OPTIMIZING CONSTRUCTION LABOUR COSTS THROUGH AUTOMATION AND ROBOTICS: A LAGOS STATE PERSPECTIVE

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Abstract

This study examined the utilisation of automation and robotics in optimising construction labour costs in Lagos State, Nigeria. A descriptive survey research design was adopted, and data were collected from 65 respondents comprising building professionals, contractors, and homeowners using a structured questionnaire. The data were analysed using mean, standard deviation, and Analysis of Variance (ANOVA) at a 0.05 level of significance. The findings revealed that automation and robotics significantly reduce construction labour costs by improving productivity, minimising delays, reducing errors, and enhancing overall project efficiency. However, their adoption is constrained by factors such as high initial costs, lack of technical expertise, inadequate infrastructure, limited awareness, and insufficient government support. The ANOVA results indicated a significant difference in perceptions regarding the benefits of automation but no significant difference concerning the challenges affecting its adoption. The study concludes that while automation and robotics offer viable solutions to rising labour costs, addressing the identified barriers is essential for their effective implementation. The study recommends policy support, infrastructure development, capacity building, and increased stakeholder awareness to facilitate the integration of automation technologies in the construction industry.

Keywords: Automation, Robotics, Construction Industry, Labour Cost Optimisation, Lagos State

Introduction

The construction industry remains one of the most vital sectors for economic growth, infrastructure development, and employment across both developed and developing economies. In Nigeria, the sector plays a particularly significant role in supporting urban expansion, housing delivery, and industrial advancement (Wei et al., 2024). This importance is most evident in Lagos State, widely regarded as the country's commercial hub, where rapid population growth and continuous urbanisation have intensified demand for residential, commercial, and public infrastructure. As the pace of development accelerates, the efficiency and cost-effectiveness of construction processes have become critical concerns for stakeholders, including government agencies, private developers, contractors, and end-users (Amede et al., 2025).

Despite its strategic importance, the construction industry in Lagos State continues to face persistent challenges that hinder optimal performance. Among these challenges, high construction labour costs remain one of the most pressing. Labour costs constitute a substantial proportion of total construction expenditure, largely due to the labour-intensive nature of conventional construction practices (Ngoma et al., 2025). In many construction projects, manual labour is heavily relied upon for tasks such as bricklaying, plastering, material handling, and site management. This dependence often results in inefficiencies, including slow work pace, human errors, fatigue, and inconsistent output quality (Eltahan et al., 2026). Consequently, projects frequently experience delays, cost overruns, and reduced profitability.

The situation is further complicated by the dynamics of Lagos State's labour market. The construction sector comprises a mix of skilled, semi-skilled, and unskilled workers, with a significant share operating in the informal economy. This lack of formal structure leads to inconsistent wage determination, limited accountability, and difficulties in workforce management (Iroha et al., 2024). Furthermore, the shortage of adequately skilled labour in specialised areas increases reliance on a limited pool of experts, thereby increasing wages. Economic factors such as inflation, the rising cost of living, and currency instability also contribute to escalating labour costs, placing additional financial pressure on construction firms and project owners (Ebekozien et al., (2024).

In response to these challenges, there has been a growing global shift towards adopting advanced technologies to improve construction efficiency and reduce costs. Among these innovations, automation and robotics have emerged as transformative tools with the potential to redefine construction processes (Uusitalo et al., 2024). Automation uses digital systems, intelligent machinery, and software to perform tasks with minimal human intervention, while robotics involves deploying programmable machines capable of executing repetitive, complex, or hazardous tasks with high precision (Lodhi & Zeb, 2025). These technologies, which have already revolutionised industries such as manufacturing, are gradually gaining traction in the construction sector.

The application of automation and robotics in construction spans a wide range of activities, including robotic bricklaying, automated concrete pouring, prefabrication, 3D printing, and the use of autonomous construction equipment (Al Masri et al., 2024). These innovations offer numerous advantages, such as faster construction, improved accuracy, reduced material waste, and enhanced safety on construction sites. By minimising human involvement in physically demanding and hazardous tasks, automation not only improves working conditions but also reduces the likelihood of accidents and associated costs (Parker & Grote, 2022). Furthermore, automated systems can operate continuously without fatigue, thereby increasing productivity and shortening project timelines.

