of the total area. Our desire is to confine the output values within this 3σ limit and narrow down this limit so as to render the process and its outputs more consistent and qualified.

III. DMAIC METHODOLOGY

Six sigma is based mainly on understanding the customer needs and expectations, improving and establishing new process, manufacturing and service process. Six sigma is a continuous improvement methodology by using DMAIC. For implementation of six sigma method to improve the quality of products and processes base tool is DMAIC (Define, Measure, Analyze, Improve, Control). DMAIC framework gives some techniques such as DOE (Design of Experiments), FMEA (failure mode and effect analysis), control chart, QFD (Quality Function Deployment) in a logical direction.

Define: The system, the voice of the customer and their requirements, and the project goals, specifically.

Measure: Key aspects of the current process and collect relevant data.

Analyze: The data to investigate and verify cause-and-effect relationships. Seek out root cause of the defect under investigation.

Improve: The current process based upon data analysis using management techniques

Control: The future state process to ensure that any deviations from the target are corrected before they result in defects.

IV. SCOPE AND OBJECTIVE

The objective of this paper is to study various literatures about quality management using six sigma and identify the key parameters that affect the quality in construction and to reduce the defects in construction.

The Scope of this paper includes:

- ❖ To study the basic theory of six sigma, its principles, methodology and various tools.
- ❖ DMAIC, the Six Sigma Concept can be used as an improvement process to address the individual problems that have occurred or can be used for preventive actions.

V. LITERATURE REVIEW

A literature review is a detailed report of information obtained from the literature that are related to our topic of study. The review describe, summarize, evaluate and clarify this literature. It gives a base for the research and helps in determining the nature of the study. This section represents the review of literature collected from various journals and articles that are most relevant to the study.

1. Implementation of Six Sigma Concepts in Construction Project for Ensuring Quality Improvements : Sriram.S (2016)

This paper describes the implementation of Six Sigma concepts in Construction project to meet the quality standards and customer satisfaction. The author has suggested DMAIC methodology which has been applied to enhance the quality of the existing process by analyzing the defects, their percentage of occurrence, the possible causes and effect of defects and recommendations to overcome them. It shows a case study which was conducted in a residential building to which Six Sigma principles are applied for internal finishing work. In this paper tiling work of a residential building has been studied and sigma level has been evaluated. DMAIC methodology has been implemented based on Six Sigma principles which give a systematic framework to identify the impact of defects, their root causes and ways to reduce them.

2. Applying Six Sigma Principles in Construction Industry for Quality Improvement: Sneha P.Sawant (2014)

In this paper a residential building is taken in which six sigma principles are applied for internal finishing work. The sigma level of the building is 3.36; set target sigma level of 4.5. The findings suggest that proper training and management support and minor changes in current work procedure can help improve the quality and ultimately customer satisfaction. Six-Sigma also provides scale to measure whether the quality has been improved or not.

3. Implementation of six sigma for quality Evaluation of RMC plant with DMAIC Methodology : Darpan Keshore (2017)

This paper describes an idea to identify & analyze the major quality factors for RMC plant at Indore. The feedback of company identified with customer satisfaction survey which is ranked using relative important index (RII) Scale. The existing sigma

level of the company has been found to be 2.03, it shows poor level of company. In order to validate manufacturing system's current status, improvement potential and solutions, statistical tools such as excel state software and linear regression analysis were used. This ensured that all decisions were based on actual data.

4. Defects Reduction in High Rise Residential Building using Six Sigma: A Case Study: Susmy Michael(2016)

This paper is to determine defects which lead to low quality in the construction projects. In this paper, DMAIC phase of six sigma is used for improving the quality of building using questionnaire survey & then calculation of six-sigma level by DPMO computation. Factors affecting is determined and then six-sigma is used for data analysis. Thereafter sigma level quality of the building is calculated which helps to reduce the costs for variations, improve quality of the product, greater utilization of labor and facilities.

