CHAPTER 127

Statistical study of Digitalization in Construction Industry

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ABSTRACT

Digitalization is revolutionizing the construction sector by addressing inefficiencies, high costs, and poor project outcomes. This study explores the impact of digital tools such as Artificial Intelligence (AI), the Internet of Things (IoT), Building Information Modelling (BIM), and project management tools focused on time, cost, and quality management in building projects. Using a mixed-methods approach combining doctrinal analysis and survey-based empirical data, it examines adoption rates, benefits, and challenges. Research shows that digital tools significantly enhance productivity, reduce timelines, and lower costs. Technologies like BIM, AI for defect detection, and drones for site inspections improve project quality. However, barriers such as high initial costs, a lack of skilled professionals, and resistance to change hinder broader adoption, highlighting the need for targeted strategies. The study underscores the transformative potential of digitalization in optimizing the Project Management Triangle (scope, cost, and time) while enhancing quality. It aims to guide stakeholders in leveraging digital tools for greater innovation, sustainability, and improved project outcomes in the construction industry.

Keywords: Digitalization; Building information modeling (BIM); Project management triangle; Construction industry; Quality improvement.

1.0 Introduction

Digitalization is revolutionizing the construction sector by addressing inefficiencies, high costs, and poor project outcomes. This study explores the impact of digital tools such as BIM-Building information modelling, IOT-Internet of things, AI-Artificial intelligence and project management. Using a mixed-methods approach combining doctrinal analysis and survey-based empirical data, it examines adoption rates, benefits, and challenges. Research shows that digital tools significantly enhance productivity, reduce timelines, and lower costs. Technologies like BIM, AI for defect detection, and drones for site inspections improve project quality. However, barriers such as high initial costs, a lack of skilled professionals, and resistance to change affect broader adoption, highlighting the need for targeted strategies.

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The study underlines the transformative potential of digitalization in optimizing the Project Management Triangle (scope, cost, and time) while enhancing quality. It aims to guide stakeholders in leveraging digital tools for greater innovation, sustainability, and improved project outcomes in the construction industry.

2.0 Literature Review

Prebanić & Vukomanović (2021). This paper reviews the impact of digital transformation on stakeholder behavior and engagement in the construction industry, focusing on tools like BIM, social network analysis, and web-based applications. Musarat *et al.*, (2023). This study explores how digitalization in the construction industry enhances quality of life by optimizing energy use, promoting economic growth, and improving building efficiency. Liu *et al.*, (2023). This research proposes a conceptual project governance model to promote digitalization in construction projects. The authors identify three integration dimensions: stakeholder, lifecycle, and project management knowledge. Irina Vladimirova *et al.*, (2018). The study highlights the benefits of BIM in reducing construction costs, improving productivity, and enhancing project outcomes. Hwang *et al.*, (2021). This study examines the challenges and strategies for adopting smart technologies in Singapore's construction industry. Key challenges include data sharing, regulatory compliance, and data ownership. Effective strategies involve workforce training, government incentives, and improved communication.

3.0 Research Methodology

A systematic framework known as research design directs the investigation from the creation of research questions to the data analysis. A mixed-methods research design is used in this study, integrating qualitative and quantitative techniques. While quantitative technique is used to evaluate the effect of digital tools and technologies on project efficiency, the qualitative approach is used for studying the challenges, strategies, and views related to digital transformation in the construction sector. By using the advantages of both strategies, the mixed-methods design guarantees a thorough grasp of the study subject. Professionals in the construction sector, including project managers, architects, engineers, and contractors, are among the target population. To guarantee representation across various jobs and organizational sizes, a stratified random selection technique is used. The sample size guarantees a 5% margin of error and a 95% confidence level. Responders, drawn from both public and private construction companies, make up the final sample.

4.0 Discussion of Findings- Graphs and Results

From the response given by the sources, it is clear that 89.1% respondents out of 100% have said that digitalization has reduced the overall project time (Figure 1).