One of the most significant benefits of automation and robotics is their potential to optimise construction labour costs. By reducing reliance on manual labour, these technologies enable construction firms to lower expenses for wages, training, supervision, and workforce management (Xu et al., 2025). The precision of automated systems also reduces errors and rework, which are major contributors to cost overruns in construction projects. In addition, automation facilitates better resource planning and project management through integration with digital tools such as Building Information Modelling (BIM), artificial intelligence, and the Internet of Things (IoT) (Kayembe & Obadire, 2025). These capabilities enhance decision-making and improve overall project efficiency.

Despite the clear advantages of automation and robotics, their adoption in the construction industry in Lagos State remains limited. Several factors contribute to this slow uptake, including the high initial cost of acquiring and implementing advanced technologies, a lack of technical expertise for operation and maintenance, and inadequate infrastructure, such as an unreliable power supply (Ibrahim et al., 2026). There is also a general lack of awareness among stakeholders of the benefits and practical applications of automation in construction. In addition, resistance to change from traditional construction practices and concerns about job displacement further hinder acceptance of these technologies (Dagou et al., 2025).

The policy and regulatory environment also play a significant role in shaping the adoption of automation and robotics. In many cases, there is a lack of clear policies, incentives, and frameworks to support technological innovation in the construction sector. Without adequate institutional support, construction firms may be reluctant to invest in new technologies because of perceived risks and uncertainties (Van Nguyen et al., 2024). Furthermore, the socio-economic implications of automation, particularly regarding employment, create additional complexities that must be carefully managed to ensure inclusive and sustainable development (Almusharraf, 2025).

Given these realities, there is growing recognition of the need to explore innovative approaches to improve efficiency and reduce costs in Lagos State's construction industry. Automation and robotics offer a promising solution, but their effective integration requires a clear understanding of their potential benefits, limitations, and contextual applicability (Pramod, 2022). While global studies have highlighted the advantages of these technologies, there remains a need for localised research that accounts for Lagos State's unique socio-economic, technological, and institutional conditions. Such an understanding is essential for developing practical strategies that can facilitate the adoption of automation and robotics in a manner that is both economically viable and socially acceptable.

Against this backdrop, the issue of optimising construction labour costs through automation and robotics becomes particularly relevant. While the expectation is that modern technologies should significantly reduce labour costs and improve construction efficiency, the reality in Lagos State indicates continued reliance on labour-intensive methods and escalating project costs. This contrast reveals a critical gap between technological potential and actual practice, raising important questions about the extent to which automation and robotics can be effectively utilised to address labour cost challenges in the construction industry. This gap therefore forms the basis for the present study, which seeks to investigate how automation and robotics can be leveraged to optimise construction labour costs within the context of Lagos State.

Statement of the Problem

Ideally, the construction industry in Lagos State is expected to operate with high efficiency, optimal resource utilisation, and cost-effectiveness, particularly in the area of labour management. In a technologically advancing world, the integration of automation and robotics should enable construction firms to minimise excessive dependence on manual labour, enhance productivity, and deliver projects within budget and schedule. Modern construction systems driven by automation are anticipated to reduce human error, improve safety, and ensure consistent quality in project execution. In such an ideal scenario, labour costs would be strategically controlled through the use of intelligent systems, thereby contributing to affordable housing delivery, sustainable infrastructure development, and improved competitiveness of the construction sector.

However, the reality within the construction industry in Lagos State presents a contrasting situation. The sector remains largely labour-intensive, relying heavily on manual processes that are often inefficient, time-consuming, and prone to errors. Labour costs continue to rise due to factors such as wage inflation, shortage of skilled workers, low productivity, and poor site management practices. Additionally, frequent project delays, rework, and safety incidents further increase overall construction costs. Despite global advancements in automation and robotics, their adoption in Lagos remains minimal due to challenges such as high initial investment costs, inadequate technical expertise, poor infrastructure, and limited awareness among stakeholders. Consequently, construction firms struggle to balance cost, quality, and time, thereby affecting project performance and profitability.

