
ABSTRACT

Six Sigma is a Qualitative and Quantitative approach used with the goal of eliminating defects from any process and achieves a high quality output by conforming to requirements and meeting customer satisfaction. Six sigma is a new technique to construction industry for process performance & quality improvement. Complete the project within time and cost as per the required standards and specifications, minimum waste and efficient use of resources are the critical objective of construction industry. Now days due to non-completion of the work as per the required standard and specification, most of construction companies face poor client satisfaction. Six Sigma provides performance measurement in detail, broader quality concept, repeatable process and performance improvement. In construction industry Six Sigma is discussable due to differences between manufacturing and construction industry by considering performance, quality and management aspects. This paper deals with some important literature reviews related to implementation of Six Sigma in construction industry.

KEYWORDS: Six Sigma, Quality improvement, customer satisfaction

INTRODUCTION

Six Sigma techniques developed and used by manufacturing industries to enhance the process improvement and constant output. Initially Six Sigma introduced by Bill Smith an engineer was working with **Motorola** company in 1986. This technique was firstly used in the General Electric in early on 1990s because they difficulty in to achieve challenging quality targets on complex manufactured products. Over two decades, Six Sigma is broadly used by manufacturing and some other industries.

Implementation of Six Sigma concept in the construction sector is new as compared to the manufacturing and other sectors. In the construction sector, the key objective of project manage is to make certain the projects are accomplished within the time, cost and with decided specification. For this it is required to measure the progress, evaluates the plans, and take the corrective actions whenever is necessary. The construction industry is also widely suffering for its low performance, poor safety, low work quality, wasteful, inefficient and low productivity. Huge amount of money spent on projects due to errors and reworks. Project mismanagement, insufficient planning and poor workmanship contribute to poor quality performance. To improve the performance and quality of work, needs quality management strategies and quality improvement programmes in the construction industry.

Statistical based Six Sigma technique is used as like quality improvement technique with the aim that enhancing the highest quality of the products. Which can be achieved by means of identify and remove the defects and their causes consequently minimize the variability. The specific sequence of various steps follow by Six Sigma project and have clear cut targets that reduces the cycle time of process, pollution, costs etc. and increase the satisfaction of the customer and profits of the company. Recently, no of organizations have concentrated to accomplish the satisfaction of the customer. High quality product that means is less defect product is the most essential aspects of achievement of customer satisfaction.

LITERATURE REVIEW

Susmy Michael and Sahimol Eldhose, (2016) In multi-storied buildings, amount of defects during the construction works are most common. It is important to find out the defects which resulting, low quality in the construction projects. This paper describes the viable strategies for the improvement of quality in the construction processes and operations with the six sigma principle. In this paper factors affecting quality of building recognized that are include schedule delay, low quality of materials, low quality of machinery, deficiency of knowledge in labours and safety precautions. Sigma level of the multi storied residential buildings is calculated. The success rate for the building lies in between 85-90%, while considering each activities this shows that to reach sigma level, reduction in defects doing each item of work is necessary.

Francisco Ribes Garcia, (2014) Six Sigma is a method which is mainly improve the quality and time management of the projects. The Six Sigma system enhanced the time, quality and cost management in the projects. In the construction industry, each and every building is like a example for the information technology industry, that means improving time and quality in the Construction industry can be complicated. Aim of this study is to presents that Six Sigma can get better time and quality management within the sector of building construction. As per the Six Sigma principle, the goal is to detect the defects in fields. This principle can reduce the defects, minimize accidents and minimize wastage of money, by means of focusing on management of quality. This research concluded that Six Sigma is able to optimize and improve common and definite projects in time and quality.

