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An Investigation in to the Influence of the Use of Technology on Labour Productivity in the Construction Industry in Nairobi City, County Kenya

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Abstract
The construction industry in Nairobi City County, Kenya, serves as a pivotal driver of economic development, infrastructure enhancement, and job creation, contributing significantly to the local economy and social fabric. However, amidst rapid urbanization and evolving development needs, the sector encounters challenges such as resource constraints and project inefficiencies. In response, technological innovations have emerged as transformative agents, offering opportunities to enhance productivity and streamline processes. This study investigates the relationship between technology utilization and labour productivity in Nairobi City County's construction industry. Through a combination of quantitative analysis and qualitative assessments, the study explores the impact of safety technology, Building Information Modeling (BIM), construction automation, and remote monitoring and control on labour productivity. The findings reveal a significant positive correlation between technology use and labour productivity, emphasizing the importance of technology adoption for enhancing efficiency and competitiveness in the construction sector. These results underscore the need for strategic interventions to promote technology integration and foster sustainable growth in Nairobi City County's construction industry.
Keywords: An investigation, Technology, Labour Productivity

1.1 INTRODUCTION

The construction industry in Nairobi City County, Kenya, stands as a vital driver of economic development, infrastructure improvement, and job creation within the region(Adams et al., 2019). With its significant contributions to the local economy and social fabric, the construction sector plays a crucial role in shaping the urban landscape and fostering sustainable growth(Alinaitwe et al., 2017). However, amidst the backdrop of rapid urbanization and evolving development needs, the industry faces an array of challenges, ranging from resource constraints to inefficiencies in project delivery. In response to these challenges, technological innovations have emerged as a catalyst for transformation, offering unprecedented opportunities to enhance productivity, streamline processes, and elevate project outcomes within the construction domain.

In recent years, the adoption of technology has become increasingly prevalent across various sectors, revolutionizing traditional practices and reshaping industry dynamics. The construction sector, in particular, has witnessed a surge in technological advancements, ranging from Building Information Modeling (BIM) and Geographic Information Systems (GIS) to advanced construction equipment and materials (Mugisha et al., 2024). These technologies hold immense potential to optimize resource utilization, improve project management, and drive innovation within the construction industry. Against this backdrop, understanding the influence of technology utilization on labour productivity emerges as a critical imperative for stakeholders within Nairobi City County's construction ecosystem.

This study seeks to investigate the intricate relationship between the use of technology and labour productivity within

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the construction industry in Nairobi City County, Kenya. By examining the adoption levels of technology among construction firms and analyzing their impact on labour productivity metrics, this research aims to provide valuable insights into the dynamics of technology integration in construction practices. Through a combination of quantitative analysis and qualitative assessments, the study endeavors to elucidate the factors driving technology adoption, assess its effectiveness in enhancing labour productivity, and identify opportunities for further innovation and improvement within the construction sector. Ultimately, the findings of this study are expected to inform policymakers, industry practitioners, and researchers about the implications of technology adoption for labour productivity and pave the way for strategic interventions aimed at fostering sustainable growth and development in Nairobi City County's construction industry.

2.1 GENERAL OBJECTIVE

The overall objective of this study was to investigate the influence of use of technology on labour productivity in the construction industry in Nairobi City County, Kenya.

2.2 Specific objectives

This study was guided by the following objectives:

1. To establish how safety technology influences labour productivity in the construction industry in Nairobi City County, Kenya.
2. To assess the extent to which BIM technology influences labour productivity in the construction industry in Nairobi City County, Kenya.