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Figure 1: Digitalization's Impact on Timeline

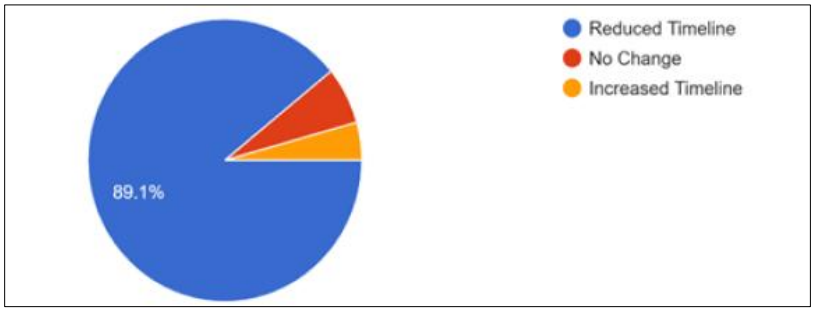


Figure 2: Most Effective Digital Tool in Reducing Project Timeline

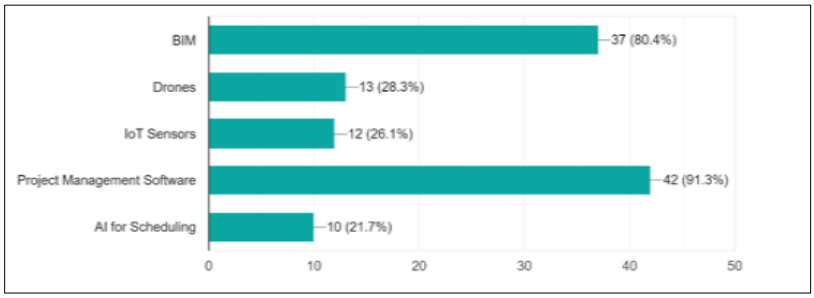
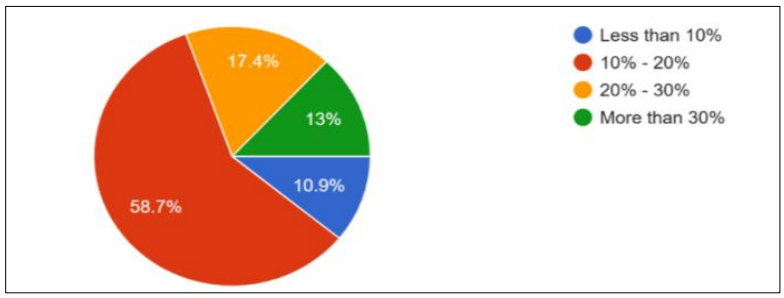


Figure 3: Percentage Time Saved in Projects due to Digitalization



In Figure 2,Project management software and BIM is the most effective tools used in the construction industry to reduce the project timeline with 91.3% & 80.4% respectively

In Figure 3, Over 58.7% experienced 10-20% time reductions in their projects due to digitalization. 17.4% experienced 20-30% time reductions in their projects due to digitalization.

In Figure 4, Over 78.3%out of 100% respondents have reported that the use of digital tools have reduced the construction costs

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Figure 4: Digitalization's Impact on Cost

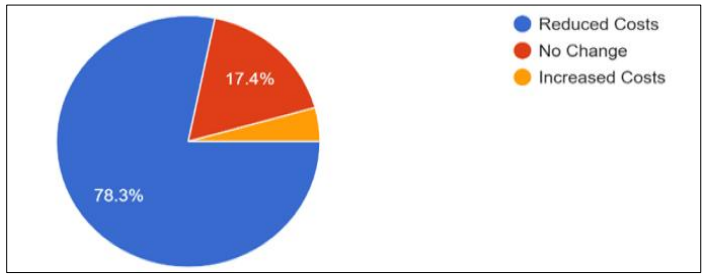
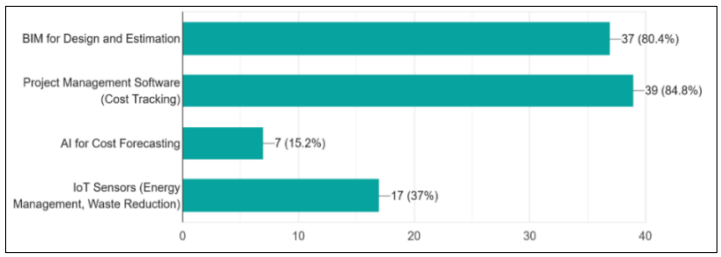
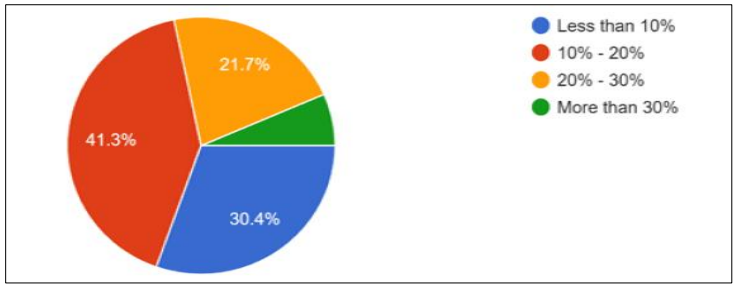