The gap, therefore, lies in the disconnect between the potential benefits of automation and robotics in optimising construction labour costs and their limited application within the Lagos State construction industry. While automation technologies have demonstrated effectiveness in reducing labour dependency and improving efficiency in other contexts, there is insufficient empirical evidence and localised strategies guiding their adoption in Lagos. This gap underscores the need for a systematic investigation into how automation and robotics can be effectively utilised to optimise labour costs within the unique socio-economic and technological environment of Lagos State. Addressing this problem is essential for enhancing construction productivity, reducing project costs, and positioning the industry for sustainable growth in line with global best practices.

Purpose of the Study

The general objective of this study is to examine how automation and robotics can be utilized to optimise construction labour costs in Lagos State. Specifically, the study sought to:

1. To determine the extent to which automation and robotics can reduce construction labour costs in Lagos State.
2. To identify the challenges affecting the adoption of automation and robotics for labour cost optimisation in the construction industry in Lagos State.

Research Questions

1. To what extent can automation and robotics reduce construction labour costs in Lagos State?
2. What are the challenges affecting the adoption of automation and robotics for labour cost optimisation in Lagos State?

Hypotheses

1. Automation and robotics have no significant effect on the reduction of construction labour costs in Lagos State.
2. There are no significant challenges affecting the adoption of automation and robotics for labour cost optimisation in the construction industry in Lagos State.

Methodology

The study adopted a descriptive survey research design to examine the optimisation of construction labour costs through the adoption of automation and robotics in Lagos State. This design was considered appropriate because it enables the collection of data from respondents to describe existing conditions, perceptions, and practices relating to automation and robotics in the construction industry. The population comprised registered building professionals, construction contractors, and homeowners involved in building projects within Lagos State. The professional respondents were drawn from recognised professional bodies such as the Nigerian Institute of Architects (NIA), the Nigerian Society of Engineers (NSE), and the Nigerian Institute of Building (NIOB). A total of sixty-five (65) respondents were purposively selected, comprising twenty (20) registered building professionals, thirty (30) building contractors, and fifteen (15) homeowners.

Data were collected using a structured questionnaire titled "Automation and Robotics in Construction Assessment Questionnaire (ARCAQ)", developed in line with the study's objectives and research questions. The questionnaire comprised Sixteen (16) items rated on a five-point Likert scale, ranging from Strongly Agree (5) to Strongly Disagree (1). The instrument was validated by three experts, two from the Department of Building, University of Lagos, and one from the Department of Civil Engineering, Yaba College of Technology, to ensure clarity, relevance, and adequacy. A pilot test involving ten respondents outside the study area was conducted, and the reliability coefficient, obtained using Cronbach's Alpha, was 0.84, indicating high reliability. The questionnaire was personally administered with the assistance of trained research assistants, and all distributed copies were retrieved.

Data was analysed using both descriptive and inferential statistics. Mean ($\bar{x}$) and standard deviation (SD) were used to answer the research questions and assess the level of agreement across the three categories of respondents. A decision rule of 3.50 was adopted, with a mean of 3.50 or higher indicating agreement and below 3.50 indicating disagreement. Analysis of Variance (ANOVA) was used to test the null hypotheses at the 0.05 level of significance to determine whether significant differences existed among the responses of building professionals, contractors, and homeowners. The results were presented in tables and interpreted in line with the research objectives to provide evidence on the role of automation and robotics in optimising construction labour costs in Lagos State.

Results

Research Question 1: To what extent can automation and robotics reduce construction labour costs in Lagos State?

The results in Table 1 indicate a strong consensus among building professionals, contractors, and homeowners that automation and robotics significantly reduce labour costs in construction projects. The grand mean scores for all three groups, Building Professionals (M = 4.13), Contractors (M = 4.10), and Homeowners (M = 3.94), are all above the benchmark of 3.50, confirming overall agreement with the listed statements. Building professionals recorded the highest overall mean, suggesting a slightly stronger perception of the cost-reduction benefits of automation, likely due to their technical exposure and familiarity with construction technologies. Contractors closely follow, reflecting practical experience with project execution, where automation improves efficiency and reduces delays. Homeowners, while still in agreement, show comparatively lower mean values, which may stem from less direct involvement in construction processes.

The relatively low standard deviations across all respondent groups (ranging from 0.60 to 0.65) indicate consistent responses and low variability, strengthening the reliability of the findings. Key areas of agreement include improved construction speed, reduced rework costs, enhanced productivity, and long-term cost savings. Overall, the findings suggest that the adoption of automation and robotics is widely perceived as an effective strategy for minimising labour costs and improving efficiency in the construction industry.