3.1 LITERATURE REVIEW

In the construction industry, technology plays a crucial role in driving labour productivity. This study investigates the association between technology utilization and labour productivity, with a specific focus on digital documentation and reporting, safety technology adoption, building information modeling (BIM), construction automation, and remote monitoring and control(Karatas & Budak, 2023). Digital documentation and reporting are vital for enhancing labour productivity in construction. Research demonstrates that replacing traditional paper-based processes with digital tools streamlines data collection, enhances accuracy, and facilitates real-time communication among project stakeholders (Anastasopoulos, 2012). Digital documentation enables efficient tracking of project progress, resource allocation, and quality assurance, leading to quicker decision-making and reduced administrative burdens. Therefore, embracing digital technologies for documentation and reporting is critical for optimizing labour productivity in construction projects.

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The adoption of safety technology, such as Internet of Things (IoT) sensors and wearable technology, promotes labour productivity in the construction industry (Chen et al., 2023). Studies illustrate that IoT sensors can monitor environmental conditions, equipment performance, and worker activities in real-time, enabling proactive safety measures and risk mitigation strategies (Zhang et al., 2023). Wearable technology, such as smart helmets and vests, provides workers with immediate feedback on potential hazards and alerts them to safety violations, enhancing situational awareness and reducing accidents (Anastasopoulos, 2012). Therefore, integrating safety technology into construction operations is essential for safeguarding workers' well-being and optimizing labour productivity.

The utilization of Building Information Modeling (BIM) facilitates labour productivity in the construction industry. BIM technology enables the creation of digital representations of building projects, incorporating detailed information on design, construction, and maintenance processes (Azhar et al., 2015). By centralizing project data and fostering collabouration among stakeholders, BIM streamlines project workflows, reduces errors, and enhances communication, leading to improved efficiency and productivity. Furthermore, BIM facilitates clash detection, 4D scheduling, and quantity take-offs, enabling better decision-making and resource optimization (Papadonikolaki et al., 2019). Therefore, leveraging BIM technology is essential for enhancing labour productivity in construction projects.

Construction automation enhances labour productivity in the construction industry. Automated technologies, such as robotic arms, 3D printing, and autonomous vehicles, streamline repetitive tasks, minimize manual labour, and accelerate project timelines(Wang et al., 2021). Automation improves construction efficiency, reduces costs, and mitigates safety risks associated with manual labour-intensive activities. Additionally, automated construction methods enable precision and consistency in project execution, resulting in higher-quality outcomes and greater productivity (Amfo-Otu & Agyemang, 2017). Therefore, embracing construction automation is essential for driving labour productivity and innovation in the construction industry.

Remote monitoring and control play a crucial role in enhancing labour productivity in the construction industry. Advanced technologies, such as drones, sensors, and telematics systems, enable real-time monitoring of construction sites, equipment, and processes from remote locationsb-Saharan Africa has been characterised by inadequate infrastructure services due to insufficient financing coupled with prohibitively expensive approaches to land acquisition from private owners. Land readjustment (LR) has been promoted as an approach that has the potential to overcome financial challenges but studies on LR design in the context of sub-Saharan Africa are scanty. Using Nunga LR project in Kigali, Rwanda, this study analyses the adopted LR model, highlighting its benefits towards enabling development of formal urban settlements and suggests improvements. The results show that Nunga LR model overcomes the challenge of assembling land for infrastructure, has resulted in development of settlements adjacent to the project area with similar standards, but faces drawbacks that include inadequate land and cash contributions, inequitable sharing of project costs, inadequate construction of roads, uncertainties, and conversion of land planned for green spaces and social infrastructure. Establishing equal land contribution ratio and a revolving fund, levying betterment charges, designating and subsidising plots for social infrastructure and social/affordable housing can help curbing those drawbacks. This study contributes to the discourse on the application of LR as an innovative approach to overcoming infrastructure dearth and enabling formal human settlements in rapidly urbanising countries. These findings have implications for urban planning in the context of cities in the global south, where the rate of urban growth is high but city authorities face constraints in timely providing infrastructural development (Mugisha et al., 2024). Remote monitoring enhances project visibility, facilitates proactive decision-making, and enables prompt interventions to address issues and optimize resource utilization (Fugate & Alzraiee, 2023). Furthermore, remote control capabilities empower project managers to adjust workflows, allocate resources, and coordinate activities efficiently, regardless of geographical constraints. Therefore, implementing remote monitoring and control technologies is essential for maximizing labour productivity and project success in the construction industry.