Figure 5: Most Effective Digital Tool in Reducing Project Cost



Project management software and BIM is the most effective tools used in the construction industry to reduce the project timeline with 84.8% & 80.4% respectively. Also, 37% respondents reported that IoT is also used to reduce project cost by reducing wastes and managing energy efficiently (Figure 5).

Figure 6: Percentage Cost Saved in Projects due to Digitalization



Over 41.3% experienced 10-20% cost reductions in their projects due to digitalization. 21.7% experienced 20-30% time reductions in their projects due to digitalization. 30.4% experienced less than 10% cost reductions due to digitalisation (Figure 6).

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Figure 7: Digitalization's Impact on Quality

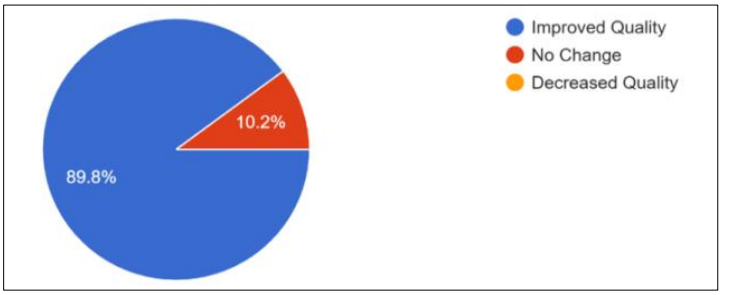


Figure 8: Most Effective Digital Tool in Enhancing Quality

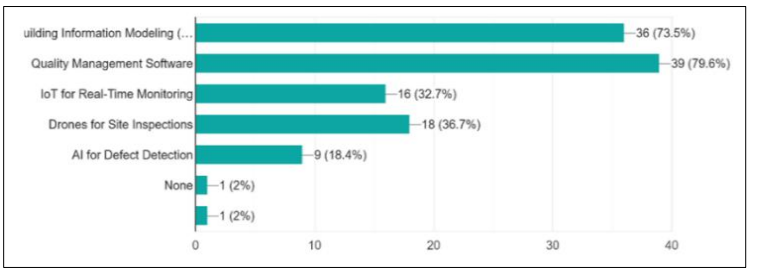
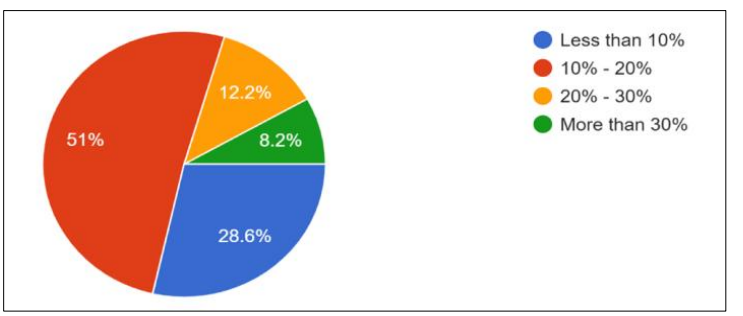


Figure 9: Rate of Reduction of defects Because of Digitalization



In Figure 7, From the response given by the sources, it is clear that 89.8% respondents out of 100% have said that digitalization has improved the overall project quality Quality management software and BIM is the most effective tools used in the construction industry to improve the project quality with 79.6% & 73.5% respectively (Figure 8). Also, respondents reported that IoT (32.7%) & Drones (36.7%) is used to improve project quality by real time monitoring and site inspections

