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A Review on Adoption of Bim in Reducing Construction Rework

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Abstract: *In the construction industry, the aim of project control is to ensure that the projects are completed on time, within budget and achieving other project objectives .Rework is one of the most major problems in the construction industry. It has an impact on time, cost, quality, and practically every other project success factor. There is always a significant loss of resources, materials, investments, and workforce-time as a result of rework and poor use of resources and materials in the works. Rework may be reduced by designing and planning with full understanding of customers and stakeholders, good communication amongst project aspects, applying quality management systems, and utilizing Information Technology. Because of the worldwide expansion of IT and the widespread use of BIM ,which coordinates all of the software and parts of the construction--the appearance of mistakes and inconsistencies has been drastically reduced in recent years, allowing specialists to realize their full potential in doing projects. To the best of the author's knowledge, this study is to use actual project data to measure the effects of BIM implementation on rework in construction projects. The study's findings enable practitioners to develop techniques to reduce rework with BIM implementation, enhance project cost and time performance, and increase project delivery efficiency.*

Keywords: Rework, BIM, Project performance, Construction Projects

I. INTRODUCTION

The construction industry has been criticized widely for poor performance and inefficient output as it has faced significant problems of unappropriated financial performance. The high cost of project delivery and the difficulty to execute projects on schedule are the other major construction issues. Reworking is one of the key contributors to these issues. Construction experts have highlighted rework as a key factor leading to poor project performance. Inconsistencies with specified needs (Burati et al. 1992), deviations from needed quality (Hwang and Yang 2014), changes in the scope or specifications from project stakeholders, and omissions/errors made by project experts can all lead to rework. Research has been conducted to investigate the negative impact of rework on project performance. Rework leads to around 50% of project time overruns, and rework costs account for 5%-25% of contract value (Forcada et al. 2017).

According to (Love et al.2016), error management and a learning culture in project execution may significantly reduce accidents and rework (up to more than 50% as a result of ordering modifications) (Love et al., 2016).Furthermore, many techniques such as BIM technology, modular construction, Lean construction, reviewing project feasibility by the design team, and project construction and procurement based on project team communications can be helpful in reducing rework (Love et al, 2016).

Lu et al. (2018) shown that sharing design information with on-site personnel assists in preventing construction errors. Many academics have worked to reduce the sources of rework, including as design flaws and faults. Kwon et al. (2014), for example, investigated a faulty management system that integrated BIM, image-machining, and augmented reality to automatically identify and omit flaws. Furthermore, according to many studies, defect data should be communicated through a BIM-integrated network. Bryde et al. (2013) evaluated the benefits and disadvantages of adopting BIM in projects and determined that the benefits exceed the drawbacks, problems, and limits. However, the direct application of BIM technology will help to reduce rework and increase project performance directly.

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1.1. KEY PAPERS REFERENCED

Table 1. Key papers referenced

Authors	Year of Publication
Sandbhor et al.	2023
K.V.Prasad	2023
Ramin Asadi et al.	2022
Hamidreza et al.	2020
Bon-Gang	2019
Forcada et al.	2017
Love et al.	2016
Bon-Gang	2016
Lee et al.	2016
Love et al.	2010
Bon-Gang Hwang	2009
Love et al.	2000

II. REVIEW ON LITERATURES

2.1 REVIEW ON EFFECT ON BIM IN REWORK

Several studies have utilized BIM to identify and eliminate rework causes such as defects and design problems. Some construction researchers created BIM-integrated technological solutions with the goal of minimizing the causes of BIM and increasing quality or schedule management. (Lee et al.2016), for example, suggested a BIM-integrated architecture for sharing defect data across heterogeneous data sources. (Kwon et al. 2014) used BIM, image-matching, and augmented reality in a defect management system to detect and eliminate errors on the building site automatically. However, the previously stated designed technologies were only evaluated in experiments and were not used in real operations. The impact of BIM implementation on rework is yet unclear.The developed framework may be utilised to decrease the occurrence of defects and associated rework. Other study looked at industry practitioners' perspectives on the benefits of using BIM in construction projects.(Jin et al. 2017) conducted a study to explore Chinese BIM experts' perspectives of the impact of BIM implementation and discovered that eliminating design flaws and following construction rework are viewed as the top benefits of utilising BIM. (Bryde et al. 2013) gathered and analysed data from case studies on the benefits of BIM implementation and discovered that such benefits (such as cost management and time savings) exceeded the negative consequences (e.g., software-related difficulties