The adoption of technology in construction significantly impacts labour productivity in the construction industry. Digital documentation and reporting, safety technology adoption, building information modeling, construction automation, and remote monitoring and control are key technological innovations that drive efficiency, safety, and quality in construction projects (Abaya & Ondieki, 2021). By embracing these technologies and leveraging their capabilities, construction stakeholders can optimize labour productivity, enhance project outcomes, and stay competitive in today's rapidly evolving construction landscape. Future research should focus on exploring emerging technologies and best practices for technology integration in diverse construction contexts.

3.2 Theoretical Framework

3.2.1 The Theory of Constraints

The Theory of Constraints, as introduced by Eliyahu M. Goldratt in his seminal work "The Goal" in 1984 and later applied to project management in "Critical Chain" published in 1997, represents a management philosophy aimed at assisting organizations in identifying and surmounting impediments to accomplish their objectives and enhance labour productivity (Adams et al., 2019). Goldratt's theory suggests that organizations can be assessed and managed

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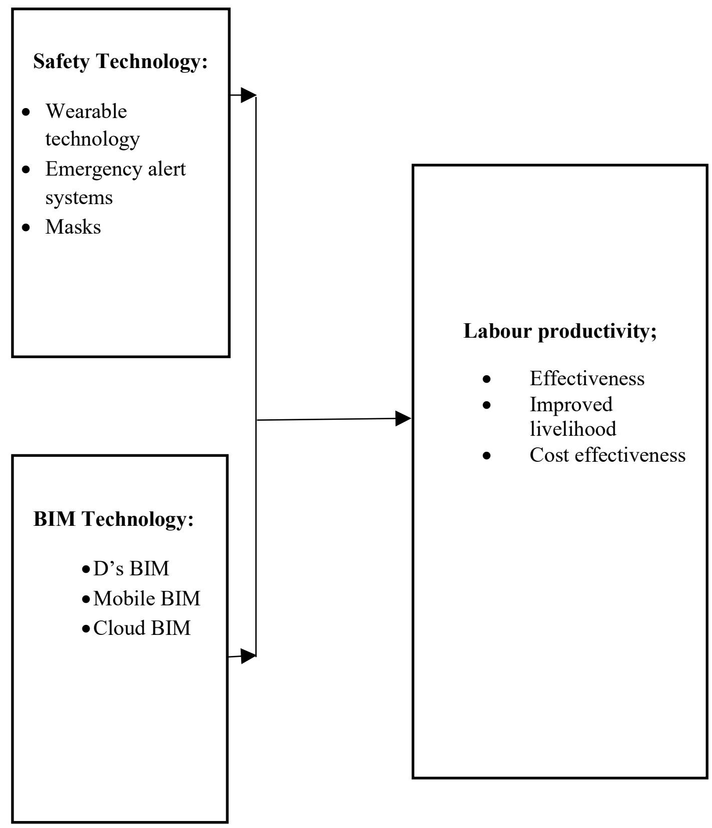
based on throughput, operational expenses, and inventory, with diverse constraints restricting system performance.

Within the context of construction, constraints that may impede labour productivity encompass inadequate stakeholder engagement, restricted resource availability, insufficient adoption of construction technology, and a scarcity of technical skills. The theory advocates for the systematic identification and improvement of these constraints until they no longer hinder progress. For instance, budgetary limitations highlighted by Eliyahu (2009) can obstruct managers from achieving success within designated budgets, while the failure to consider the organization holistically during cost estimation can also present constraints (Rothwell, Hohne, & King, 2018). The availability of resources plays a pivotal role in addressing budget constraints and ensuring uninterrupted operations by furnishing the necessary funds for labour, materials, and equipment. A construction manager endowed with adequate cash flow can sidestep delays and interruptions in project execution, thereby augmenting labour productivity.

