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About the Journal

The **Journal of the Association of Professional Women Builders of Nigeria (APWBN)** is a peer-reviewed, open-access forum for new, original research in building construction and management. We publish rigorous work that advances best practice across the Project and asset lifecycle, while drawing attention to **gender-related issues in the construction sector**. The journal encourages multidisciplinary collaboration across engineering, architecture, planning, management, economics and the social sciences.

The Scope of the **Journal of Association of Professional Women Builders of Nigeria** is to expand the knowledge base of professionals and academics by disseminating high-quality studies on: Building-materials science & innovation, Construction technology, methods & digital tools, Project, contract & supply-chain management, Built-environment design, planning & policy, Gender equity and inclusion in practice, education and leadership. We welcome multidisciplinary collaboration across engineering, architecture, planning, and the social sciences. Our readership includes researchers, academics, postgraduate students, professional bodies, and industry practitioners.

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EDITORIAL

Advancing Sustainability, Gender Inclusion, Digital Innovation and Workforce Productivity in the Nigerian Construction Industry

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Editorial

The Nigerian construction industry is undergoing significant transformation as it confronts emerging challenges related to environmental sustainability, technological advancement, workforce inclusion, and labour productivity. These challenges are occurring within a rapidly changing global environment where construction organisations are expected to deliver infrastructure that is environmentally responsible, socially inclusive, technologically enabled, and economically efficient.

This first issue of the *Journal of the Association of Professional Women Builders of Nigeria* presents four papers that collectively address critical dimensions of contemporary construction practice. The papers explore regenerative construction, gender inclusion, Internet of Things (IoT) adoption, and labour relations within the Nigerian construction industry. Together, the papers demonstrate that the future of construction depends not only on technical excellence but also on sustainable practices, inclusive participation, digital readiness, and effective workforce management.

Discussion of the Papers

Windapo, Chinasamy and Alade examine the concept of regenerative construction and its potential to transform the building industry beyond conventional sustainability approaches. Their review of eighteen peer-reviewed studies demonstrates that regenerative construction seeks to achieve net-positive environmental and social outcomes rather than merely reducing negative impacts. The study highlights the economic, environmental, social, and technological benefits of regenerative construction, including enhanced asset value, reduced operational costs, ecological restoration, improved occupant well-being, and innovation enabled by digital technologies and circular economy principles. The authors also identify important barriers to implementation, such as fragmented supply chains, regulatory uncertainty, and limited professional capacity. The paper proposes a Regenerative Construction Implementation Framework that provides practical guidance for integrating regenerative principles throughout the building life cycle. The study contributes to ongoing discussions regarding sustainable development and offers valuable insights for professionals seeking to align construction activities with global environmental objectives.

Agubata, Ebenehi, Mohammed, Yarima and Balteh investigate the challenges faced by female professionals in the building industry in Bauchi State, Nigeria. Their findings reveal that women encounter significant barriers, including limited access to leadership positions, discrimination in recruitment and promotion, wage disparities, exclusion from major projects, and difficulties balancing professional and family responsibilities. The study further demonstrates how socio-cultural norms and gender stereotypes influence women's participation and career progression

within the construction industry. Importantly, the authors identify several interventions that can improve female representation, including mentorship programmes, leadership development initiatives, networking opportunities, scholarships, and gender-inclusive organisational policies. The findings reinforce the mission of the Association of Professional Women Builders of Nigeria by providing empirical evidence to support advocacy efforts aimed at advancing gender equity and professional advancement in the built environment.

Alao, Asunogie and Ifabiyi focus on the growing importance of digital transformation in construction by investigating factors influencing the implementation of the Internet of Things (IoT) on Nigerian construction sites. As construction projects become increasingly data-driven, IoT technologies offer opportunities to improve site monitoring, productivity, resource management, and decision-making processes. Using Structural Equation Modelling (SEM), the authors identify four key factors influencing successful IoT implementation: technology, security, organisational readiness, and environmental considerations. The study demonstrates the interconnected nature of these factors and provides a useful framework for understanding the conditions necessary for effective technology adoption. The findings contribute to the body of knowledge on digital construction and highlight the need for organisations to strengthen their technological capabilities to remain competitive in an increasingly digital construction environment.

Omale, Inuwa, Bustani and Ebenehi examine the relationship between labour relations and construction craftsmen productivity in Abuja, Nigeria. Their study addresses a longstanding concern within the Nigerian construction industry: the impact of labour exploitation and poor workplace relations on project performance. The findings show that positive employer-craftsmen relationships significantly influence productivity levels. Factors such as adherence to statutory work breaks, commitment to duties, mutual respect, access to benefits, job security, adequate tools and equipment, and effective communication were found to contribute positively to productivity. The study establishes a significant relationship between labour relations and craftsmen productivity, demonstrating that improvements in workplace conditions can lead directly to better project outcomes. The paper provides recommendations for contractors, employers, and policymakers seeking to improve productivity through enhanced workforce management practices.