The importance of addressing construction defects, rework, and waste in order to improve the quality and productivity of construction projects. It emphasizes the need for research in applying AI and BIM-based techniques to optimize output in these areas (Sandbhor et al. 2023) and the advantages of using BIM in a residential project located in Pune, India. The goal of the study is to encourage practitioners in India to accept BIM more widely by illustrating the implementation process and highlighting its advantages (K.V.Prasad et al. 2023) and the impact of Digital Building Information Modelling (BIM) technology on building project implementation in Indonesia. It discovered that the use of BIM has a considerable impact on the success factors of BIM-based projects. Specifically, factors linked to BIM adoption and the excess of BIM adoption exhibited positive and substantial effects on project success determinants (Bambang Herumanta et al. 2022).The current state of BIM knowledge in Indian construction, as well as its advantages and disadvantages. The advantages that BIM implementation can have for safety management are also discussed in this paper. A questionnaire was created specifically for this study in order to determine the degree of BIM knowledge within the Indian construction sector (Shalaka Hire et al. 2021)and categorized 49 rework causes in building construction projects, including design errors, differences among plans and operational specifications, non-compliance with specifications, insufficient skill level, unrealistic schedules, poor communication, and economic fluctuations andThe study identified and categorized 49 rework causes in building construction projects, including design errors, differences among plans and operational specifications, non-compliance with specifications, insufficient skill level, unrealistic schedules, poor communication, and economic fluctuations (Hamidreza Khalesi et al. 2020) and finally

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proposed a framework for an integrated BIM ROI, consisting of three phase's assessment planning, primary BIM ROI based on preventing rework, and integrated BIM ROI. The framework is established from substantive requirements from experts in the construction field.The paper aims to provide a simple, easy-to-understand, and practical tool that can be used by construction firms to assess the positive effects of BIM and determine its suitability for decision-making Myungdo Lee et.al 2020.

A set of practical strategies that can help prevent rework in projects with BIM implementation using a fuzzy set theory-based model and this study proposes a set of practical solutions for reducing rework in BIM projects that use a fuzzy set theory-based model (Bon-Gang Hwang et.al 2019). The integration of Building Information Modeling (BIM) and system dynamic modeling to minimize construction waste generation from change orders. It does not specifically mention the effect of BIM in reducing rework in construction projects and Integration of BIM and system dynamic modeling minimizes construction waste generation and Change iterations in construction contribute to 30% of construction cost(Mohammadsaeid et al. 2020).).Few studies, however, have clearly evaluated the effect of BIM use on rework in construction projects, and even fewer have presented actual evidence of rework cost/time in projects with and without BIM implementation.

2.2 REVIEW ON REDUCTION OF REWORK WITHOUT USING BIM IN CONSTRUCTION INDUSTRY

Rework-related studies in the construction industry through a critical review of literature to investigate the main causes of rework in the construction contracts. A content analysis of the previously proposed rework classification techniques indicated that all rework reasons could be classified according to project phases. The causes of rework might also be attributed to other project stakeholders (Ramin Asadi et al. 2023)and the causes, size, and costs of rework in two construction projects obtained through various contractual structures. The causes and costs of rework projects are investigated and debated. According to the data, the cost of rework for the case study projects was 3.15% and 2.40% of the project contract value, respectively. Changes initiated by the client and end-user, as well as faults and omissions in contract documentation, were identified as the leading sources of rework. It is advised that construction businesses and consulting firms (especially design consultants) use quality management practices and place an emphasis on project documentation coordination during the design development phase in order to decrease or eliminate the amount of rework in projects (O. S. Dosumu et al. (2023).

The valuable insights for stakeholders in the construction industry to understand the quantitative impact of different causes on rework and prioritize efforts to control or eliminate it and to identify and analyses the causes of rework in building construction projects, both qualitatively and quantitatively, using Structural Equation Modelling (SEM) .The study aimed to understand the ranking and criticality of various causes of rework by conducting personal interviews with stakeholders from across India(Sahil Garg et.al 2021) and further showed that an increase in the frequency of rework on finishes and mechanical installations could speed up rework cost. As a result, this study confirms the stakeholders' requirement to prevent rework on service components (mechanical and electrical), concrete works, and finishes for the purpose to enjoy a quick decrease in the cost of rework. The study improved the body of knowledge by identifying building components with a high rework impact and their accompanying economic impact as assessed by end-user customers and built environment professionals(Abiodun 2021).when a contractor implements quality assurance system in conjunction with an effective continuous improvement strategy, rework costs were less than 1% of the contract value. Adoption of information technology is another approach of decreasing rework Love et al. (2000).

