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A Review on "Study & Analysis for Reduction of Housing Construction Defects on Existing Housing Construction Projects using Six Sigma Technique."

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Abstract – Nowadays, construction defects have become widespread and frequently occur in construction projects, particularly in those with inadequate management or insufficient supervision on-site. A construction defect is often regarded as a major error in the construction industry, significantly impacting costs and causing the value of a building to diminish over time. These defects lead to substantial expenses, defined as the cost incurred for rework to rectify the issue. Labor hours, materials, and equipment usage are consumed to address the defect. Additionally, delays resulting from defects lead to further time loss.In multi-storied construction projects, the prevalence of defects during construction activities is notably high. Therefore, it is essential to identify defects associated with inferior quality in construction projects, whether related to architectural, structural, or construction standards.The paper also recommends various improvement strategies to enhance the quality of buildings by minimizing defects. One effective method is Six Sigma**,** a quality improvement technique that has been implemented in manufacturing and other industries. However, its application in the construction industry is still relatively new. This paper explores the fundamental concepts of Six Sigma, its principles, methodologies, and the various tools used to reduce defects. The findings suggest that proper training, management support, and minor modifications to existing work processes can significantly enhance quality and ultimately improve customer satisfaction, which is of utmost importance.

Key Words: Building defects, Construction defects, six sigma, construction delay, DMAIC, poor workmanship.

1. INTRODUCTION:

A construction defect refers to the deficiency in a building, structure, or its components that prevents it from being constructed in a reasonably skillful manner or from performing as intended by the manufacturer, as expected by the buyer, or as designed. Such defects often lead to damage to the structure. Currently, construction defects are becoming increasingly common and frequently arise in projects, especially those with inadequate management or poor site supervision. A construction defect can be described as a significant issue in the construction industry, negatively impacting the cost and value of a building over time. These defects result in considerable expenses, defined as the resources required for rework to resolve the issue. Labor hours, materials, and equipment usage are consumed in the process of repairing defects. Additionally, time is wasted due to delays caused by such issues. The associated costs are calculated irrespective of who bears the financial burden.

The root causes of construction defects often include poor design, substandard workmanship, failure to adhere to the design specifications, or exposure to unforeseen factors not accounted for in the design. Inadequate supervision during construction also contributes to these problems. Construction defects diminish the value of buildings and escalate costs. Such defects not only reduce the project's value but also lead to delays, preventing completion within the stipulated contract timeline. Budget overruns are another consequence of construction defects on site. Furthermore, these defects can pose dangers to society, resulting in direct and indirect costs related to repairs, exceptionally high maintenance expenses, disputes, and even potential building loss. Despite the significant impact of construction defects, only a limited number of studies have been conducted to identify their root causes in construction projects. These studies focus on the building industry and general engineering practices. Major factors contributing to construction defects include poor design, inferior workmanship, failure to construct according to the design, unforeseen factors not accounted for in the design, and inadequate supervision.

2. RELEVANCE:

Construction defects are unique errors that are often unavoidable. Research indicates that reworking and repairing defective components, whether discovered late in

the construction phase or during building maintenance, accounts for approximately 15% of total construction costs. Identifying these defects promptly could save a substantial amount of money and time on a project. However, existing quality-control measures are inadequate for detecting such issues.The criteria for manufacturing components are complex and detailed, making it impractical to manually verify every specification for each element. Moreover, inspections are not always conducted frequently enough to identify a defective component immediately after its creation. A significant proportion of construction-related defects occur in multi-story buildings. It is therefore essential to pinpoint the flaws that lead to substandard quality in construction projects, particularly concerning architectural, structural, and construction standards.A systematic approach is necessary to achieve excellence in both design and construction. Systems such as the Six Sigma quality management system and the Construction Quality Assessment System offer solutions to this challenge. Six Sigma, a statistical quality improvement methodology, provides a comprehensive quality framework, precise performance tracking, coordinated efforts, and the ability to eliminate redundant processes, thereby reducing variances.Quality control in construction involves minimizing the use of inferior materials and ensuring high-quality workmanship to guarantee that a structure performs as intended. Six Sigma introduces process targets defined in parts per million (PPM) at all stages of the construction process. This methodology has evolved into a powerful tool for improving operational efficiency, with a focus on enhancing productivity, reducing costs, and ensuring quality.In the construction industry, Six Sigma can be applied to minimize defects, particularly in internal finishes. Key factors affecting the quality of construction projects include a lack of construction knowledge, errors in assessing material quality, and the use of substandard tools. Addressing these issues can significantly improve the overall quality of construction outcomes.

