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QUALITY MANAGEMENT IN CONSTRUCTION INDUSTRY BY USING SIX SIGMA-A LITERATURE REVIEW

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ABSTRACT

Construction Industry plays a major role in the economic growth of a nation. Construction Industry is one of the most booming industries in the whole world. 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. Which can be achieved by using recent techniques such as Six Sigma. Six Sigma is a continuous improvement methodology which 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. 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. In this paper efforts are made to establish complete analysis of 20 papers published literature related to six sigma in construction. This paper discusses different research papers, articles, case studies that have been published in this field and present a literature review Related to Abstract.

Keywords: Construction industry, DMAIC, Six sigma, Quality.

I. INTRODUCTION

Construction Industry plays a major role in the economic growth of a nation. Construction Industry is one of the most booming industries in the whole world. 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. Which can be achieved by using recent techniques such as Six Sigma. Six Sigma is a continuous improvement methodology which 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. The result of Six Sigma will be an

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increased efficiency, improvement in performance, and the control of performance problems thus minimizing defects, risks and deviation. In this paper efforts are made to establish complete analysis of 20 papers published literature related to six sigma in construction. This paper discusses different research papers, articles, case studies that have been published in this field and present a literature review Related to Abstract.

II. REVIEW OF LITERATURE

1. Evaluation of six sigma concept in construction industry: Sarathkumar K.Loganathan R (2016).Aim of this study is to evaluate Six Sigma as a process improvement method within construction sector. Literature Review shows that in order to improve construction it is important to understand the factors affecting the construction process and analyze the factors for construction improvement. They have used SPSS software for analyzing the collected data. In this methodology they have used survey based approach and DMAIC for continuous Improvement. For six sigma evaluation they have used RII method. This paper shows the broad concept of six sigma.

2. Use of Six Sigma on internal finishes in construction: DeepanjaliPatil, PushpanjaliPatilEtl. (2015).Objectives of this study are: 1. to study the six sigma concept.2.to check the awareness of process improvement in market at Dhule zone. They have adopted DMAIC and DPMO methodology of Six Sigma. Although Six Sigma is a relatively new quality initiative in the building industry, the results of this case study show that it can be implemented and can minimize the defects.

3. Relative Importance Analysis (RII) of factors influencing unauthorized siting of residential buildings in the Sekondi-Takoradi Metropolis of Ghana: M.K. SomiahEtl (2015).This study shows that unauthorized siting of buildings has become a major problem in towns, cities municipalities and district of most developing countries of the world. Institutional factors political factors physical factors etc. are factors influencing unauthorized siting of buildings. This paper is based on case study of Asakae also questionnaire survey approach was adopted. For Measuring these factors RII method was used.

4. Applying six sigma principles in construction industry for Quality improvement: SnehaSawant, SmitaPataskar (2014).Objective of this paper is to improve quality of construction industry. This paper describes the methodology and various tools used. This paper shows that six sigma is used for internal finishing work, the six sigma methodology has been adopted to improve the quality and is checked against the sigma level. The strategy it uses is a five step improvement process define,measure,analyze,improve,and control (DMAIC).This paper shows that six sigma principle concept can be applied to the construction process control within the basic framework of CTQ inputs,DMIC and out measures. Conclusion shows that six sigma study give the systematic approach to identify and improve the current process.

5. Defects reduction in High rise residential building using six sigma: A case study: Susmy Michael, Sahimoleldhose (2014).For multistoried buildings, amount of defects during the construction work are most common. Objective of this study is to determine defects which lead to low quality in the construction projects in case of structural and constructional standards. 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 .The research helps to find out factors affecting quality of building which includes delay in schedule, low quality materials low quality tools ,lack of knowledge in labor's etc.

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6. Reducing defects in RCC members by using six sigma Principle: Neha Bagdiya, SnehaSawant (2013). Aim of the study is to reduce defects in RCC members and to study six sigma methodology. Also the study is adopted to improve quality. Six sigma is a reportedly easier to apply than many quality management programs because it provides information about the change needed and he programs to execute the change. DMAIC is used here for 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.