2.3 REVIEW ON REWORK REDUCTION BASED ON PROJECT PERFORMANCE

Rework has an influence+ on project performance in ways that are both direct and indirect. It is a key contributing element to the expenses and Construction project time overruns (Hwang et al. 2009). Previous research examined into the impact of rework on the cost, time, and quality of building projects. The Building Industry According to CII (2005), the direct expenses associated with rework account for approximately 5% of total construction costs. (Love et al. 2010) studied 115 civil infrastructure projects and discovered that direct and indirect rework costs vary from 5.07% to 5.22% of contract values.According to (Love et al 2010), the rework cost of construction projects is greater than that of infrastructure projects.Another effect of rework is time delay or overrun. According to (Hwang and Yang 2014), rework

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accounts for an average of 25% of the increase in construction length in Singapore. Although project length can be shortened by assigning more resources, working overtime, or a combination of the two, these strategies may increase project expenses.

The causes of rework in construction projects, its influence on construction project performance, and give solutions to the causes of rework based on extant studies and examine the causes of rework in construction projects, its influence on construction project performance(Adeosun Juliana (2023).The more effective rework management may be obtained by grouping a number of rework root causes into integrated components. The data indicate that rework reasons have arisen in all five defined categories during the design stage of a project; however, human resources and technical-related elements have the largest number of rework root causes when compared to the other categories. In this project stage, however, material and equipment-related issues contribute to the fewest number of causes (Ramin Asadi et al. 2022).The cost of rework and the cost of preventing rework in civil works during the pre-construction and construction stages by identifying the basic reasons and analyzing a preventative method with the cost associated with it.Although rework conditions have both direct and indirect effects, the long-term negative effects can be prolonged if the reworks go unidentified. To do this, it is critical to quantify the negative impact of rework (Phalguni et al. 2022).

The root causes of rework for Egyptian construction projects and their impact on the project duration and cost and the current study can be considered valuable for international academics and research as it identified the largest number of rework causes, as well as it provides adequate knowledge about the common causes of rework and its impact in the Egyptian construction industry(Assim Muwafaq et.al 2020).Investigated to be alert and eliminate rework risk triggers before starting construction, improve communication among project participants, involve skilled professionals, and develop team-building and relationship models and study analyzed the impact of rework cost on time and cost performance of building construction projects in Abuja, Nigeria(Emmanuel et al. 2018). (Bon-Gang Hwang et al. 2014)investigated that rework is a major element influencing schedule performance, and its occurrence is very common in the construction sector, contributing greatly to construction schedule growth. It also highlighted design-related modifications, poor design coordination, and poor site management as variables that have the most negative impact on schedule performance. Originality/value - It is expected that once organizations understand the causes of rework and the effects on schedule, they will create techniques to control and prevent rework, allowing the industry to enhance project delivery schedule performance.

The significant variables that contribute to rework in civil infrastructure projects and suggests that design firms may need to provide better IT training, improve design checks and review processes, and better plan and manage the design and documentation process to reduce rework and to determine the underlying factors that contribute to rework in civil infrastructure projects before effective preventive strategies can be identified and to understand the root causes and consequential costs of rework in civil infrastructure projects (Love et al. 2010). The effects of rework varies depending on project parameters, and that the sources of rework with the highest impact are not significantly different across project categories. The construction industry may minimize rework and eventually enhance project cost performance by recognizing the implications of rework and its causes. (Bon-Gang Hwang et al. 2009) .The management of construction projects is complex and changes (unplanned disturbances) are a familiar characteristic that can interfere with the intended progression of work. These changes can have consequences on project performance and the paper emphasizes the importance of understanding how particular dynamics can hinder the performance of a project management system in construction. It suggests that project managers should develop the ability to identify and respond promptly to changes within the project management system(Li et al. 2002).Changes started by the customer and end-user, as well as mistakes in contract documentation, were the primary reasons. They recommended that construction companies and consulting firms, particularly design consultants, employ quality management methods and prioritize project documentation coordination throughout the design process in order to decrease or eliminate rework. This would result in lower costs and more efficient project execution. Rework accounted for 3.15% and 2.40% of the project contract value, respectively (Liet al. 2000) and analyzed the implementation of metrics and models to quantify rework in Complex Systems Design and Management with the aim of reducing waste in development processes and the paper aims to illustrate the implementation of metrics and models to quantify rework in Complex Systems Design and Management at Thales Airborne Systems (Edmond et al. 2012).The fact that rework developed greater from the design

