

Review on Six Sigma in Construction

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Abstract—Six Sigma methodology is nowadays one of the most used approaches in the Quality Management field since its benefits coming from the improvement of the process outputs quality by identifying and removing the causes of defects and variability in manufacturing and business processes. Few studies are done on reviewing the literature of Six Sigma in all the areas including manufacturing, construction, education, financial service, BPOs, healthcare etc. All the literatures are in the way that it would help research academicians and practitioners to take a closer look at the growth, development, and applications of this technique. Globalization, advanced technology, increased sophisticated customer demands change the way of conducting business. Old business models no longer work in new economy. Defects rate of product plays an important role for the improvement of yield and financial conditions of any company. Organizations are increasingly adopting Six Sigma in a bid to improve the quality of their processes and products, and thus achieve competitive advantage. Six Sigma is a smarter way to manage business or department.

Keywords—Construction, Globalization, improvement, Quality management, Six sigma.

I. INTRODUCTION

In order to remain competitive in the market, organizations look for ways to improve their production, manufacturing & management processes. This calls for ways to improve product quality, reduce production cost & enhance productivity. Therefore, in order to cater the customers with high quality products at low price, the organizations must utilize all the available resources efficiently & effectively. Various initiatives like Total Quality Management (TQM), Quality Awards, Total Preventive Maintenance (TPM), Lean & Six Sigma are used as improvement tool to tackle the problem of quality deployment. The productivity of the construction industry worldwide has been declining over the past 40 years. The construction industry has been suffering from low productivity and poor performance as compared to other industries. During the construction project, certain causes leads to delay in construction activities. There are a lot of wastes in construction processes, which were left unnoticed. In order to improve its performance, industrial experts and researchers have looked at the manufacturing industry as a point of reference and a source of innovation. One approach for improving the process is using Six Sigma concepts in construction. The critical objective of construction industries nowadays is to complete the project in time and within the scheduled costs and budget. Also need for contractors to improve performance relates mostly to quality assurance, Improving quality and customer satisfaction has received considerable attention in recent years.

Six sigma is a set of techniques and tools for improvement. It was introduced by engineer Bill smith while working at Motorola in 1986. It seeks to improve the quality of the output of a process by identifying and minimizing variability in manufacturing and business process. It just not provide quality assurance (QA) but also provide quality control (QC) function. It is systematic and organized methodology for existing as well as new product, process and service improvement.. Six sigma enables the organization to improve their process by making them more capable for delivering what the customer wants at right time. Sigma is nothing but a deviation from mean. Six Sigma derived from statistical distribution called "standard normal distribution". Six Sigma consider the range of lower and upper limit defect is +/- 6 sigma from the mean.

II. PROCESS IMPROVEMENT IN CONSTRUCTION

The purpose of process improvement is to get better quality of product in less time. However there are many systematic approach for obtaining the process improvement. The process improvement methods under Total Quality Management includes:

- Process Cost Model
- Kaizen
- Statistical Process Control

Out of all of the above process SPC proved to be beneficial for evolution of six sigma. Statistical Process Control is used in order to follow and improve the manufacturing processes and operations and has an important role in the quality improvement processes. The focus of this model is to analyze process defects and reduce them by root cause analysis and problem solving methods.

III. SIX SIGMA PROCESS

Six Sigma project follows two project methodologies, composed of 5 phases in each. They are DMAIC and DMADV. DMAIC is used for the projects which is aimed at improving the existing business process. DMADV is used for the projects which aimed at creating new product or process designs.

The one known as DMAIC (define, measure, analyze, improve, control) aims to enhance the efficiency of the existing processes and increase customer satisfaction through designed methods or techniques. Whereas DMADV project methodology includes Define design goals, Measure and identify CTQs, analyze to develop and design alternatives, design an improved alternative and finally verify the design. Adoption of six sigma required to go through DMAIC (when product is actually existing and quality improvement is required) and DMADV (when newly developed product is required to improved quality) approaches. The result of Six Sigma will be an increased efficiency, improvement in performance, and the control of performance problems thus minimizing defects, risks and deviation.

DMAIC methodology offers structured framework in following steps to establish systematic continuous improvement.

Define: To define customer requirements and any things that do not meet those requirements are defects. Identify problems which affect quality.

Measure: Construction activity is a set of various dependent activities. Identify the performance requirements of the process with respect to its defects characteristics.

Analyze: To study and analyze the data collected in previous step and find out the root causes of defects.

Improve: Improve for eliminate the defects. Identify the ways to destroy the existing defects. Develop the solution.