Conclusion

The papers presented in this issue collectively demonstrate that sustainable development of the construction industry requires a balanced focus on environmental stewardship, social inclusion, technological innovation, and workforce well-being. Regenerative construction provides methods for achieving net-positive environmental outcomes. Gender inclusion is essential for expanding the industry's talent pool and promoting diversity in leadership and decision-making. Digital technologies such as the Internet of Things offer opportunities to enhance productivity and efficiency, while positive labour relations serve as a foundation for successful project delivery.
A central theme emerging from these studies is that meaningful industry transformation requires collaboration among practitioners, professional associations, policymakers, educational institutions, and researchers. Addressing environmental challenges, closing gender gaps,

accelerating digital adoption, and improving labour productivity are not isolated objectives but interconnected priorities that will shape the future of the Nigerian construction industry.

We thank the authors for their valuable contributions to this issue. We also acknowledge the reviewers and members of the editorial board whose dedication has ensured the quality of the published papers. We encourage readers to engage critically with the findings and continue advancing knowledge and practice in sustainability, gender inclusion, digital transformation, and workforce development within the built environment.

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Omale, P. A., Inuwa, I. I., Bustani, S. A., & Ebenehi, I. Y. (2026). *Labour Relations and Construction Craftsmen Productivity in Abuja, Nigeria.*

Windapo, A., Chinasamy, D., & Alade, K. (2026). *Promoting Regenerative Construction in the Building Industry.*

ARTICLES

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PROMOTING REGENERATIVE CONSTRUCTION IN THE BUILDING INDUSTRY

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ABSTRACT

The construction industry is a major contributor to resource extraction, greenhouse gas emissions, waste generation and ecosystem degradation. Scholars argue that conventional sustainability and green building approaches are insufficient because they focus on reducing negative impacts rather than creating net-positive environmental and social outcomes. This paper reviews 18 peer-reviewed publications on regenerative construction, published between 2020 and 2025, drawing mainly on indexed journal repositories, including ScienceDirect/Elsevier, Emerald Insight, and Taylor & Francis Online. The review synthesises evidence on the economic, social, environmental and technological benefits of regenerative construction, while also identifying limitations that hinder implementation in contemporary construction practice using a systematic narrative literature review. The findings show that regenerative construction can improve whole-life asset value, reduce operational and material costs, create new circular-economy markets, enhance occupant health and social inclusion, restore ecological systems, reduce embodied carbon and stimulate innovation through digital technologies, bio-based materials, material passports, building information modelling and life-cycle assessment tools. However, the adoption of regenerative construction practices is constrained by high initial costs, fragmented supply chains, immature markets for reused and regenerative materials, limited professional capacity, the absence of standardised indicators/metrics, weak procurement incentives, regulatory uncertainty, and insufficient post-occupancy evidence. The paper proposes a Regenerative Construction Implementation Framework structured around seven stages: place-based assessment, regenerative briefing, integrated design, circular and bio-based procurement, regenerative construction management, operational stewardship, and end-of-life reintegration. The study concludes that regenerative construction requires a shift from project-based efficiency to long-term stewardship, collaborative governance and measurable net-positive performance across the entire building life cycle.

Keywords: Bio-based materials, Circular economy, Construction management, Life-cycle assessment, Net-positive development, Regenerative construction.

1. Introduction

The last five years have witnessed increasing academic and professional attention on built environments that do more than minimise harm. While green building systems have improved energy efficiency and reduced waste, global reports show that the building and construction sector is not on track to meet

decarbonisation, biodiversity, and resource-efficiency targets (IPCC, 2022; UNEP, 2023). This has stimulated interest in regenerative construction as a more ambitious approach for transforming how buildings are planned, procured, constructed, operated and recovered at the end of life (Persson, 2023). Regenerative construction is an approach to building and infrastructure development that goes beyond sustainability, actively restoring and enhancing the environment, rather than merely reducing negative impacts (Ajayabi et al., 2019). It is a progressive approach that aims to restore, renew, and grow ecosystems, not only sustain them. It goes beyond typical sustainable design, encompassing the design of structures that actively support ecosystems and have a net-positive impact on the environment (El Kouche, 2024).

Regenerative construction is relevant because the construction sector is simultaneously an economic driver and an ecological burden. It consumes large volumes of minerals, timber, water and energy, generates substantial construction and demolition waste, and locks cities into long-term carbon and resource pathways. The industry makes use of a significant percentage -about 30% of global resources and 40% of global energy consumption (Uddin, 2021). This dependence on natural resources for survival and day-to-day activities has given rise to the idea of sustainability. According to Mouton et al. (2023), a potential strategy to reduce the embodied impacts of buildings is to replace conventional, fossil-fuel-based construction materials with bio-based alternatives. Peretti and Druhmann (2019) stated that moving towards a regenerative economy is a key factor in the purpose of buildings. In the same vein, Oyefusi et al. (2024) argued that the construction industry needs to transition from sustainable to regenerative practices. Construction practices that restore ecosystems, strengthen communities, enhance resilience and create circular material flows.