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stage than the construction stage. It was also found that 50% of the origin of errors which leads to rework in buildings occur in the design stage and 40% occur during the construction stage (Smith et al. 2000).

Rework research has demonstrated that project factors can predict the influence of rework on project performance. According to (Love et al. 2010), the level of rework relates to the entire project cost and time. Building type and project scale are related to project complexity, influencing overall performance and the impact of rework (Forcada et al. 2017).Rework costs have multiple consequences in commercial buildings, infrastructure, and industrial projects, according to (Jaafari et al.1994) this study looks into how BIM implementation affects the size and impact of rework in three different types of projects: construction, industrial, and infrastructure.

III. DATA TEXT ANALYSIS IN VOS VIEWER

The data text analysis presented here explores the adoption of Building Information Modeling (BIM) as a strategy to reduce construction rework. The study focuses on leveraging BIM to enhance construction processes by systematically categorizing its impact on rework reduction. To gain insights from existing literature, a Visualizing Output of Science (VOS) Viewer analysis was conducted. The analysis involved the extraction and examination of relevant texts from scholarly articles, conference papers, and research publications related to BIM adoption, construction rework, and process improvement. The aim was to identify key themes, influential authors, and the interconnectedness of concepts within the context of reducing construction rework.

This data text analysis using VOS Viewer offers a clear understanding of the key themes, influential authors, and relationships between concepts in the context of reducing construction rework through BIM adoption. The study serves as a valuable resource for researchers, practitioners, and policymakers seeking to advance the understanding of BIM's role in minimizing rework and improving overall construction efficiency and outcomes. (Fig.1)

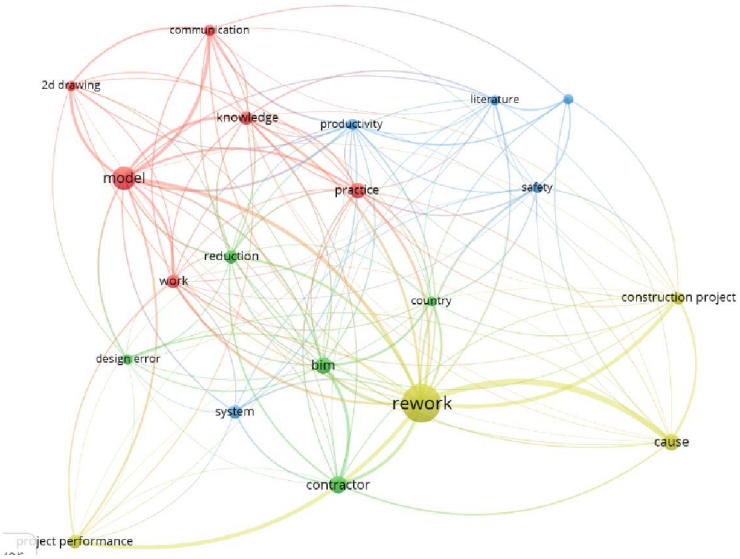

Fig.1 Text data
Source: VOS Viewer

IV. CONCLUSION

This Paper highlights the adoption of BIM in reducing construction rework will be helpful in enhancing project performance and also increase project productivity. According to the findings, BIM implementation may help decrease the impact of rework in building projects. The impact of rework on both project cost and time was significantly smaller in construction and industrial projects with BIM adoption than in projects without BIM and it shows that BIM has a substantial influence on rework cost reduction and rework time reduction in both construction and industrial projects. However, the study's findings would be useful since it used first-hand empirical data to present the status of rework in projects with BIM implementation and examined the influence of BIM implementation on the reduction of rework cost

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and time in building projects. The identified primary causes of rework may be utilized by construction organizations to conduct risk prediction and assessment, as well as plan activities for rework reduction prior to the start of a project's construction. The study's practical solutions enable industrial practitioners to successfully use BIM to decrease rework and increase the construction industry's overall efficiency.