Control: Measure the performance of the new process under a controlled plan to control the quality level of the process. For increase the sigma level.

IV. INNOVATIONS IN SIX SIGMA

Latest trend in the field of quality engineering is the mixture of two powerful methodologies lean and six sigma to enhance performance. Lean is primarily focuses on exchange of information and materials between the process steps whereas Six Sigma is concentrating on addressing poorly performing value adding transformations within the process. Lean Manufacturing focuses on elimination of various losses associated with production system such as waiting time, overproduction, rework/rejection, unnecessary motion, over processing, excess inventory, unnecessary transport. Starting in 1980's, consultants trained in both techniques such as lean and Six Sigma. The different tools of Six Sigma focus on improving quality and Lean focused on removing waste, together, it's a combined management approach. Many of benefits of Lean Six Sigma include cost reduction, value addition, reduction in process variation, customer satisfaction, financial performance learning.

V. REVIEW OF LITERATURE

This paper discusses different research papers that have been published in this field and present a literature review Related to Abstract.

Sneha P. Sawant and Smita V. Pataskar[1] in their research "Applying Six Sigma Principles in Construction Industry for Quality Improvement", ICAET (2014) explained how important six sigma technique is in quality improvement in construction. This paper describes the basic theory of Six Sigma, principles, methodology and various tools used and also describe about a case study of a residential building. In this case study six sigma principles are applied for internal finishing work, and is adopted to improve the quality and to cross check against the sigma level. There are many factors have high impact on the quality of the construction. These factors must be identified as early as possible so that the quality can be improved. Six Sigma principles are adopted in such case to identify and improvise the current process, and it can also be used to measure whether the quality has been improved or not.

Sarathkumar K, Loganathan R[2] published their paper, "Evaluation of six sigma concept in construction industry", in IJSER (2016) which deals with six sigma concept in construction industry. In this paper author have tried to improve the Painting work, Tile work and Brick work of a building by using DMAIC methodology. The questionnaire is prepared which fulfils the criteria for control plans of construction and further questionnaire is distributed among Site Engineers, Contractors, Consultants and Project managers. With help of SPSS software, the collected data's were analyzed and result stated that the implementation of Six Sigma in construction context will be achieved its aim by reducing the defects. The Six Sigma maturity level is a measure developed by the authors to be able to compare the wished position and the current situation to best practice according to Six Sigma.

Sandeep Bodke, Snehal Nikam[3] in their research "Quality Improvement in Building Construction Using Six Sigma" published in IOSR JMCE (2017) describes the study on Six Sigma and quality improvement in building construction using Six Sigma principle. There are number of factors which affect the quality of product, time of work, cost, waste of material, etc. The objective of construction industry is to complete a project within a stipulated time, cost as per required standard and specification. In this research DMAIC methodology of Six Sigma which help to identify the quality of existing structure by analyzing the defects is used that will suggest in DFSS for changes that is required in current work. These factors must be identified as early as possible so that the quality of construction can be improved. 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 eliminate variation and improve quality through different six sigma methods.

Sukumar. S, Radhika. R[4] in their paper "A Study of Implementing Lean Six Sigma in Construction Industry" explained application of a new technology, Lean Six Sigma concept is likely to be effective for improving the efficiency of construction industry. It eliminate all defects so as to minimize the wastage of materials, time and effort in order to generate the maximum possible amount of value. The purpose of this study is to evaluate Lean six sigma as a process improvement method to improve the construction processes by understanding and analyzing the factors affecting the formation of construction wastes. Here DMAIC methodology is used where data is collected from the Respondents and by using SPSS software the collected data is analyzed. The expected results of the study is the reduction of defects and minimization of wastes by the implementation of Lean six sigma in construction industry. The purpose of lean six sigma is to enhance the performance, quality, capacity, cycle time, inventory levels, and other key factors such as reduction waste, energy sources and environment will also be enhanced. By implementing DMAIC method to any of the project following benefits were obtained like Use replacement, Reduce or recycle, Eliminate the unnecessary things, Doing different tasks at the same time, Easy work flow, Develop collaboration, Introduce cross training, enhance the level of inspection, concentrate on preventive maintenance of tools and equipment.