3. LITERATURE REVIEW:

Hamraz MP, Hameed Faiz NH & Basima Parveen TP [06](2023): Highlight the crucial role of construction in fostering a nation's economic growth. This project emphasizes maintaining quality standards and achieving client satisfaction. The aim is to evaluate the quality benchmarks of a multi-story building by applying Six Sigma principles. Utilizing Six Sigma techniques helps reduce inconsistencies and addresses the root causes of defects. Data gathered from defect analysis sheets, based on a case study of a residential building, are reviewed to assess the quality of brickwork, concrete placement, plastering, flooring, and painting.While Six Sigma has been extensively employed in manufacturing and service industries, this study explores its implementation as a quality enhancement tool in the construction field. The research examines the fundamental principles, processes, and performance indicators of Six Sigma. It further showcases the application of Six Sigma in improving the quality of interior finishes during construction.A detailed case study of a residential building is conducted to identify and evaluate defects in brickwork, concrete works, plastering, painting, and flooring. These issues are methodically analyzed using the DMAIC (Define, Measure, Analyze, Improve, Control) framework of Six Sigma. This systematic approach seeks to enhance the quality of current processes by identifying defects, calculating their frequency, analyzing their causes and impacts, and suggesting strategies to address them effectively.

Fayera Tolera & M. Vignesh Kumar [09](2020): Ethiopia, as one of the developing countries with numerous ongoing projects, faces significant challenges related to construction defects. These issues are particularly common in projects that suffer from insufficient management or inadequate on-site supervision. This study aimed to examine the types, causes, and effects of construction defects in Nekemte Town.The research adopted a mixed-methods approach, integrating both quantitative and qualitative methodologies, and utilized a case study framework. The study identifies various types of defects, their underlying causes, associated impacts, and potential remedies for addressing construction flaws in public projects within Nekemte Town.In conclusion, the research offers recommendations based on the findings to improve the quality performance of public construction projects in the area, aligning with the study's specific objectives.

Patrick Schober, Christa Boer & Lothar A. Schwarte [17](2018): In its broadest sense, correlation refers to the measurement of the relationship or interdependence between variables. When variables are correlated, changes in the size or magnitude of one variable correspond to changes in the size or magnitude of another variable—either in the same direction (positive correlation) or in the opposite direction (negative correlation). The term correlation is commonly used to describe a linear relationship between two continuous variables and is typically quantified using the Pearson product-moment correlation coefficient. The Pearson correlation coefficient is generally applied to datasets where the variables exhibit joint normality (i.e., follow a bivariate normal distribution). For continuous data that deviate from normality, for ordinal data, or for datasets containing substantial outliers, the Spearman rank correlation provides an appropriate alternative to measure monotonic relationships. Both correlation coefficients are standardized, ranging from –1 to +1, where 0 indicates no linear or monotonic association. As the coefficient approaches an absolute value of 1, the relationship becomes stronger, approximating a perfect straight line (in the case of Pearson correlation) or a consistently increasing or decreasing trend (in the case of Spearman correlation).The statistical significance of these

associations can be assessed through hypothesis testing and the use of confidence intervals.

Sandeep Bodke, Snehal Nikam, Yogita Phad, and Kiran Kangane[21](2017) : The research examined Six Sigma and its implementation as a tool for enhancing quality in building construction through the Six Sigma framework. Utilizing the DMAIC (Define, Measure, Analyze, Improve, Control) process, this methodology assesses the quality of existing structures by identifying flaws and recommending modifications in DFSS (Design for Six Sigma) for upcoming projects. The Six Sigma approach offers a systematic method for evaluating and refining the construction process.

Jemima A. Ottou, Bernard K. Baiden & Joseph K Ofori [07](2016): This study explores emerging developments in Six Sigma and their application as tools for improving construction performance. A review of previous research identified 18 distinct uses of Six Sigma, categorized into three primary trends: Six Sigma Off-Shoot, Six Sigma Hybrid I (merging Six Sigma with one additional concept), and Six Sigma Hybrid II (integrating Six Sigma with two additional concepts).The review revealed one application under Off-Shoot, ten under Hybrid I, and seven under Hybrid II. Among these, Hybrid I is the most commonly utilized trend, with Lean Six Sigma being the leading application. Hybrid II represents the most recent trend, combining Lean Six Sigma and Project Management as an emerging approach.The analysis concludes that 17 of the 18 applications are feasible for performance enhancement in the construction industry, with the sole exception being the combination of Six Sigma and the Capability Maturity Model under Hybrid I.

K.-L. Lee, S. Yang, Y. Su, and S. Yang[08](2013) : The suggested Supplier-Input-Process-Output-Customer (SIPOC) diagram, which emphasizes the inputs, outputs, and customer requirements of work processes, is used to streamline process mapping for road construction. The data is examined using the Relative Importance Index (RII). Additionally, a cause-and-effect diagram is employed to pinpoint potential root causes of specific issues, while Failure Mode and Effects Analysis (FMEA) is utilized to devise strategies and assess processes.The final phase in improving quality and reducing waste in construction activities involves introducing control measures to efficiently minimize or prevent the recurrence of critical issues.