REFERENCES

[1]. Sandbhor, (2023).AI and BIM-based Construction defects, rework, and waste optimization. doi: 10.1109/esci56872.2023.10099726.

[2]. Adeosun, Julianah & Oladimeji, Olubimbola & Adejumo, Abiodun & Haddad, Assed & Tam, Vivian. (2023). Influence of rework on construction project performance in Nigeria. International Journal of Construction Management. 1-6.10.1080/15623599.2023.2239439.

[3]. Asadi, Ramin & Rotimi, James & Wilkinson, Suzanne. (2023). Rework causes classification model with liable parties of the contract in construction projects. Frontiers in Built Environment.1143829. 10.3389/ fbuil.2023.1143829.

[4]. Dosumu, Oluwaseun & Akinsiku, O & Giwa, F & Aigbavboa, C. (2023). Implication of Rework on Selected Residential Building Projects in Lagos, Nigeria.

[5]. Vigneshwar, R. V. K., Shanmugapriya, S., & Vaardini, U. S. (2022, February 9). Analyzing the Driving Factors of BIM Adoption Based on the Perception of the Practitioners in Indian Construction Projects. Iranian Journal of Science and Technology, Transactions of Civil Engineering. https://doi.org/10.1007/s40996-022-00834-9

[6]. Asadi, Ramin & Rotimi, James & Wilkinson, Suzanne. (2022). Classification of rework root causes in the design stage of projects for contract assessment. IOP Conference Series: Earth and Environmental Science. 1101. 042033. 10.1088/1755-1315/1101/4/042033.

[7]. Herumanta, Bambang & Islami, Rizky & Hazhiyah, Amalia. (2022).The Effects of Building Information Modeling (BIM) Implementation in the Success of Construction Projects. International Journal of Engineering Science Technologies. 6. 52-62. 10.29121/ijoest.v6.i3.2022.326.

[8]. Singh, Phalguni & Rohila, Diksha & Khursheed, Salman & Paul, Virendra. (2022). Evaluation of Rework Cost and Prevention Cost Of Rework in Building Construction. International Journal of Sustainable Building Technology. 10.37628/ijsdt.v5i1.902.

[9]. Hire, Shalaka K. & Sandbhor, Sayali & Ruikar, Kirti & Amarnath, C. (2021). BIM usage benefits and challenges for site safety application in Indian construction sector. Asian Journal of Civil Engineering. 22. 1-19. 10.1007/s42107-021-00379-8.

[10]. Sahil, Garg, Sudhir, Misra. (2021). Causal model for rework in building construction for developing countries. Journal of building engineering, doi: 10.1016/J.JOBE.2021.103180.

[11]. Abiodun, Oluwapelumi & Nwaogu, Janet. (2021). Comparative Assessment of Rework on Buildings in Akure Municipal, Ondo State, Nigeria. International Journal of Sustainable Construction Engineering Technology. 12. 24-37.

[12]. Trach, Roman & Lendo-Siwicka, Marzena & Pawluk, Katarzyna & Połoński, Mieczysław. (2021). Analysis of direct rework costs in Ukrainian construction. Archives of Civil Engineering. 67.397-411.10.24425/ ace.2021.137175.

[13]. Khalesi, Hamidreza & Balali, Amirhossein & Valipour, Alireza & Antucheviciene, Jurgita & Migilinskas, Darius & Zigmund, Viačeslav. (2020). Application of Hybrid SWARA-BIM in Reducing Reworks of Building Construction Projects from the Perspective of Time. Sustainability. 12. 1-21. 10.3390/su12218927.

[14]. Lee, Myungdo & Lee, Ung-Kyun. (2020). A Framework For Evaluating An Integrated BIM ROI Based On Preventing Rework In The Construction Phase. Journal of Civil Engineering and Management 26.410-420.10.3846/ jcem.2020.12185.

[15]. Al-Janabi, Assim & Abdel-Monem, Mohamed & Eldash, Karim. (2020). Factors causing rework and their impact on projects' performance in Egypt. Journal of Civil Engineering and Management. 26. 666-689. 10.3846/jcem.2020.12916.

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International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
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[16]. Porwal, Atul & Parsamehr, Mohammadsaeid & Szostopal, Dylan & Ruparathna, Rajeev & Hewage, Kasun. (2020). The integration of building information modeling (BIM) and system dynamic modeling to minimize construction waste generation from change orders. International Journal of Construction Management.20.10.1080/ 15623599.2020.1854930.