Amitha P, Dr. T. Shanmugapriya [5] in their research paper "Implementation of lean six sigma in construction : A review" describe that how most of the Indian Contractors are not much aware about the potential demands and hence the projects are always effected by low quality and cost-overruns. Occurrences of wastes in construction sites is one of the problems that we are facing. Introduction of Lean concepts have provided an opportunity to address the existing problems in the construction sector. There are many non-value-adding activities in construction sector that cause loss of quality and profits in quantitative or qualitative terms. In this paper, Lean Six Sigma concept is as waste elimination and process improvement technique. Lean Six Sigma framework is used for problem identification, providing suitable solutions to solve problem and controlling the improvement made. Lean Six Sigma is also used for improving performance, develop effective leadership, waste and variation reduction, customer satisfaction and bottom line results. DMAIC and DMADV are two methods of six sigma which can be used for enhancing the quality of product or process. The combination of six sigma and lean principle will provide a coherent approach for continuous improvement, and also provides a conceptual method for their successful integration. If the two methods such as Lean and Six Sigma are fused together, it acts as a powerful tool for improvement of construction process.

Shantanu Sathe, Dr. Satish B. Allampallewar [6] in the paper "Application of Six sigma in construction" stated that how important it is to improve the quality and maintain excellent performance in the highly competitive world market, lead many organizations, their top managers, project managers, and engineers to implement the new philosophies such as pull scheduling and lean principle at their organizations. In this paper Six Sigma is used as a statistical method that provides a structured framework to organize and implement strategic process improvement initiatives to attain reductions in process variability or defects. A case study on a commercial building was conducted to which six sigma principle of DMAIC were applied for few internal finishing works: Brickwork, Plastering, flooring and Painting. The improvement in this process is presented in terms of process sigma and standard deviation. The purpose of the study was understanding the needs of construction industry from process improvement perspective and matches these needs with the expected outcomes of Six Sigma. The studies conducted deploy that Six Sigma applications are widely accepted by manufacturing/ production industries and it is also possible to implement it in construction. Past case studies disclose that it requires team efforts involving top management and every worker in the organization to fully employ the concept. Actual awareness among consultants, engineers, employees should be produced regarding Six Sigma in construction for the actual execution of the process.

M. I. Solanki, Dr. D. A. Desai [7] published the paper "Literature Review on Six Sigma Quality Improvement Methodology" which has different quality improvement methods. Six sigma methodology works on principles of customer converging, process oriented, process data driven and breakthrough improvement strategy. The paper gives a brief literature survey regarding each phase of DMAIC methodology, latest trend of integration two powerful methodologies Lean and Six sigma as well Critical Success Factors for effective implementation of Six Sigma methodology and found that Lean and six sigma both focuses on concept of continuous improvement and also impact of management leadership & commitment and linking six sigma with the business and customer needs are the most significant among all success factor. The main aim is to understand concept of DMAIC methodology studied by various researchers and illustration of methodology in detail for learning purpose. Six Sigma is data driven, customer centric and process oriented methodology which focuses on elimination of causes producing variation. It is the powerful methodology for breakthrough quality improvement through effective use of statistical and non-statistical tools. However it is focusing only on trivial few root causes elimination however variation is also contributed by vital many root causes.

Neha P. Ninawe, Jyotsna A. Pawar [8], in the paper "Quality management in construction industry by using six sigma: A literature review" explained how Construction sector is viewed as a service industry which generates substantial employment and provides growth impetus to other manufacturing sectors. The critical objective of construction industries nowadays is to complete the project in time and within the scheduled costs and budget. Also need for contractors to improve performance relates mostly to quality assurance, Improving quality and customer satisfaction has received considerable attention in recent years. Six Sigma which is a continuous improvement methodology is used to enhance the efficiency of the existing processes and increase customer satisfaction through designed methods or techniques. Output of Six Sigma gives increased efficiency, improvement in

performance, and the control of performance problems thus minimizing defects, risks and deviation. This research is carried out to show various techniques and how more research work is required in this field.

VI. CONCLUSION

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. From this research it is clear that various factors affected to quality of the construction, and these factors must be identified as early as possible so that the quality of construction can be improved. Six sigma is used in various industrial process as it is used to reduce and eliminate variation which cause defect, to meet the quality standards also improve the quality and ultimately customer satisfaction. The overall study indicate that Six Sigma framework is used for problem identification, providing suitable solutions to solve problem and controlling the improvement made. And it is hoped that, Implementation of Six Sigma methodology leads to process improvement and enhance the reduction in wastes. It is also concluded that DMAIC methodology which is a concept of Six Sigma which objects at developing and providing a highly effective process improvement and quality improvement technique in construction. For better result it requires team efforts involving top management and every worker in the organization to fully employ the concept. In recent trend it is most powerful methodology for breakthrough quality improvement through effective use of other tools.

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