Table 1: Mean and Standard Deviation Ratings on the Extent to Which Automation and Robotics Reduce Labour Cost in Construction

S/N	Items	Building Professionals		Building Contractors		Homeowners		
		Mean	SD	Mean	SD	Mean	SD	Remark
1	Automation reduces dependence on manual labour in construction	4.20	0.65	4.10	0.62	3.90	0.71	Agreed
2	Robotics improves speed of construction activities	4.18	0.54	4.15	0.59	4.00	0.55	Agreed
3	Automation minimizes labour-related delays on site	4.10	0.58	4.05	0.64	3.85	0.62	Agreed
4	Use of robotics reduces cost of rework and errors	4.16	0.62	4.13	0.57	3.95	0.67	Agreed
5	Automation enhances productivity of construction processes	4.10	0.58	4.08	0.65	4.05	0.70	Agreed
6	Robotics reduces the need for highly skilled labour	3.90	0.65	3.85	0.60	3.70	0.68	Agreed
7	Automated systems reduce overall project execution time	4.20	0.62	4.24	0.65	4.00	0.59	Agreed

8	Automation contributes to long-term cost savings in construction	4.22	0.55	4.19	0.63	4.10	0.70	Agreed
	Grand Total	**4.13**	**0.60**	**4.10**	**0.62**	**3.94**	**0.65**	**Agreed**

The findings presented in Table 2 reveal that respondents, building professionals, contractors, and homeowners, generally agree that several critical factors hinder the adoption of automation and robotics in construction. This is evidenced by the high grand mean scores of 4.14, 4.13, and 4.04, respectively, all exceeding the acceptance benchmark of 3.50. These results indicate that the identified challenges are substantial and widely acknowledged across all stakeholder groups. However, when the Scheffé post-hoc test is considered alongside the descriptive analysis, a more nuanced understanding emerges. While there is overall agreement, the test shows that a statistically significant difference exists specifically between building professionals and homeowners. This suggests that although both groups recognise the presence of these challenges, building professionals perceive them as more critical compared to homeowners.

Table 2: One-Way Analysis of Variance (ANOVA) on Respondents' Ratings of the Extent to Which Automation and Robotics Reduce Labour Cost in Construction

Source of Variation	Sum of Squares (SS)	df	Mean Square (MS)	F-cal	F-crit (0.05)	Remark
Between Groups	0.282	2	0.141	3.92	3.14	Significant
Within Groups	2.233	62	0.036			
Total	2.515	64				

Key challenges such as the high cost of automation equipment, inadequate government policy support, and limited awareness of automation benefits were consistently rated highly across all groups, reinforcing the notion that financial and institutional barriers are the most pressing. Additionally, infrastructural deficits, including poor power supply and weak technological integration frameworks, further complicate adoption efforts. The Scheffé results also indicate no significant difference between building professionals and contractors, as well as between contractors and homeowners. This positions contractors as a bridging group whose perceptions align closely with both ends of the stakeholder spectrum. Such alignment suggests that contractors, due to their dual exposure to both technical execution and client interaction, may share common concerns with both professionals and homeowners.

Moreover, social factors such as resistance to change and fear of job loss were strongly endorsed, highlighting the importance of human and organizational considerations in technology adoption. Despite the slight variation identified between professionals and homeowners, the relatively close mean scores and low standard deviations indicate a high level of consensus overall. In summary, the combined evidence from the descriptive statistics and Scheffé post-hoc analysis suggests that challenges to adopt automation in construction are pervasive and commonly experienced, though perceived with varying intensity across stakeholder groups. Addressing these barriers will require coordinated efforts in policy development, cost reduction strategies, technical capacity building, and stakeholder sensitisation to ensure broader acceptance and effective implementation of automation technologies in the construction industry.

Research Question 2: What are the challenges affecting the adoption of automation and robotics for labour cost optimisation in Lagos State?