[17]. Hyun, Hosang & Kim, Hyunsoo & Lee, Hyun-Soo & Park, Moonseo & Lee, Jeonghoon. (2020). Integrated Design Process for Modular Construction Projects to Reduce Rework. Sustainability. 12.530. 10.3390/ su12020530.

[18]. Hwang, B.-G., Zhao, X., & Yang, K. W. (2019). Effect of BIM on Rework in Construction Projects in Singapore: Status Quo, Magnitude, Impact, and Strategies. Journal of Construction Engineering and Management, 145(2), 04018125. Doi: 10.1061/(asce)co.1943-7862. 000 1600.

[19]. Trach, Roman & Pawluk, Katarzyna & Lendo-Siwicka, Marzena. (2019). Causes of Rework in Construction Projects in Ukraine. Archives of Civil Engineering. 65. 61-74. 10.2478/ace-2019-0034.

[20]. Ghannadpour, S. F. (2018, December 30). Reducing rework and increasing the civil projects quality, through Total Quality Management (TQM), by using the concept of building information modeling (BIM).

[21]. Eze, Emmanuel & Idiake, John. (2018). Analysis of Cost of Rework on Time and Cost Performance of Building Construction Projects in Abuja, Nigeria. International Journal of Built Environment and Sustainability doi.10.11113/ijbes.v5.n1.246.

[22]. Yap, Jeffrey & Low, Pak & Wang, Chen. (2017). Rework in Malaysian building construction: impacts, causes and potential solutions. Journal of Engineering, Design and Technology. 15. 00-00. 10.1108/JEDT-01-2017-0002.

[23]. Forcada, Nuria & Gangolells, Marta & Casals, Miquel & Macarulla, Marcel. (2017). Factors Affecting Rework Costs in Construction. Journal of Construction Engineering and Management.04017032. 10.1061/ (ASCE) CO.1943-7862.0001324.

[24]. Chou, Hui-Yu & Chen, Pei-Yu. (2017). Benefit Evaluation of Implementing BIM in Construction Projects. IOP Conference Series: Materials Science and Engineering. 245. 062049. 10.1088/1757-899X/245/6/062049.

[25]. Love, P. E., D. J. Edwards, and J. Smith. 2016. "Rework causation: Emergent theoretical insights and implications for research." J. Constr. Eng. Manage. 142 (6): 04016010.https://doi.org/10.1061/ (ASCE) CO. 1943 -7862.0001114.

[26]. Hwang, Bon-Gang & Yang, Shimin. (2014). rework and schedule performance: A profile of incidence, impact, causes and solutions. Engineering. 21. 10.1108/ECAM-10-2012-0101.

[27]. Zhang, D., C. T. Haas, P. M. Goodrum, C. H. Caldas, and R. Granger. 2012. "Construction small-projects rework reduction for capital facilities." J. Constr. Eng. Manage. 138 (12): 1377–1385. https://doi.org/10.1061 / (ASCE) CO.1943-7862.0000552.

[28]. Love, P. E., D. J. Edwards, H. Watson, and P. Davis. 2010. "Rework in civil infrastructure projects: Determination of cost predictors." J. Constr. Eng. Manage. 136 (3): 275–282. https://doi.org/10.1061/ (ASCE)CO .1943-7862 0000136.1

[29]. Simpeh, Eric. (2012). An Analysis of The Causes And Impact of Rework in Construction Projects.

[30]. Hwang, Bon-Gang & Thomas, Stephen & Haas, Carl. (2009). Measuring the Impact of Rework on Construction Cost Performance. Journal of Construction Engineering and Management-asce - J Constr Eng Manage-ASCE.135.10.1061/(ASCE) 0733-9364(2009) 135:3 (18 7).

[31]. Edwards, David. (2004). Determinants of rework in building construction projects. Engineering, Construction and Architectural Management. 11. 259-274. 10.1108/09699980410547612.

[32]. Li, Heng. (2000). Quantifying the causes and costs of rework in construction. Construction Management & Economics.479-490. 10.1080/01446190050024897.

[33]. Vaardini.U, K Subramanian Identification of causes and impacts of time overrun in construction projects. International journal of applied engineering research, 2015. 10 .19