This involves continuous improvement over time, adapting as the subject changes, and sustaining it long after a construction project is complete (Persson, 2024). From a construction management perspective, regenerative construction is not only a design issue. It requires changes in project governance, procurement, supply chains, site management, labour skills, performance measurement, digital integration and post-occupancy responsibility. The extant studies (Oyefusi et al., 2024; Malheiro et al., 2021; Baper et al., 2020) revealed that, despite the growing emphasis on green and sustainable approaches in construction, there is a noticeable gap in understanding the benefits of implementation and the effective use of regenerative practices in the building and construction industry. The aim of this paper is therefore to identify recent themes in regenerative construction scholarship; categorise the benefits of regenerative construction into economic, social, environmental and technological dimensions; determine the barriers limiting implementation in contemporary construction projects; and propose a practical framework for embedding regenerative principles across the construction life cycle.

2. Overview of the Concept of Regenerative Construction

2.1 Transition from Sustainable to Regenerative Construction

The concept of Regenerative construction integrates ecological principles into the

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design, construction, and operation of buildings to regenerate ecosystems, enhance biodiversity, and support the health of natural and human systems (Baper et al., 2020; Malheiro et al., 2021; Oyefusi et al., 2024). These studies distinguish regenerative construction from conventional sustainable construction by its emphasis on positive contribution rather than impact reduction. Benachio et al. (2020), Munaro et al. (2020), Çimen (2021) and Norouzi et al. (2021) show that circular construction strategies can reduce resource extraction, promote design for adaptability and generate secondary material markets.

Peretti and Druhmann (2019), in the RESTORE Working Group Three report, examined how buildings can be procured, constructed, operated, and maintained to create positive environmental and social impacts rather than merely reducing harm. A key contribution of the report is its focus on life-cycle thinking in regenerative construction. Kasina et al. (2025) identified seven key themes that hold potential for integrating regenerative design principles in the construction phase. The themes include scheduling and construction logistics, worker health and safety, energy and resource efficiency, waste management and site restoration, On-site water management, Stakeholder collaboration and technology integration, as well as quality control and Life Cycle Assessment (LCA). The authors stress that regenerative performance must extend across procurement, construction, operation, maintenance, and future reuse stages, rather than focusing solely on initial design or embodied impacts. This aligns with regenerative construction principles that advocate closed-loop systems, adaptability, and long-term ecological integration.

2.2 Regenerative Materials and Bio-Based Construction

The Biomimicry theory involves designing buildings and infrastructure based on the principles and processes found in nature (Helmrich et al., 2020). A major theme in recent studies is the use of bio-based and regenerative materials. Baper et al. (2020) highlight material effectiveness as a key aspect of regenerative architecture, while Malheiro et al. (2021) demonstrate the potential of reed as a building material with useful thermal and durability characteristics. Mouton et al. (2023) further show, through life-cycle assessment, that bio-based construction materials can provide environmental benefits compared with conventional materials, particularly by reducing embodied carbon and storing biogenic carbon. Mouton et al. (2023) demonstrated that bio-based materials generally achieve substantially lower embodied GHG emissions than conventional construction products. The study further revealed that straw-based systems had the lowest global warming potential (GWP), outperforming both hemp- and timber-based alternatives and conventional systems. Other scholars, including Persson (2024), Andreucci et al. (2021) and Baper et al. (2020), support the broader transition toward regenerative design and construction by demonstrating that renewable, carbon-storing materials can significantly lower embodied emissions when evaluated through a full life-cycle perspective.

However, literature also warns that bio-based materials are not automatically regenerative. Their benefits depend on responsible sourcing, transport distances, treatment methods, durability, maintenance needs and

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end-of-life recovery. The RESTORE report, Peretti & Druhmann (2019), contributes to the literature on promoting regenerative construction by expanding the concept beyond material selection and energy efficiency to include collaborative governance, operational management, digital integration, smart energy systems, user participation, and circular life-cycle strategies. It therefore demonstrates that regenerative material selection requires whole-life assessment rather than a narrow focus on initial embodied carbon.

2.3 Regenerative Construction and Circular Economy

The circular economy theory (Stahel, 2019) promotes the idea of closed-loop systems in construction. It emphasises reuse, repair, remanufacture, design for disassembly and closed-loop material systems. Materials used in buildings should be renewable, recyclable, or biodegradable. The construction process should aim to minimise waste, and buildings should be designed for easy disassembly and material reuse at the end of their life cycle. This approach aligns with the concept of "cradle to cradle" design.