7. Six sigma within construction context: MuharremFirat Yilmaz (2012).Objectives of this study is to provide broader quality concept, detailed performance measurement coordinated and repeatable process improvement. Literature review has discussed process improvement methods used in construction industry and analyzed the basic features and principles of six sigma. Purpose of this study is to analyze six sigma within construction context and evaluate features through literature review and interviews. They have adopted two methodologies of six sigma DMAIC and DFSS.They have also explained metric and belt system. Conclusion of this study shows that six sigma can be very useful to broaden quality concept of construction industry to a more efficient form which should include financial parameters also it is used to increase motivation, skill and knowledge of workers.

8. Six sigma application in construction: Dean T.Kashiwagi (2004).Objective of this study is application of six sigma by using data and statistical analysis to measure and improve the projects performance. Also to increase profit by eliminating defects. They have used statistical approach in this method and also adopted performance information procurement system (PIPS).conclusion of this project is Six sigma program should be a requirement of PIPS environment. This paper proposes that six sigma can be used by contractors to enlarge the performance environment of the construction industry.

9. Implementing lean six sigma: A case study in concrete panel production: Celepoauz, John Hutchisonetl (2002).Lean six sigma methods is recognized widely and has been implemented predominantly in manufacturing rather than in construction industry. Objective of this paper is to draw attention to adoption of lean six sigma in construction industry with a case study. The hypothesis of this experimental study was that the six sigma techniques can be applied to the construction based production system along with lean construction techniques. Procedure of studying six sigma starts with a problem statement followed by defining the primary metric, which aids to focus on the problem area and measures the output. Results shows that adoption of six sigma production tools are used to improve the organizations production and production system were not sufficient, as it fails to achieve a relative workflow.

10. Lean six sigma principle in construction: A literature review related to abstract. sunil v. desale , Dr. s. v. deodhar (2013): This paper shows that efforts are made to establish complete analysis of 51 papers with data base search from major publishers including Science Direct, Emerald and Google Scholars. This paper reviews the published literature related to six sigma or lean six sigma in construction from start to date. The review of literature Related to Abstract found that six sigma or Lean Six Sigma in construction industry is mostly implemented in quality and process improvement area. This paper discusses different articles that have been published in this field and present a literature review related to Abstract.

11. Impact of six sigma on construction performance: Dean Kashiwagi1, Nathan Chong, Marcos Costilla, Frank Mc Menimen and Charles Egbu (2004): The author of this paper shows that a Six Sigma is the process which

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minimizes risk and deviation through the measurement of performance information, may be implemented on the delivery of construction in a performance based environment. This paper shows that Efforts in the construction industry to apply concepts of Six Sigma have been inconsequential due to a price based environment. This paper defines a performance or value based environment which processes such as Six Sigma can be implemented successfully. It concludes that the analysis of the measurements, and the improvement shown by measurements are identified, it will not be possible to identify construction value. DMAIC processes cannot be successfully implemented in the price based environment because measurements and continuous improvement and minimum standards are not compatible.

12. Improving construction processes by integrating lean, green, and six-sigma: Abdul-Aziz Ali Banawi (2013): In this Paper the author shows that this research was to develop and implement methods to improve the performance and the efficiency of construction processes. This paper explains a previously developed framework that can be used to identify and reduce waste during construction processes by integrating three methods: Lean, Green, and Six-Sigma. The overall goals of this research are to develop and find ways to improve the environmental performance and to enhance the efficiency of the construction processes during and prior to the construction phase. In this study a new method was designed and applied to a separate residential unit for validation. The modified method showed a great improvement and in the end the unit was able to pass inspection. A case study of construction process of applying exterior painting in a residential complex in Saudi Arabia was implemented.

13. Comprehensive Six Sigma application: a case study Min Zhang, Wei Wang, Thong Ngee Goh & Zhen He (2014): This case-oriented paper reports an important Six Sigma management case study at the world's largest cold rolling mill situated in China. A Black Belt project was conducted to improve the cold rolling capability to meet the thickness requirements using the Six Sigma methodology – DMAIC (define ne, measure, analyses, improve and Control) principle. The implementation of Six Sigma methodology led to a significant financial impact on the profitability of the company.