The Theory of Constraints guided the examination of factors influencing labour productivity in the construction industry in Nairobi City County, Kenya. By contemplating elements such as stakeholder engagement, technical proficiency, technology utilization, and resource availability, the study aimed to tackle constraints and optimize productivity. Moreover, the theory facilitated the evaluation of contractors' capacity to manage work schedules, engage stakeholders adeptly, and utilize available resources to attain project objectives. In summary, the Theory of Constraints furnished a valuable framework for comprehending and enhancing labour productivity in the construction sector.

3.3 Conceptual Framework

Independent variable
Dependent variable



Source: Researcher (2024)

Figure 1 : Conceptual framework showing the inter-relationship between the variables

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Safety technology encompasses various tools and systems designed to enhance workplace safety and mitigate risks in various industries. These technologies aim to protect workers from accidents, injuries, and occupational hazards by implementing preventive measures and providing real-time monitoring and alerts. Examples of safety technology include personal protective equipment (PPE) such as helmets, gloves, and goggles, as well as more advanced solutions like fall detection systems, gas detectors, and machine guarding systems. Additionally, wearable devices equipped with sensors can track vital signs and movement patterns, providing early warnings of potential dangers(Abaya et al., 2021). Safety technology also encompasses digital platforms and software applications for safety training, incident reporting, and emergency response coordination. By leveraging safety technology, organizations can create safer work environments, reduce workplace accidents, and safeguard the well-being of their employees.

Building Information Modeling (BIM) technology encompasses various dimensions and applications tailored to different stages and aspects of the construction process(Karatas & Budak, 2023). 3D BIM represents the physical and spatial aspects of a building, aiding stakeholders in visualizing design and layout effectively. 4D BIM adds the time dimension, facilitating visualization of construction sequences and schedules for improved planning and coordination. 5D BIM integrates cost data, enabling cost estimation and budget management throughout the construction lifecycle. 6D BIM expands to include facility management data, offering insights into ongoing operations and maintenance. 7D BIM incorporates sustainability metrics, allowing stakeholders to assess environmental performance over the building's lifecycle. Mobile BIM enables on-site personnel to access BIM data in real-time, enhancing communication and decision-making. Cloud-based BIM platforms facilitate collabouration and data sharing among project stakeholders from anywhere with an internet connection. Interoperable BIM solutions ensure seamless integration between different BIM software, enhancing collabouration and coordination across disciplines

4.1 RESEARCH METHODOLOGY

The overall strategy adopted to integrate the different components of the study in a coherent and logical way; it constitutes the blueprint for the collection, measurement, and analysis of data (Sacred Heart University, 2020). The study adopted a survey design that involved data collection, data analysis and determination of the relationship between the variables. This research used a descriptive survey design that incorporated both the qualitative and quantitative approaches to gather the research data. The research design gave the advantage of collecting information from a dispersed populations easily using questionnaires.

4.2 The Population

A simple random sampling was used to select a non-biased sample size of 261 respondent from the entire population of 2610. According to Mugenda and Mugenda (2013) a target population of 10-20% was useful when the population is high. The sample for the study consisted of 261 construction personnel from the area of study which took a 10% proportion of the target population(Mugenda & Mugenda, 2013). Therefore, the following respondents were targeted for the study, Quantity Surveyors (40), Architects (39), Engineers (43), Technicians (67), Artisans (42), and Contractors (30) giving a total of 261 respondents.