Circular economy literature provides practical approaches for regenerative construction. Ghaffar et al. (2020) argue that construction and demolition waste should be treated as a resource stream rather than a disposal problem, while Dams et al. (2021) propose evaluation approaches that support design for disassembly and adaptability. These studies indicate that buildings should be treated as temporary material banks whose components can be recovered, reused and reconfigured.

For construction management, circularity affects procurement, logistics, quality control, contracts and risk allocation. Reused materials often require early identification, testing, certification, storage, traceability and coordination between demolition and new-build projects (Ellen MacArthur Foundation, 2021; Akanbi et al., 2019; Adams et al., 2017). This suggests that regenerative construction depends on supply-chain integration and data transparency.

Miller (1973) defines living systems as open, self-organising systems interacting with their environment through exchanges of information, energy, and matter. In a sense, buildings are dynamic, adaptive systems that respond to changes in their environment. In regenerative construction, this could mean creating buildings that evolve over time to better support human and ecological health. For example, buildings might be designed with adaptable features that allow them to adjust to changing climate conditions or the needs of their inhabitants.

2.4. Regenerative Performance and Assessment

Another important trend is the development of performance evaluation frameworks. Oyefusi et al. (2024) proposed a framework for evaluating regenerative practices in construction, demonstrating the need for measurable indicators across environmental, social, economic, and operational dimensions, as regenerative construction is prone to vague claims when performance is not measured.

Literature suggests that regenerative assessment should include embodied and operational carbon, renewable energy generation, water reuse and watershed

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contribution, biodiversity enhancement, material circularity, local employment and skills development, indoor environmental quality, social value and community participation, post-occupancy performance, and adaptability and end-of-life recoverability (World Green Building Council, 2019; Cole, 2012a; Mang & Reed, 2012; du Plessis & Cole, 2011; Pomponi & Moncaster, 2017).

For example, regenerative design prioritises the site of placement as the primary starting point and the connection between people and the spirit of the place. Lyle's (1996) concept of regenerative design focuses on creating systems that restore and renew the resources they consume. Lyle's work emphasises designing built environments that go beyond sustainability and actively regenerate resources, such as water, energy, and biodiversity. A key gap is that many projects claim to have regenerative intent but lack long-term monitoring. This makes it difficult to verify whether regenerative outcomes are achieved beyond design intent.

Ajayabi (2019) highlighted that the potential market for reclaimed, remanufactured, and reused products will be driven by a range of factors. The main factors identified included the rate of new build, building design and technical innovation.

2.5 Digital Technologies Supporting Regenerative Construction

Digital technologies are identified as enablers of regenerative construction by supporting resource optimisation, lifecycle assessment, material traceability, circularity, performance monitoring, and integrated decision-making (Akanbi et al., 2019). BIM supports collaborative design, clash detection, quantity take-off, materials tracking and integration with LCA. Digital twins support operational monitoring of energy, water, indoor environmental quality and maintenance. Material passports can document the origin, composition, reuse potential and recovery approaches of building components. Technological tools also support regenerative decision-making by allowing project teams to compare design options across carbon, cost, circularity and performance criteria (Lu et al., 2020; Akanbi et al., 2019). However, technology alone does not guarantee regenerative outcomes. Digital systems need to be linked to procurement decisions, contractual requirements, site practices and post-occupancy management.

2.6 Restoration and Enhancement

Peretti and Druhmann (2019) argued that the restorative-regenerative approach holds that sustainability is linked to a neutral impact. This is based on the concept of sustainable development, which emphasises meeting present needs without compromising the ability of future generations to meet their own needs. In contrast, being restorative or regenerative would imply having a positive impact. Regenerative construction seeks to restore ecosystems, enhance biodiversity, and improve the quality of the natural environment. This can include activities such as reforestation, wetland restoration, and the creation of green spaces that support wildlife.

2.7 Other Principles of Regenerative Construction

These include:

2.7.1 **Energy Efficiency and Renewable Energy:** Buildings and infrastructure are designed to maximise energy efficiency while incorporating renewable energy

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sources such as solar and wind power. This reduces dependence on fossil fuels, lowers greenhouse gas emissions, and supports low-carbon development (World Green Building Council, 2019).

2.7.2 **Resilience and Adaptation:** Regenerative construction promotes the design of buildings and infrastructure that are adaptable to changing environmental conditions and resilient to climate-related hazards and natural disasters, thereby enhancing long-term sustainability and functionality (Cole, 2012b).

2.7.3 **Water Management:** Regenerative approaches incorporate sustainable water management strategies, including rainwater harvesting, greywater recycling, water-sensitive urban design, and landscape interventions that restore and support natural hydrological cycles (Mang & Reed, 2012).

2.7.4 **Community and Social Well-being:** Regenerative construction emphasises the creation of inclusive, accessible, and healthy spaces that promote social well-being, community participation, equity, and improved quality of life for occupants and surrounding communities (du Plessis, 2012).