5. Quality Improvement in Building Construction Using Six Sigma: Sandeep Bodke, Snehal Nikam, Yogita Phad, Sayali Katkade and Kiran Kangane (2017)

This paper describes the study on Six Sigma and quality improvement in building construction using Six Sigma principle. By using the DMAIC methodology of Six Sigma which help to identify the quality of existing structure by analyzing the defects that will suggest in DFSS for changes that required in current work. The methodology of six sigma principles gives systematic approach to identify and improve the current construction process. It also measure whether the quality has been improved or not. It is used to reduce and eliminate variations which cause defect, to meet the quality standards also improve the quality and ultimately customer satisfaction.

6. Evaluation of Six Sigma Concepts in Construction Industry: Sarathkumar (2016)

In this paper the Painting work, Tile work and Brick work of a building by using DMAIC methodology. Six-sigma is new to construction sector and this philosophy is to reduce the defects in the construction. The aim of this study is to evaluate Six Sigma as a process improvement method within construction sector. In order to improve the process in construction it is important to understand the factors affecting the construction process and analyze the factors for the construction improvement.

7. Reducing Defects in RCC Member by using Six Sigma Principle: Neha Bagdiya (2016)

This paper describes the basic theory of six sigma principles, methodology and various tools used for reducing defects. A case study of a residential building is taken in which the DMAIC principle is applied for reducing defect in RCC members. Process improvement for present study, residential building at wagholi, Pune is selected to find out the causes of construction defects. For case study, checklist was prepared for all the RCC members and the percentage defects were found out. Six sigma also provides scale to measure whether the quality has been improved or not.

8. Effectiveness of Implementation of Lean Six Sigma Techniques in Construction: Molly Thomas (2017)

This paper describes the factors contributing to wastes in construction which is identified by ranking. Ranking was done by SPSS software and it is validated by the value stream mapping. Variations in the Key performance indicators can be easily analyzed to compute lean performance with the fuzzy inference model.

9. Quality Control in Construction using Six Sigma Techniques: Swethaa.B (2016)

In this paper, Concrete samples in the form of cubes were collected from RMC plant. The strength values will be analysed for variances and defects and the sigma levels would be identified. The defects arising in concreting process due to various controllable and non-controllable factors are identified and the remedies are suggested.

10. A study of implementing lean six sigma in construction industry: Radhika.R (2017)

This paper describes how to reduce waste in construction, to identify and analyze the defects. Then ranking is done by SPSS software based on the influence in project. The main aim is to eliminate defects by less labour, machinery, space and time by reducing the number of activities.

11. Six sigma as a total quality management tool: Odendaal.C.E and Claasen.S.J (2014)

This paper describes the use of Six Sigma methodologies as a tool in achieving Total Quality Management in the manufacturing environment, with specific emphasis on power transformer manufacturing. The concepts encompassed by Six Sigma are included, their relevance explained and some early results are shared. The measure, analyze, improve and control cycle is the main emphasis of this paper. It is concluded that by

adopting Six Sigma as a Total Quality Management tool, company bottom lines are improved.

12. Process and quality improvement using six sigma in construction industry: Megan Florent Tchidi and Zhen He (2012)

This paper explores practical solutions for construction process and quality improvement by using prefabricated composite structure (PCS) based on Six Sigma method. The D-M-A-I-C model of Six Sigma has been applied to conduct the analysis of the construction process, to discover essential factors to improve and thus to achieve higher customer satisfaction. These improvement measures help to overcome and reduce considerably concrete cracking and slippage in building construction.

13. Production planning process in residential construction using lean construction and six sigma principles: Thanveer M.Bearly (2005)

This research is focused on the prevalent practices for production planning in homebuilding companies. The overall research aim is to develop a production planning model that reduces variations and defects. Data was collected from a homebuilding site and a set of analysis tools was used to analyze the data and find areas of improvement. A production planning process model was developed using the analysis results and a combination of the DMAIC methodology and the Last Planner System.