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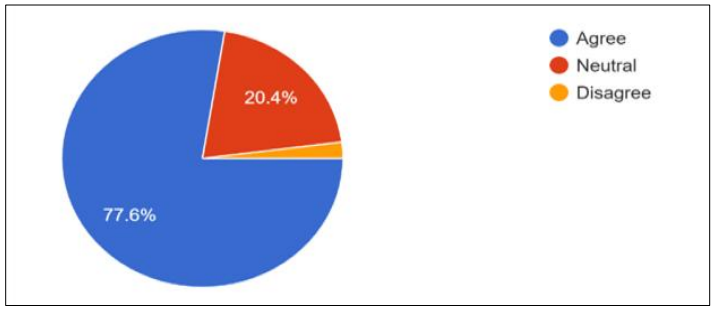
Figure 10: Agreeableness on Improved Quality Standards due to Digitalization



In Figure 9, Over 51% experienced 10-20% defects reductions and quality improved in their projects due to digitalization. 12.2% experienced 20-30% defects reductions and quality improved in their projects due to digitalization. 28.6% experienced less than 10% defects reductions and quality improved due to digitalisation. 77.6% respondents have agreed that use of digital tools and digitalization in the construction industry has helped in meeting the quality standards more effectively (Figure 10).

Figure 11: Challenges Faced While Adopting Digital Technologies

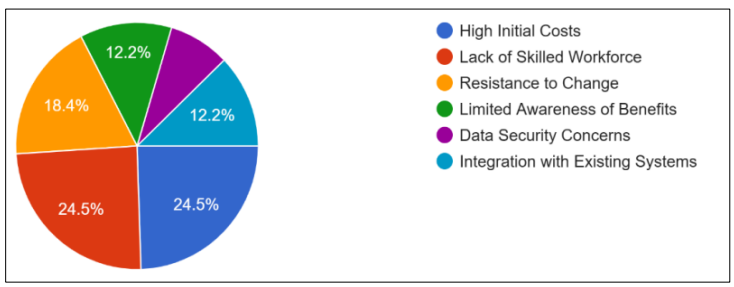
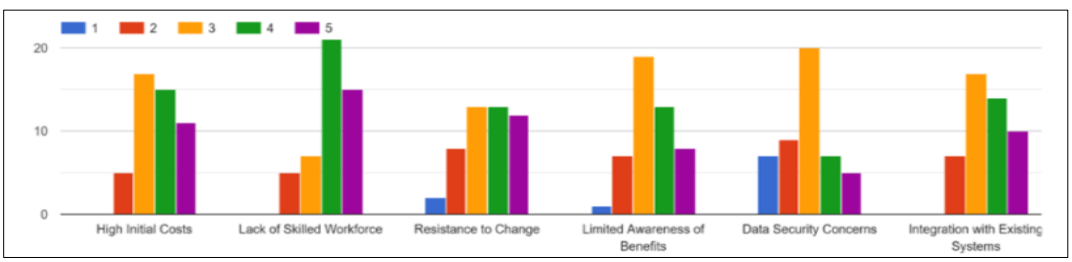


Figure 12: Significance of Each Challenge



In Figure 11, High initial costs for implementation: 24.5% of respondents. Lack of skilled manpower necessary to implement new technology: 24.5% of respondents. Opposition to

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change: 18.4% of those surveyed. Limited awareness and integration with current systems: 12.2% for each factor. It is clear from the respondents that lack of labour resources is the most significant challenge with more that 20% repondents voting a scale of 4 and 15% respondents voting a scale of 5, followed by data security concerns, limited awareness of benefits, high initial concerns and finally integration with existing concerns.

5.0 Conclusion

In conclusion, digitization has enormous potential to improve project quality and optimize the Project Management Triangle, which consists of scope, cost, and time. BIM-Building information modelling, IOT-Internet of things, AI-Artificial intelligence and project management software are examples of cutting-edge digital solutions that construction companies can use to increase productivity, sustainability, and competitiveness. According to survey results, these technologies have proven effective in streamlining workflows, cutting project timeframes, and lowering costs; more than 90% of respondents reported shorter timelines, and almost 80% reported cost reductions.

Further establishing its position as a transformational force in the construction sector, digitalization has also greatly improved project quality, as seen by a dramatic decrease in defect rates and improved adherence to quality standards. With the insights gained from this study, stakeholders can more effectively navigate the challenges of digital transformation. By understanding and leveraging the full potential of digital technology, they can drive the industry toward a more resilient and innovative future. As the world becomes increasingly digitally connected, embracing digitalization is not only a strategic advantage but also essential for long-term success. This approach ensures that construction companies remain competitive and can deliver high-quality projects efficiently and sustainably.

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