2.7.5 **Connection to Place:** Regenerative design considers the cultural, historical, ecological, and social context of a site, seeking to create developments that respect local identity, ecosystems, and community values while strengthening the relationship between people and place (Mang & Reed, 2012; Cole, 2012b).

The literature shows that regenerative construction has evolved from a narrow focus on reducing environmental impact to a broader life-cycle approach that seeks to create net-positive ecological, social, and economic outcomes. The reviewed studies demonstrate that regenerative construction is closely linked to circular economy principles, the use of bio-based materials, design for disassembly, ecological restoration, digital technologies, life-cycle assessment, social well-being, and place-based design. However, despite this growing body of knowledge, there are gaps. The main knowledge gap lies in translating regenerative construction from an aspirational design philosophy into measurable, practical and construction-management-based processes that can be implemented across the whole building life cycle. This study addresses that gap by reviewing recent literature on the benefits and limitations of regenerative construction and proposing a framework that links regenerative principles to the practical stages of modern construction practice.

3. Research Methodology

3.1 Review Design

This study adopted a systematic narrative literature review. The review focused on literature published between 2020 and 2025, with an emphasis on peer-reviewed journal articles indexed in accredited academic databases, particularly ScienceDirect (Elsevier), Emerald Insight, and Taylor & Francis Online. Additional indexed sources, such as Scopus, Web of Science, and Google Scholar, were used for citation tracing and to locate relevant studies that were not directly indexed under the phrase “regenerative construction” but addressed regenerative construction principles, such as circularity, material reuse, design for disassembly, bio-based construction, and net-positive environmental performance.

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3.2 Search Strategy

The search was conducted using combinations of the following keywords shown in Table 1
.

Table 1. Search Themes and Search Terms used

Search Theme	Search Terms Used
Core regenerative construction terms	"regenerative construction", "regenerative building", "regenerative built environment", "regenerative design" AND "construction"
Circular construction terms	"circular construction", "circular economy" AND "construction", "construction circularity", "closed-loop construction"
Material and resource terms	"bio-based materials" AND "construction", "regenerative materials", "reclaimed materials", "construction material reuse"
End-of-life and adaptability terms	"design for disassembly", "adaptive reuse", "building material passports", "building as material bank"
Performance assessment terms	"life cycle assessment" AND "building materials", "embodied carbon" AND "construction", "net positive building"
Technology terms	"BIM" AND "circular construction", "digital twin" AND "building performance", "material passports" AND "buildings"

3.3 Inclusion and Exclusion Criteria

Table 2 presents the inclusion and exclusion criteria used to source the relevant literature.

Table 2. Inclusion and Exclusion Criteria

Criterion	Inclusion Decision
Publication period	2020–2025
Language	English-language publications
Publication type	Peer-reviewed journal articles and selected indexed conference papers where directly relevant to regenerative construction.
Subject area	Construction, buildings, built environment, infrastructure, circular economy, regenerative design, building materials, environmental assessment and construction management.
Relevance	Studies had to address at least one of the following: regenerative construction principles, circular construction, bio-based materials, life-cycle performance, design for disassembly, material reuse, digital tools for circularity, net-positive environmental performance or implementation barriers.
Exclusion	Studies were excluded if they focused only on general sustainability without a connection to regenerative, circular, restorative or net-positive construction practices.

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3.4 Specific Literature Reviewed

Table 3 outlines the sources of the literature review and the number reviewed.

Table 3. Reviewed Literature Matrix, 2020-2025

Journal / Repository Source	Number reviewed
Journal of Cleaner Production, Elsevier/ ScienceDirect	5
Environmental Impact Assessment Review, Elsevier/ScienceDirect	3
IOP Conference Series: Earth and Environmental Science	2
International Journal of Technology	1
Earth's Future	1
Journal of Building Engineering	1
Energies	1
Energy and Buildings, Elsevier / ScienceDirect	1
Proceedings of the Institution of Civil Engineers: Urban Design and Planning	1
Philosophical Transactions of the Royal Society B	1
Journal of Physics: Conference Series	1
Total	**18**

It can be seen from Table 3 that more of the reviewed papers were published in the Journal of Cleaner Production (Elsevier/ScienceDirect), followed by Environmental Impact Assessment Review (Elsevier/ScienceDirect) and IOP Conference Series: Earth and Environmental Science.

4. Results and Discussion

The following sections present the benefits and limitations of regenerative construction identified in the literature.

4.1 Economic, Social, Environmental and Technological Benefits of Regenerative Construction

The literature review was coded into four benefit categories: economic, social, environmental, and technological. The results obtained are presented in Table 4.