14. Six sigma-based approach to improve performance in construction operations: Seung Heon Han (2008)

In this paper, two case studies have been presented and process simulation analyses are performed to observe the performance changes based on the six sigma principle. Critical total quality control, as the sigma level rises, is also discussed. For a smooth application of the six sigma principle onto construction work, this research suggests a two phased six sigma application. The first phase is to apply the six sigma principle to a simple and repetitive construction process Similar to a manufacturing process. The second phase is to apply the principle to a real construction process which is more complicated and less repetitive. This paper explored the feasible strategies for the Improvement of the construction processes and operations by combining the six sigma principle with the idea of lean construction.

15. Implementing six sigma via TQM improvement : an empirical study in Taiwan: Jung-Lang Cheng (2008)

This research paper is to examine the relationship between TQM and Six Sigma. To achieve this, the paper conducted a conceptual framework with six improvement factors such as system, product, control, training, technical, and assessment. The results of using TQM improvement activities to implement Six Sigma may be divided into two main paradigm shifts, namely transfer and adjustment.

16. A review of six sigma approach : methodology, implementation and future research: Hongbo Wang (2008)

This paper summarizes four issues within the sub-category of the initial Six Sigma concepts: basic concept, DMAIC, DFSS and deployment. The primary focus should be on improving overall management performance, not just pinpointing and counting defects. Researchers and practitioners are trying to integrate Six Sigma with other existing innovative management practices that have been around to make Six Sigma method even more attractive to different organizations.

17. The use of six sigma as a performance improvement strategy in the construction industry : new trends and applications: Jemima A.Ottou, Bernard K.Baiden and Joseph K.Ofori (2016)

This paper explores new trends in Six Sigma and their applications as a means of improving construction performance. These applications were categorized under three Six Sigma trends namely, Six Sigma Off-Shoot, Six Sigma Hybrid I (Six Sigma and another concept) and Six Sigma Hybrid II (Six Sigma and two other concepts). The review concludes that these applications can be deployed in the construction industry as performance improvement strategies except one application under hybrid I, namely, Six Sigma and Capability Maturity Model.

18. Quality analysis in construction projects using six sigma concept: Manoj kumar.R (2018)

This paper deals to improve the quality of concrete structures, paint work, brick work, welding and joints of a building by using DMAIC methodology. From the point of view of achieving Six Sigma concept on site the recommended corrective action plans on the defect is done. Thus the questionnaire fulfils the criteria for control plans of the construction activities in the final stage. The answered questionnaires were collected then by using SPSS software, the collected data's is

analyzed. The results of the study indicate that the implementation of Six Sigma in construction context will be achieved its aim by reducing the defects.

19. Implementing and applying six sigma in construction: Low Sui Pheng and Mok Sze Hui (2004)

This paper described the Six Sigma concept as a quality initiative that may be applied in the building industry. A case study of how Six Sigma was pioneered in an organization in the building industry is presented. The findings suggest that management initiative and support, relevant training, appropriate selection of pilot projects, and commitment by team members are crucial for the successful implementation of Six Sigma in the organization. Improvement measures taken by a contractor helped to raise the sigma from 2.66s to 3.95s for quality of internal finishes.

20. Applying six sigma to quality improvement in construction: Kuo-Liang Lee and Yang Su (2013)

This research demonstrates how a Six Sigma team can determine and improve the key input variables affecting the cracks in lightweight partition walls. A case study methodology is used in this research to illustrate the tools of Six Sigma by using the project charter to define problems, by using tools of process mapping to display all the input and output variables affecting cracks in lightweight partition walls, by using the C&E (cause-and-effect) matrix to select highly correlated input variables, and by using failure modes and effects analysis (FMEA) to identify causes of the cracks.

VI. CONCLUSION

This paper considers that wide literature and knowledge about six sigma method was obtainable and gives a wide idea of foregoing practices and techniques used in construction industry and researches carried across the world. Six sigma concept is new to construction industry but is being used widely by production/manufacturing industries and it is also possible to use it in construction industry. Several papers have been presented on six sigma it is to improve the process performance thus increasing customer satisfaction. This research is carried out to show various techniques and more research work is required in this field. In this paper, I have studied several journal papers about quality management using six sigma in residential construction. Thus,

it is concluded that six sigma is used to reduce the quality defects in construction.

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