Muharrem Firat Yilmaz, (2014) Six Sigma give the benefits of process improvement which are very important for the performance improvement. To implement the Six Sigma principle does not necessitate longer time than normal project duration unlike other process and quality improvement methods. Six Sigma provides qualitative & quantitative approach and process improvement tools, to measure performance of processes and consequently improve it. From this paper it is concludes that, DMAIC methodology of Six Sigma can be helpful to enhance quality and quantity, simultaneously it will have an effect on technical and financial success of project. Researcher also said, Six Sigma has provided an accurate system, uninterrupted data collection system and also measurement techniques for performance and process measurement. The combination of Six Sigma system to the existing method of Project Control department makes the group efforts of Site and Office department more competent.

Sunil V. Desale and Dr. S. V. Deodhar, (2013) In construction industry to achieve the growth, a unbroken effort wants to be taken. Such a growth chances can be increased by adapting the various management principals and tools of lean and six sigma for minimizes or zero wastage. Delays are wide-ranging in construction and costs also too high for quality that is specified. As increasing competition from national and international construction companies, modernization growth up for the implementations of Lean concepts. This paper places of interest the real issues contrasting construction companies and also explores the effects of Lean and Six Sigma construction concepts in construction sector in India. A Lean Construction and Six Sigma concept has been successfully accepted by Automobile industry in many countries. But still it is not to be used in construction industry. This paper focus on this emerging concept, "Lean Construction", which is based on the basic principles of management.

Mehmet Tolga Taner, (2013) This paper identifies the importance of Critical Success Factors for the victorious beginning of the Six Sigma to construction companies. Participation and dedication of top managers, concerning quality initiative of suppliers and customers was founded the most significant factors to the success of construction companies. Leadership and dedication of top managers, teamwork and dedication of middle management was also founded the CSFs for victorious beginning of the Six Sigma, while deficiency of knowledge about the method to initiate is also found to be affecting its implementation. Large amount of waste and high costs are founded to lesser the construction companies performance. Six Sigma is very useful for products with minor rates of defects and waste, cheap costs, higher satisfaction of customers.

Abdulaziz Ali Banawi, (2013) Ineffective and badly managed projects can be produces high quantity waste and also consumes resources, power, time and money in high quantity, this makes difficulty in construction sector. This study aims towards the improvement of performance and the effectiveness of processes earlier and during the phase of construction. They were implement three systems that are Lean, Green, Six Sigma. This systems can be help to reach the most wanted benefits, if the dedication of the top management and the efforts of people participated obtained and also if implementation of the improvement actions planned carefully. Without any support of top management and peoples involvement it is not possible to get the desired improvements. Carefully implementation will also need time and efforts, though it is very essential for exact results.

Raid-Al-Aomer, (2012) Lean construction uses the concepts of lean principles and lean thinking to control construction projects. The intention of this researcher is to investigate the existing lean construction processes and to develop a

realistic framework to implement lean techniques and measure the lean construction performance. In this paper investigation and categorization done for the different waste in the construction industry. They analyzed around 27 different wastes occur in construction. Defects are the general type of waste in construction was founded from the survey of various companies. The second general type of waste in construction is over processing. Researcher acknowledged the impacts of waste on projects quality, speed and cost. They recommended the LC-KPIs set which measure and directs to improvement in terms of cost, quality, speed and waste. Incentives for worker in the form of reward system also suggested for achieving objectives of lean construction.

Maryam Dabbaghi Tehrani, (2010) This paper describes the Six Sigma principle, Systems and structures in industry. The core focus of report is on accepting the Six Sigma principle in construction sector. Six sigma is latest concept in construction sector. The idea of application of this principle on construction projects was also studied in this paper. In addition this paper also identifies the advantages of DMAIC methodology and their impact to achieve the quality level of the construction. Study has been demonstrates the DMAIC methodologies flexibility in construction and suggested how to apply every stage taking into consideration the indices of construction. This study concluded that Six Sigma is a improvement system which gives a systematic approach to coordinate and control all processes involved in every construction projects, efficiently. Other conclusions was that the proper description of critical matter in project, appropriate metrics, proper coordination system and dedication of involved people are capable to implement the Six Sigma methodology successfully in construction projects.