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Table 4. Economic, Social, Environmental and Technological Benefits of Regenerative Construction

Benefits	Main Finding	Reference (s)
Economic	Whole-life cost reduction	Dams et al. (2021); Mouton et al. (2023); Oyefusi et al. (2024)
	Material cost recovery	Benachio et al. (2020); Munaro et al. (2020); Ghaffar et al. (2020); Çimen (2021)
	Reduced construction and demolition waste disposal costs	Ghaffar et al. (2020); Benachio et al. (2020); Norouzi et al. (2021)
	New circular business models	Munaro et al. (2020); Çimen (2021); Norouzi et al. (2021); Oyefusi et al. (2022)
	Increased long-term asset value	Scrucca et al. (2023); Plaves et al. (2024); Oyefusi et al. (2024)
	Local economic development	Malheiro et al. (2021); Mouton et al. (2023); Dorninger et al. (2024)
	Risk reduction	Helmrich et al. (2020); Scrucca et al. (2023); Persson (2024)
Social	Improved occupant health and well-being	Baper et al. (2020); Helmrich et al. (2020); Plaves et al. (2024)
	Community participation and place-based design	Dorninger et al. (2024); Plaves et al. (2024); Persson (2024)
	Social value creation	Scrucca et al. (2023); Oyefusi et al. (2024); Dorninger et al. (2024)
	Skills development and employment	Oyefusi et al. (2022); Yao et al. (2023); Kasina et al. (2025)
	Cultural and ecological connection	Dorninger et al. (2024); Persson (2024); Plaves et al. (2024)
	Improved worker well-being and site practices	Kasina et al. (2025); Oyefusi et al. (2024)
Environmental	Reduced embodied carbon	Mouton et al. (2023); Malheiro et al. (2021); Baper et al. (2020)
	Carbon storage through bio-based materials	Malheiro et al. (2021); Mouton et al. (2023)
	Reduced virgin resource extraction	Benachio et al. (2020); Munaro et al. (2020); Çimen (2021); Norouzi et al. (2021)
	Construction and demolition waste minimisation	Ghaffar et al. (2020); Dams et al. (2021); Çimen (2021)
	Improved biodiversity and ecosystem restoration	Helmrich et al. (2020); Dorninger et al. (2024); Persson (2024)

	Water regeneration and improved hydrological cycles	Persson (2024); Plaves et al. (2024); Oyefusi et al. (2024)
	Climate resilience	Helmrich et al. (2020); Scrucca et al. (2023); Persson (2024)
	Improved life-cycle environmental performance	Mouton et al. (2023); Dams et al. (2021); Oyefusi et al. (2024)
Technological	Life-cycle assessment-supported decision-making	Mouton et al. (2023); Dams et al. (2021); Oyefusi et al. (2024)
	Digital support for circular construction	Çimen (2021); Norouzi et al. (2021); Dams et al. (2021)
	BIM-enabled coordination	Dams et al. (2021); Oyefusi et al. (2024); Kasina et al. (2025)
	Design for disassembly and adaptability tools	Dams et al. (2021); Benachio et al. (2020); Munaro et al. (2020)
	Material passports (documenting the material properties) and material traceability	Çimen (2021); Norouzi et al. (2021); Plaves et al. (2024)
	Construction-stage monitoring	Kasina et al. (2025); Oyefusi et al. (2024)
	Smart building and operational technologies	Plaves et al. (2024); Persson (2024); Oyefusi et al. (2024)

Table 4 summarises the key benefits of regenerative construction identified in the literature across four major dimensions comprising economic, social, environmental, and technological. First, the economic benefits include whole-life cost reduction, material recovery, reduced landfill cost, local value creation and improved asset resilience. These findings are supported by circular construction studies that show how design for disassembly, waste recovery and circular material markets can reduce long-term resource costs and create new business opportunities.

Second, social benefits include improved occupant health, community participation, social value, cultural connection and employment generation. The literature shows that regenerative construction is concerned not only with environmental performance but also with improving the relationships among buildings, users, and local communities.

Third, the environmental benefits are the most developed in the literature. They include reduced embodied carbon, carbon storage through bio-based materials, waste minimisation, reduced virgin material extraction, biodiversity enhancement, improved water cycles and climate resilience. However, these benefits depend on life-cycle assessment and responsible sourcing.

Fourth, technological benefits include the use of BIM, life-cycle assessment tools, digital monitoring, material passports, and circularity assessment frameworks. These tools improve decision-making and traceability, but their effectiveness depends on data quality, interoperability and professional capacity.

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4.2 Limitations of Regenerative Construction

The study also sought to know the limitations and barriers of regenerative construction. Table 5 highlights the limitations that restrict the implementation of regenerative construction in the literature.