The study utilized semi-structured questionnaires as the primary instrument for data collection, targeting a large and geographically diverse sample. Questionnaires were chosen for their cost-effectiveness, ease of administration, and ability to generate a substantial amount of data efficiently, particularly when administered electronically to respondents across different locations. The questionnaires comprised close-ended questions, including Likert scale items and rating questions, to gather quantitative data on use of technology and labour productivity in the construction industry of Nairobi City County, Kenya. Additionally, an interview guide was employed to collect qualitative data from contractors, senior engineers, architects, and quantity surveyors. The semi-structured nature of the interviews allowed for flexibility and depth in data collection, with open-ended questions enabling the researcher to gather comprehensive insights. Face-to-face interviews further facilitated the observation of nonverbal cues, enriching the qualitative findings through triangulation with the questionnaire data.

5.1 RESULTS

5.1.1 Correlation Analysis of the Use of Technology and Labour Productivity in Construction industry in Kenya

Pearson's correlation analysis was used to determine the strength as well as direction of the correlation between independent variable (Use of Technology) and dependent variable (Labour Productivity in Construction industry in Kenya). The following are correlation analysis results, as shown in Table 1

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Table 1: Correlation Analysis of the Use of Technology and Labour Productivity in Construction industry in Kenya

Variable		Use of Technology	Labour Productivity in Construction industry in Kenya
Use of Technology	Pearson Correlation	1	0.386
	Sig. (2-tailed)		0.000
	N	230	230
Labour Productivity	Pearson Correlation	0.386	1
	Sig. (2-tailed)	0.000	
	N	230	230

Correlation is significant at 0.05 level (2 - tailed)

Correlation analysis results shows a significant as well as strong positive relationship between the Use of Technology and Labour Productivity in Construction industry in Kenya (r =0.386, p<0.000). Moreover, this simply means, the more technology is in use the better the Labour Productivity in Construction industry in Kenya. Again, the association is significant indicating that use of technology can be experienced positively in labour productivity in Construction industry in Kenya.

5.1.2 Model Summary of Use of Technology and Labour Productivity in the construction industry in Kenya
Model Summary Regression Analysis was run using SPSS Version 25 to examine the associations between independent variable (Use of Technology) and dependent variable (labour Productivity in Construction industry in Kenya) and results were presented in Table 2

Table 2: Model Summary of Use of Technology and Labour Productivity Construction industry on in Kenya

Model	R	R - Square	Adjusted R - Square	Standard Error of Estimate
1	0.386a	0.149	0.145	0.72987

a. Predictor: (Constant) Use of Technology
Analysis from Table 2 show that Use of Technology has a significant effect on Labour Productivity in Construction industry in Kenya as R^2=0.149 shows an increase in Use of Technology would lead to 14.9 percent influence in Labour Productivity in Construction industry in Kenya.

5.1.3 Regression ANOVA Analysis of Use of Technology and Labour Productivity Construction industry in Kenya
ANOVA regression analysis was used to examine the degree of association between independent variable (Labour Productivity in Construction in Kenya) and dependent variable (Use of Technology). Results were presented in Table 3

Table 3: ANOVA Analysis between Use of Technology and Labour Productivity in Construction industry in Kenya

Model		Sum of Squares	Df	Mean Squares	F	Sig.
1	Regression	21.302	1	21.302	39.989	0.000b
	Residuals	121.458	228	0.533		
	Total1	142.760	229			

a. Dependent Variable: Labour Productivity in Construction industry in Kenya

b. Predictors:(Constant); Use of Technology

ANOVA analysis from table 3 shows that p=0.000 is below 0.05 the alpha level, hence significant. As a result, we conclude that Use of Technology is important in Labour Productivity in Construction industry in Kenya.