Behnam Nakhai and Joao S. Neves, (2009) This paper evaluates the potential of six sigma principle to the progress of quality and the challenges to reach the field application of six sigma. Their quality structure provides an significant contribution with practical value rate to six sigma. Their model of quality structure also highlights the linking of perception-expectation gap to the determinants of quality, specifications of quality, delivery of quality, and communication gaps of quality. Researcher said that six sigma principle not designed to cure all ills. Six sigma can be extensive to lots of operations if innovative tools and concepts are developed to tackle areas which are critical to quality. For the development of six sigma successfully, training of service quality to black belt is very important.

Seung Heon Han, Myung Jin Chae, Keon Soon Im, and Ho Dong Ryu, (2008)

This paper gives the way for improvement of construction performance through the application of the six sigma. This Six sigma principle gives the metrics essential to set up the goal of performance improvement and a system for measuring this improvement. With the combination of the lean construction idea and six sigma this study presents the strategy to improve the construction operations and processes. They concluded that six sigma is managerial tool used not only for quality improvement and productivity but also used for process and quality control. Quality error or defects in processes can be controlled with the help of this principle, in more realistic ways to achieve the desirable range.

CONCLUSION

From literature study it is recognize that in recent years most of attention given towards the implementation or application of the Six Sigma principle. Many researches have been conducted to describes the significance of six sigma principle for improving the quality and process performance. Literature study concludes that Six sigma methodology is largely adopted by manufacturing sectors and it should be possible to implement in construction sector. Team efforts of upper management and each employee in the organization are essentially required for the successfully implementation of the Six Sigma methodology.

REFERENCES

1. Muharrem Firat Yilmaz (2014) "Six Sigma within Construction Context as a quality initiative, Performance Indicator/Improver and Management Strategy" Department of Real Estate and Construction Management, thesis no. 176, pp.44-45
2. Seung Heon Han, Myung Jin Chae, Keon Soon Im, and Ho Dong Ryu (2008) "Six Sigma-Based Approach to Improve Performance in Construction Operations" Journal Of Management In Engineering © ASCE, Vol. 24, No. 1, pp 29-30
3. Abdulaziz Ali Banawi (2013) "Improving Construction Processes By Integrating Lean, Green And Six-Sigma" University of Pittsburgh, pp iv
4. Francisco Ribes Garcia (2014) "Six Sigma Implementation Within The Building Construction Industry.A Case Study Of The Research Building Construction".pp.2,52

5. Okonkwo, V.O. and Mbachu, V.M. (2015) "A Comparative Analysis Of Application Of Six Sigma Project Management Technique In Small And Medium Scale Construction Companies In Nigeria" *European Journal of Engineering and technology*, Vol. 3, No. 3 . pp.74, 83
6. Behnam Nakhai and Joao S. Neves (2009) "The Challenges Of Six Sigma In Improving Service Quality" *International Journal of Quality & Reliability Management*, Vol. 26 No. 7. pp. 663, 680
7. Susmy Michael and Sahimol Eldhose (2014) "Defects Reduction in High Rise Residential Building using Six Sigma: A Case Study" *International Journal of Scientific Engineering and Research (IJSER)*, Vol. 4, Issue 3, pp. 33
8. Sunil V. Desale and Dr. S. V. Deodhar (2013) "An Application of Lean and Six Sigma Principle for Constructional Process Improvement in Indian Organizations" *Indian Journal Of Applied Research*, Vol. 3, Issue 4, pp. 149
9. Mehmet Tolga Taner (2013) "Critical Success Factors For Six Sigma Implementation In Large-Scale Turkish Construction Companies" *International Review of Management and Marketing*, Vol. 3, No. 4, pp. 212, 219
10. Maryam Dabbaghi Tehrani, (2010) "Performance Improvement in Construction Project Based on Six Sigma Principles"
11. Raid-Al-Aomer, (2012) "Analysis of lean construction practices at Abu Dhabi Construction Industry" *Lean Construction Journal*, pp. 105, 121