Table 5. Limitations and Barriers of Regenerative Construction

Limitations / Barriers	Description	Reference (s)
High initial cost	Regenerative construction may require additional design time, specialist consultants, advanced modelling, unfamiliar materials, ecological studies and stakeholder engagement. These increase upfront project cost.	Oyefusi et al. (2024); Plaves et al. (2024); Yao et al. (2023)
Uncertain return on investment	Many clients prioritise capital cost over whole-life value. The long-term financial benefits of regenerative construction are not always immediately visible or easily quantified.	Scrucca et al. (2023); Oyefusi et al. (2024); Plaves et al. (2024)
Fragmented procurement systems	Traditional procurement separates design, construction and operation, whereas regenerative construction requires early contractor involvement, integrated teams and long-term stewardship.	Oyefusi et al. (2022); Yao et al. (2023); Kasina et al. (2025)
Weak circular supply chains	Markets for reclaimed materials, reused components, bio-based products and certified secondary materials are immature in many regions.	Benachio et al. (2020); Munaro et al. (2020); Norouzi et al. (2021)
Material availability and quality uncertainty	Reused and bio-based materials may be difficult to obtain in consistent quantity, quality, specification and timing for construction projects.	Ghaffar et al. (2020); Malheiro et al. (2021); Mouton et al. (2023)
Regulatory and certification challenges	Building codes and product certification systems are often designed around conventional materials, making approval of reused or novel bio-based materials difficult.	Çimen (2021); Norouzi et al. (2021); Mouton et al. (2023)
Smart building and operational technologies	Sensors, digital monitoring, and smart systems can help maintain performance in energy, water, comfort, and indoor environmental quality after handover.	Plaves et al. (2024); Persson (2024); Oyefusi et al. (2024)
Lack of professional knowledge	Many practitioners are unfamiliar with regenerative design principles, ecological systems thinking, circular procurement, LCA and material passport systems.	Yao et al. (2023); Oyefusi et al. (2024); Kasina et al. (2025)

Measurement difficulties	Regenerative outcomes such as biodiversity gains, social value, community resilience, and ecological restoration are harder to measure than energy or carbon reductions.	Oyefusi et al. (2024); Plaves et al. (2024); Dorninger et al. (2024)
Risk of greenwashing	Without standardised indicators, projects may claim to be regenerative without demonstrating measurable net-positive performance.	Plaves et al. (2024); Oyefusi et al. (2024); Persson (2024)
Technology fragmentation	BIM, LCA, carbon tools, cost planning systems, material databases and facility management platforms are not always interoperable.	Dams et al. (2021); Norouzi et al. (2021); Kasina et al. (2025)
Limited post-occupancy evidence	Many regenerative ambitions are stated at the design stage, but few projects provide long-term post-occupancy data proving ecological, social and operational performance.	Plaves et al. (2024); Oyefusi et al. (2024); Persson (2024)
Maintenance and stewardship problems	Regenerative performance depends on facility managers and users maintaining energy, water, biodiversity and circular systems after handover. Poor operation can undermine design intentions.	Persson (2024); Plaves et al. (2024); Kasina et al. (2025)

Table 5 shows that the principal limitations are high upfront cost, fragmented procurement, weak circular supply chains, lack of regulatory clarity, limited professional knowledge, poor measurement systems, data fragmentation and insufficient post-occupancy evidence.

4.4. Discussion of Findings

The review shows that regenerative construction is best understood as a life-cycle management approach rather than a single design style or material choice. Its success depends on aligning ecological intention with construction management processes. First, regenerative construction challenges the traditional project success criteria of cost, time and quality. These remain important, but they must be expanded to include carbon, biodiversity, social value, adaptability, circularity and long-term performance. This requires new key performance indicators and contract clauses.

Second, regenerative construction shows how circular economy and construction management are related. Waste prevention, material reuse, and design for disassembly cannot be achieved at the end of a project; they must be embedded from the briefing and procurement stages. Contractors must therefore be involved earlier in design decisions.

Third, the benefits of regenerative construction are interdependent. For example, bio-based materials may reduce embodied carbon, support local employment and stimulate innovation. Similarly, green infrastructure can improve biodiversity, reduce flood risk, enhance public space and increase asset value. This confirms that regenerative construction should be assessed in terms of integrated value rather than isolated environmental metrics.

Fourth, the review highlights the need for post-occupancy evidence. Many regenerative claims are made during planning and design, but fewer studies provide long-term data on

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actual performance. Without monitoring, it is difficult to prove net-positive outcomes.

Finally, regenerative construction requires policy support. Voluntary action by a built environment professional or client alone may be insufficient because market systems often reward short-term cost minimisation. Regulations, incentives, carbon pricing, public procurement standards and circular material certification can accelerate the adoption of regenerative construction principles.

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5. Proposed Regenerative Construction Implementation Framework

The proposed framework aims to provide a roadmap for implementing regenerative construction across the building life cycle.