5.1.4 Regression Coefficients of Use of Technology and Labour Productivity Construction industry in Kenya
Regression Coefficients analysis was deployed to evaluate the degree of association between Level of expertise and Construction industry in Kenya and results were presented in Table 4

Table 4: Regression Coefficients Analysis between Use of Technology and Labour Productivity in the Construction industry in Kenya

Model	**Unstandardized coefficient**		**standardized coefficient**	**t**	**Sig.**
	B	**Std. Err**	**Beta**		
1(Constant)	0.679	0.219		3.095	0.003
Use of Technology	0.785	0.061	0.844	12.957	0.000

Dependent1variable: Labour Productivity in Construction industry in Kenya

Predictors: (Constant) Use of Technology

Regression coefficients analysis results between Use of Technology and Labour Productivity in Construction industry in Kenya shows that p=0.003 is below 0.05 the alpha level hence significant. As a result, we concluded that Use of Technology has a significant impact on Labour Productivity in Construction industry in Kenya.

5.2 Conclusions

This study demonstrated that significant positive association between Use of Technology and Labour productivity in the construction industry in Kenya. Therefore, the researcher concluded that deployment of the technology will promote efficiency in Labour productivity in the construction industry in Kenya.

6.0 REFERENCE:

Abaya, P. M., Diang'A, S., & Gwaya, D. Q. A. (2021). Factors Affecting Occupational Safety and Health Compliance on Construction Sites in Kiambu County, Kenya. International Journal of Engineering Research & Technology, 10(8). https://doi.org/10.17577/IJERTV10IS080236

Abaya, P. M., & Ondieki, S. (2021). Influence of Training on Occupational Safety and Health Compliance for the Construction Projects in Embakasi South Nairobi City County. International Journal of Engineering Research & Technology, 10(2). https://doi.org/10.17577/IJERTV10IS020179

Adams, J., Castorena, C., & Kim, Y. (2019). Construction quality acceptance performance-related specifications for chip seals. Journal of Traffic and Transportation Engineering (English Edition), 6. https://doi.org/10.1016/j.jtte.2019.05.003

Alinaitwe, H. M., Mwakali, J. A., & Hansson, B. (2017). Factors affecting the productivity of building craftsmen - studies of Uganda. Journal of Civil Engineering and Management, 13(3), 169–176. https://doi.org/10.1080/13923730.2007.9636434

Amfo-Otu, R., & Agyemang, J. K. (2017). Occupational health hazards and safety practices among the informal sector auto mechanics. Applied Research Journal, 2(1).

Anastasopoulos, P. (2012). A study of factors affecting highway accident rates using the random-parameters Tobit model. Accident; Analysis and Prevention, 45, 628–633. https://doi.org/10.1016/j.aap.2011.09.015

Chen, H., Mao, Y., Xu, Y., & Wang, R. (2023). The Impact of Wearable Devices on the Construction Safety of Building Workers: A Systematic Review. Sustainability, 15, 11165. https://doi.org/10.3390/su151411165

Karatas, I., & Budak, A. (2023). Investigating the impact of lean-BIM synergy on labour productivity in the construction execution phase. Journal of Engineering Research, 11(4), 322–333. https://doi.org/10.1016/j.jer.2023.10.021

Mugenda, O. M., & Mugenda, A. G. (2013). Research Methods, Quantitative and Qualitative Approaches. ACT.

Mugisha, J., Uwayezu, E., Babere, N. J., & Kombe, W. J. (2024). Enabling planned urban settlements through land readjustment—A case study from Kigali, Rwanda. Habitat International, 145, 103025. https://doi.org/10.1016/j.habitatint.2024.103025

Wang, S., Chen, M., Li, M., Liu, Y., & Ye, X. (2021). Research on the Presentation Methods of MOOCs' Teaching Video Based on the Qualitative Research Approached: A Case Study of 322 National-Level Quality MOOCs. Open Journal of Social Sciences, 09(10), 368–379. https://doi.org/10.4236/jss.2021.910026

Zhang, L., Li, G., Nan, L., & Liu, S. (2023). Technologies for Asphalt Pavement Surface Testing in Road and Bridge Construction. Journal of Architectural Research and Development, 7, 1–5. https://doi.org/10.26689/jard.v7i2.4724

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7.0 BIBLIOGRAPHIES

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Books/Journals: 1

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