Lawson, R. [10] (2013) : It is noted that the construction sector has been instrumental in fostering the expansion of the national economy. Strengthening infrastructure boosted productivity and created job opportunities. To ensure that all tasks conform to the established project protocols—previously evaluated against defined standards—project data from the construction phase is documented during the execution stage. Risks are evaluated as specified in the initial framework. Likewise, economic progress and the growth of business prospects can further amplify the potential for growth within the construction industry.

Pihl, P.[19](2013) : The Define, Measure, Analyze, Improve, and Control (DMAIC) Six Sigma methodology is utilized in this study. This approach is particularly effective for addressing issues with unclear causes and solutions. When the causes are known but the solutions are uncertain, the Define, Explore, Develop, Implement, and Control (DEDIC) framework is applied. For cases where both the causes and solutions are well understood, the Define, Deliver, and Control (DDC) model is used. The DMAIC approach was incorporated into a systematic Six Sigma design process to establish protocols that ensure the elimination of errors and defects through defining, measuring, analyzing, improving, and controlling operations. The successful application of Six Sigma led to reduced work cycles, improved product quality, optimized costs and time, guaranteed profitability, and expanded market share. According to Six Sigma specialists, the cost savings achieved through this method are as substantial as the benefits derived from its implementation.

4. OBJECTIVES

1. To identify & enlist the various types of defects that affects on housing construction projects.
2. To study causes & effects of defects in construction projects through Questionnaire survey.
3. To Apply six sigma technique for construction projects.
4. To determine the challenge in implementing six sigma technique as well as the improvement of the manufacturing process through the DMAIC (Define, Measure, Analyze, Improve, Control).

4. METHODOLOGY

In order to accomplish the objectives, the project work has been divided into five major parts. They are:

1. To study of current status & make literature review on construction defects.
2. Collection of data by using Questionnaire survey for selected existing housing construction projects.
3. Identifying the causes & their effects on existing housing construction projects by collecting data.
4. Six sigma methodology is used to improve the construction performance.
5. The six sigma DMAIC Technique, six sigma project management & six sigma implementation these are the success factors which will use in study as framework.

REFERENCES:

[1] Abdul-Rahman, H., Wang, C., Wood, L., &Khoo, Y. (2014) "Defects in Affordable Housing Projects in Klang Valley, Malaysia", American Society of Civil Engineers, 28(2), 272-285.

[2] A. S. Ali & K. H. Wen (2011) "Building Defects: Possible solution for poor construction workmanship", Journal of Building Performance, 2(1), 59-69.

[3] Dr. Abdussalam Shibani (2016) "The Implementation of Six Sigma in Construction in China.

[4] Ganesh U. Borse, Prof. P. M. Attarde (2016) "Application of Six Sigma Technique for Commercial Construction Project- A Review" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume 03.

[5] George, M.L.2003. Lean Six Sigma for Service. First Edition. McGraw-Hill. New York. ISBN 978-0071418218.386p.

[6] Hamraz MP, Hameed Faiz NH & Basima Parveen TP (2023), " Application of Six Sigma in Construction Industry" International journal of Trend in Scientific Research and Development (IJTSRD) Vol 7 Issue 1, e-ISSN:2456-6470.

[7] Jemima A. Ottou, Bernard K. Baiden & Joseph K Ofori (2016), "The Use of Six Sigma as a Performance Improvement Strategy in the Construction Industry: New Trends and Application", International Journal of Engineering and Management Research, Vol-6, Issue-1 PP 538-546.

[8] K.L.Lee,S.Yang,Y. Su and S.Yang, "Applying Six Sigma to Quality Improvement in Construction," J.Manag.Eng.,vol.29,no.4,pp.464–470,2013.

[9] Ketama Fayera Tolera & M. Vignesh Kumar (2020), "Study on Causes, Effects and Remedial Measures of Building Defects in Case of Public Building Project in Nekemte Town, Ethopia", American Journal of Engineering Research (AJER) Vol 9, Issue 12 Page 40-48.

[10] Sandeep Bodke, Snehal Nikam, Yogita Phad, Sayali Katkade and Kiran Kangane (2017),'Quality Improvement in Building Construction Using Six Sigma', IOSR Journal of Mechanical and Civil Engineering,pp.1-5

[11] Pihl, P. 2013. Lean Six Sigma at the Linde Group. Green Belt training wave 13. StoraBrännbo, Sweden.11.-14.6.2013and 26.-28.8.2013.Training slides and notes.