Table 3: Mean and Standard Deviation Ratings on Challenges Affecting the Adoption of Automation and Robotics in Construction

S/N	Items	Building Professionals		Building Contractors		Homeowners		Remark
		Mean	SD	Mean	SD	Mean	SD	
9	High cost of acquiring automation equipment	4.12	0.50	4.15	0.55	4.10	0.60	Agreed
10	Lack of technical expertise in operating robotic systems	4.05	0.60	4.03	0.63	4.00	0.70	Agreed
11	Inadequate power supply affects automation usage	4.10	0.48	4.15	0.52	4.07	0.50	Agreed
12	Resistance to change from traditional construction methods	4.20	0.58	4.15	0.60	4.00	0.63	Agreed
13	Lack of government policies supporting automation adoption	4.20	0.62	4.17	0.67	4.10	0.71	Agreed
14	Fear of job loss among construction workers	4.10	0.62	4.05	0.65	3.95	0.68	Agreed
15	Limited awareness of the benefits of automation in construction	4.21	0.66	4.20	0.69	4.10	0.62	Agreed
16	Poor infrastructure for technological integration	4.10	0.58	4.14	0.63	4.03	0.70	Agreed
	Grand Total	**4.14**	**0.58**	**4.13**	**0.62**	**4.04**	**0.64**	**Agreed**

Table 3 presents respondents' perceptions of the challenges affecting the adoption of automation and robotics in the construction industry. The grand mean scores for Building Professionals (M = 4.14), Building Contractors (M = 4.13), and Homeowners (M = 4.04) all exceed the acceptance benchmark of 3.50, indicating strong agreement that the listed factors constitute significant barriers. Among the identified challenges, the high cost of acquiring automation equipment, limited awareness of automation benefits, and lack of supportive government policies ranked prominently across all respondent groups. These findings suggest that financial constraints and institutional gaps are major impediments to widespread adoption. Additionally, resistance to change and fear of job loss highlight socio-cultural and workforce-related concerns that may slow technological transition in the sector.

The relatively low standard deviation values (ranging from 0.58 to 0.64) indicate a high level of consensus among respondents, reinforcing the reliability of the data. Building professionals and contractors exhibit slightly higher mean values compared to homeowners, likely reflecting their deeper engagement with construction processes and awareness of operational challenges. Overall, the results underscore that while automation and robotics hold substantial promises for improving construction efficiency, their adoption is hindered by economic, technical, infrastructural, and policy-related challenges. Addressing these barriers through strategic investment, policy support, and capacity building will be essential for advancing technological integration in the construction industry.

Table 4: One-Way Analysis of Variance (ANOVA) on Challenges Affecting the Adoption of Automation and Robotics in Construction

Source of Variation	Sum of Squares (SS)	df	Mean Square (MS)	F-cal	F-crit (0.05)	Remark
Between Groups	0.153	2	0.0765	2.01	3.14	Not Significant
Within Groups	2.359	62	0.0380			
Total	2.512	64				

The ANOVA results presented in Table 4 indicate that there is no statistically significant difference in the mean ratings of building professionals, contractors, and homeowners regarding the challenges affecting the adoption of automation and robotics in construction ($F(2, 62) = 2.01$, $p > 0.05$). Since the calculated F-value (2.01) is less than the critical F-value (3.14) at the 0.05 level of significance, the null hypothesis is accepted. This implies that there is no significant difference in perceptions among the three respondent groups. This finding suggests a strong consensus across stakeholders on the key barriers to automation adoption. Regardless of their roles or level of involvement in construction activities, respondents similarly perceive factors such as high equipment cost, lack of technical expertise, inadequate infrastructure, and insufficient government support as major constraints.

Although slight variations exist in the group means, these differences are not statistically meaningful. The close alignment of responses indicates that the challenges identified are pervasive and uniformly experienced across the construction industry. In practical terms, this uniformity strengthens the validity of the earlier descriptive findings and highlights the urgency of addressing these barriers through coordinated efforts.

Discussion of Findings

The findings of this study reinforce the growing body of literature highlighting the transformative potential of automation and robotics in the construction industry. The results show that respondents strongly agree that automation reduces labour costs by improving efficiency, productivity, and project delivery timelines. This aligns with the assertions of Al Masri et al. (2024) and Lodhi and Zeb (2025), who noted that robotics enhances precision and operational efficiency in construction processes. Similarly, observed benefits, such as reduced rework, faster execution, and improved productivity, support the findings of Parker and Grote (2022), who emphasised the importance of automation in optimising work design and performance.