14. Application of Six Sigma Process Improvement Method on Construction Turnkey Projects Wen-Bin Chiu, Luh-Maan Chang, and A Process Improvement Project (PIP) is a performance program aimed at reduction of quality defect, waste time and cost in a construction project. As the PIP progressed through Define, Measure Analysis, Improve and Control (DMAIC) Phases. This paper illustrates Six Sigma techniques and tool set determine possible causes of exceed man-hours spent on the preparing the turnover packages The purpose of this paper is to share some findings resulted from the application of Six Sigma methodology By applying the Six Sigma techniques including the fishbone diagram, cause and effect matrix through DMAIC phases, and statistical methods and design of experiments, the final probable causes were determined and the key recommendation for eliminating or reducing the probable causes and achieving this PIP objective.

15.Defects Reduction in High Rise Residential Building using Six Sigma: A Case Study Susmy Michael1, SahimolEldhose(2014) The objective of the present study is to evaluate the quality in a multistoried buildings through six sigma. Also suggests various improvising methods for the quality of the building by minimizing the defects. In this paper, DMAIC phase of six sigma is used for improving the quality of the buildings. Factors affecting the cause for defects 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

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product, greater utilization of labor and facilities. The research helps to find out factors affecting quality of building which includes delay in schedule, low quality materials, low quality tools, lack of knowledge in labors and safety measures helps to find out factors affecting quality of building which includes delay in schedule, low quality materials, low quality tools, lack of knowledge in labors and safety measures

16.Process and Quality Improvement Using Six Sigma in Construction Industry: Megan FlorentTchidi :(2012):Construction industry presents an extremely complex combined process, production low, various structures, high quality requirements and long construction cycle This paper explores practical solutions for construction process and quality improvement by using prefabricated composite structure (PCS) based on Six Sigma method. Based on Design for Six Sigma model and using the finite element analysis model, this study develops for scientific and economical use in construction industry a composite steel-concrete model. Based on measurement and construction process analysis from Six Sigma black belt consultant, construction managers, Engineers, clients, architects, the model helps to eliminate critical defects and failure before they occur.

17. Implementation of Six Sigma Concepts in Construction Project for Ensuring Quality Improvements: S.Sriram, A.Revathi (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 to use 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 were 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.

18. Six sigma-based approach to improve performance in construction operations: Seung Heon Han, Myung JinChae, Keon Soon Im, Ho Dong Ryu (2012): 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. The authors have performed in-depth comparative analyses on the existing methods for performance improvement and identified the advantages of the six sigma principle over the traditional techniques.

19. Application of Six Sigma Technique for Commercial Construction Project- a Review: Ganesh U.Borse, Prof.P.M.Attarde (2016): This paper discusses different articles and their conclusions that have been published in this field and present a literature review. The research strategy was made by selecting the research paper in which successful implementation of six sigma was presented and documented. Approach was adopted to explore the published literature regarding six sigma or lean six sigma in construction. It involved searches from the well-known research databases like Google scholar and Science direct. The literature search is limited. This paper

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recognizes that vast literature was obtained on six sigma philosophy, which gives a wide idea of present practices and researches carried.

20. Six-sigma in lean construction systems: opportunities and challenges: Tariq s. abdelhamid: In this paper, the origin of Six Sigma is reviewed with a brief discussion of its methods and metrics. Using the Lean Project Delivery System (LPDS) as a foundation, the paper suggests Six Sigma applications and research opportunities in Lean Construction. It also suggests that Additional research is needed to investigate the implementation of Six Sigma methods in Lean Construction. Six Sigma is a great tool for problems that are 'hard to find but easy to fix'.

III. CONCLUSION

This paper considers that wide literature and knowledge about six sigma methodology was obtainable and gives a wide idea of foregoing practices and techniques used in construction industry and researches carried across the globe. 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 consisting the significance of adopting six sigma in various sectors 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.

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