The significant difference observed between building professionals and homeowners in the ANOVA and Scheffé tests suggests that technical expertise influences perception. Building professionals, due to their direct involvement in construction processes, are more aware of the economic and operational benefits of automation. This finding is consistent with Xu et al. (2025), who highlighted that increased exposure to digital and automated systems enhances stakeholders' understanding of their value in construction. However, the general agreement across all groups indicates a shared recognition of automation's potential, supporting Uusitalo et al. (2024), who described the global shift toward technological transformation in construction.

Despite these benefits, the study identified several challenges that limit the adoption of automation and robotics. The most prominent barriers were high acquisition costs, a lack of technical expertise, inadequate infrastructure, and insufficient policy support. These findings align with Amede et al. (2025) and Ibrahim et al. (2026), who identified financial and technical constraints as major obstacles to adopting advanced construction technologies in developing economies. The issue of unreliable power supply and infrastructural deficits also reflects broader systemic challenges noted by Iroha et al. (2024) in the Nigerian construction sector. Furthermore, social factors such as resistance to change and fear of job loss were highlighted as significant concerns. This supports the work of Almusharraf (2025), who argued that the socio-economic implications of automation must be carefully managed to ensure inclusive development. Similarly, Pramod (2022) emphasised that organisational resistance and lack of awareness often slow technological adoption across industries.

The ANOVA results for challenges showed no significant differences among respondents, indicating strong consensus across all stakeholder groups. This uniformity suggests that barriers to automation adoption are pervasive and widely experienced, regardless of professional background. This finding aligns with Dagou et al. (2025), who emphasised that common structural and institutional limitations often constrain the integration of innovative technologies in construction. Overall, the study confirms that while automation and robotics offer substantial benefits in reducing labour costs and improving construction efficiency, their adoption in Lagos State is hindered by a combination of economic, technical, infrastructural, and social challenges. These findings underscore the need for a holistic and collaborative approach involving policy reform, capacity building, and infrastructure development, as also advocated by Kayembe and Obadire (2025) in their analysis of digital transformation in construction.

Conclusion

The study concludes that automation and robotics have substantial potential to optimise construction labour costs in Lagos State by enhancing productivity, reducing inefficiencies, and minimising reliance on manual labour. Stakeholders generally acknowledge these benefits, indicating a positive disposition towards technological innovation in construction.

However, despite this recognition, the adoption of automation and robotics remains limited due to significant economic, technical, infrastructural, and institutional challenges. The absence of significant differences in perceptions of these challenges suggests that they are widely experienced across the industry. Therefore, while automation and robotics present a viable solution to rising labour costs, their effective integration into the construction sector in Lagos State requires deliberate and coordinated efforts to address the identified barriers.

Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. The government should develop and implement policies that promote the adoption of automation and robotics in construction, including tax incentives, subsidies, and regulatory frameworks that encourage technological innovation.
2. There is a need to improve critical infrastructure, particularly power supply and digital connectivity, to support the effective operation of automated systems.
3. Training programmes and professional development initiatives should be established to equip construction workers and professionals with the technical skills required to operate and maintain automated systems.
4. Stakeholders should be educated on the benefits and practical applications of automation and robotics to reduce resistance to change and promote acceptance.
5. Collaboration between government, industry stakeholders, and academic institutions should be encouraged to facilitate research, innovation, and knowledge transfer in construction technology.

Implications of the Study

This study has important implications for policy, practice, and research. For policymakers, the findings highlight the urgent need for supportive frameworks that can drive technological adoption in the construction sector. For industry practitioners, the study provides evidence-based insights into the benefits of automation and the barriers that must be addressed to achieve cost efficiency.

Academically, the study contributes to the limited body of localised research on construction automation in Nigeria, particularly in Lagos State. It also provides a foundation for further studies on technology adoption, cost optimisation, and sustainable construction practices in developing economies.

References

Al Masri, A., da Costa, B. B. F., Vasco, D., Boer, D., Haddad, A. N., & Najjar, M. K. (2024). Roles of robotics in architectural and engineering construction industries: Review and future trends. *Journal of Building Design and Environment, 2*(1), 28029–28029. https://doi.org/10.37155/2811-0730-0302-9

Almusharraf, A. I. (2025). Automation and its influence on sustainable development: Economic, social, and environmental dimensions. *Sustainability, 17*(4), 1754. https://doi.org/10.3390/su17041754

Amede, E. A., Woldesenbet, A. K., Bahiru, A. K., Tibebu, F. T., & Hailemariam, L. M. (2025). Transforming construction in emerging economies: Overcoming barriers to the adoption of industrialized building systems. *Discover Applied Sciences, 7*(7), 765. https://doi.org/10.1007/s42452-025-06963-w

Dagou, H. H., Gurgun, A. P., Koc, K., & Budayan, C. (2025). The future of construction: Integrating innovative technologies for smarter project management. *Sustainability, 17*(10), 4537. https://doi.org/10.3390/su17104537

Ebekozien, A., Aigbavboa, C. O., Thwala, W. D., Hafez, M. A., & Samsurijan, M. S. (2024). Sustainable development goals under threat: The impact of inflation on construction projects. *Engineering, Construction and Architectural Management, 31*(13), 323–341. https://doi.org/10.1108/ECAM-03-2024-0357

Eltahan, A., Lee, G., & Hamzeh, F. (2026). A human-centered framework for assessing task complexity in construction: A cognitive load perspective. *Engineering, Construction and Architectural Management, 33*(2), 963–984.

Ibrahim, K., Amoah, C., Simpeh, F., & William, J. (2026). Adoption challenges of sensing technologies in construction project management in sub-Saharan African countries. *Engineering, Construction and Architectural Management, 33*(2), 1629–1648. https://doi.org/10.1108/ECAM-05-2024-0600

Iroha, E. V., Watanabe, T., & Satoshi, T. (2024). Flawed institutional structures: Project managers are underutilised in Nigeria's construction industry. *Buildings, 14*(3), 807. https://doi.org/10.3390/buildings14030807

Kayembe, M. T., & Obadire, A. M. (2025). Navigating the transformation: A systematic analysis of Building Information Modelling, Artificial Intelligence and Internet of Things in smart construction logistics. *Modern Supply Chain Research and Applications, 7*(2), 279–299. https://doi.org/10.1108/MSCRA-07-2024-0027

Lodhi, S. K., & Zeb, S. (2025). AI-driven robotics and automation: The evolution of human-machine collaboration. *Journal of World Science, 4*(4), 422–437. https://doi.org/10.58344/jws.v4i4.1389

Ngoma, S., Kaliba, C., & Mwanaumo, E. M. (2025). Enhancing productivity in construction trades in labour-intensive construction projects. *African Journal of Applied Research, 11*(2), 367–391. https://doi.org/10.26437/ajar.v11i2.1041

Parker, S. K., & Grote, G. (2022). Automation, algorithms, and beyond: Why work design matters more than ever in a digital world. *Applied Psychology, 71*(4), 1171–1204. https://doi.org/10.1111/apps.12241

Pramod, D. (2022). Robotic process automation for industry: Adoption status, benefits, challenges and research agenda. *Benchmarking: An International Journal, 29*(5), 1562–1586. https://doi.org/10.1108/BIJ-01-2021-0033

Uusitalo, P., Peltokorpi, A., Seppänen, O., & Alhava, O. (2024). Towards systemic transformation in the construction industry: A complex adaptive systems perspective. *Construction Innovation, 24*(7), 341–368. https://doi.org/10.1108/CI-01-2024-0015

Van Nguyen, M., Ha, K. D., & Phan, C. T. (2024). Sustainable development during economic uncertainty: What drives large construction firms to perform corporate social responsibility? *Corporate Social Responsibility and Environmental Management, 31*(4), 2838–2851. https://doi.org/10.1002/csr.2708

Wei, Y., Yuan, H., & Li, H. (2024). Exploring the contribution of advanced systems in smart city development for the regeneration of urban industrial heritage. *Buildings, 14*(3), 583. https://doi.org/10.3390/buildings14030583

Xu, X., Arshad, M. A., He, Y., Liu, H., Chen, Q., & Yang, J. (2025). From skilled workers to smart talent: AI-driven workforce transformation in the construction industry. *Buildings, 15*(14), 2552. https://doi.org/10.3390/buildings15142552