5.1 Overview of the Framework

Table 6 shows the constituents of the regenerative construction implementation framework

Table 6. Regenerative Construction Implementation Framework

Stage	Key Activities	Main Actors	Performance Indicators
1. Initiation – Place-Based Assessment	Assess climate, ecology, culture, community needs, water systems, material flows and risks.	Client, urban planners, ecologists, community, designers	Baseline carbon, biodiversity, water, social value and material inventory
2. Briefing (Regenerative targets)	Define net-positive goals and measurable outcomes before design begins.	Client, project manager, consultants, users	Regenerative KPIs, whole-life value targets, social value targets
3. Integrated Design	Use collaborative design, BIM, LCA, passive design, adaptability and ecological integration.	Architects, engineers, quantity surveyors, contractors, construction managers	Energy demand, embodied carbon, adaptability score, biodiversity gain
4. Procurement (Circular and Bio-Based)	Prioritise reused, renewable, local, low-carbon and responsibly sourced materials.	Procurement team, suppliers, contractors	Reused content, recycled content, biogenic carbon, local sourcing ratio
5. Construction Management (Regenerative)	Minimise site disturbance, waste, water use, emissions and ecological damage during construction.	Contractor, site manager, construction manager, subcontractors	Waste diversion, site energy, water reuse, pollution incidents, worker welfare
6. Operations & Maintenance	Monitor performance, engage occupants and maintain ecological and technical systems.	Facility managers, owners, users	Actual energy use, water reuse, indoor air quality, occupant satisfaction

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7. End-of-Life Reintegration	Plan for disassembly, reuse, recycling, ecological restoration and material recovery.	Owners, demolition contractors, recyclers, manufacturers	Recovery rate, reusable components, material passport completeness

5.2 Logic of the Framework

To obtain the benefits of a regenerative construction and overcome its limitations, the following framework of construction activities, shown in Figure 1, is proposed.

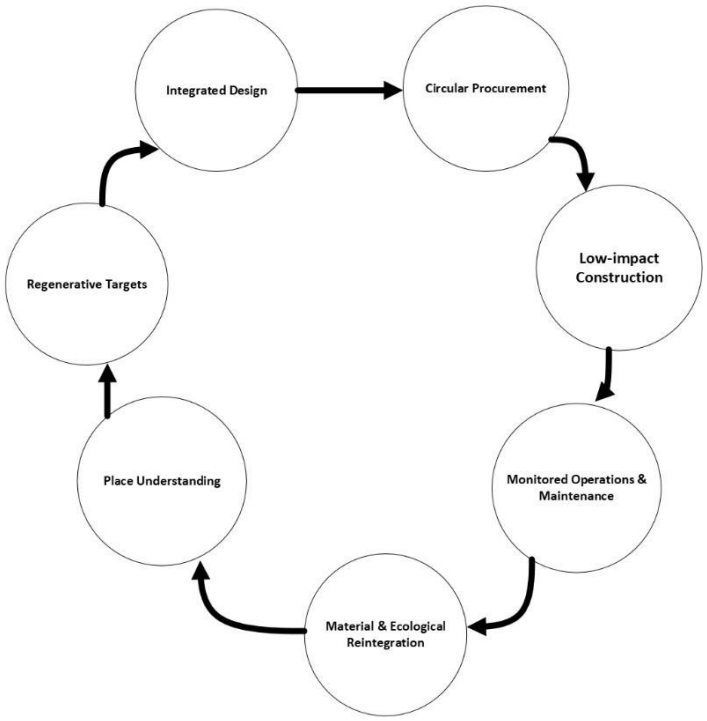


Figure 1. Regenerative Construction Framework

Figure 1 shows that the sequence ensures that regenerative construction is not treated as an add-on but as a continuous process from project conception to future reuse. To apply the framework in practice, project teams should establish regenerative objectives at the business case stage; include environmental and social value specialists in early planning; use BIM-linked LCA and cost tools to compare options; specify materials with reuse, repair and disassembly potential; include regenerative KPIs in contracts; monitor actual performance after handover; update material passports throughout the building's life; and reinvest project benefits into local ecological and social systems.

6. Conclusion and Recommendations

The literature review from 2020 to 2025 shows that regenerative construction is progressing beyond conventional sustainability in the building industry. Its benefits are economic, social, environmental and technological. Economically, it can reduce whole-life costs, create new circular markets and improve asset resilience. Socially, it can enhance health, inclusion, community participation and skills development. Environmentally, it can reduce

carbon emissions, restore biodiversity, improve water systems, and reduce waste. Technologically, it encourages the use of BIM, LCA, digital twins, material passports, smart systems and advanced material innovation.

Despite these benefits, regenerative construction is limited by upfront costs, fragmented procurement, immature supply chains, uncertain regulation, limited skills, weak measurement systems, and a lack of long-term performance data. These limitations suggest that regenerative construction cannot be achieved through design intention alone. It requires coordinated action by clients, contractors, consultants, suppliers, regulators, facility managers and building users.

The proposed framework provides a structured approach to implementing regenerative construction principles throughout the project life cycle. Future research should test the framework through empirical case studies, professional surveys and post-occupancy performance evaluations in different regional contexts. Attention should be given to developing measurable indicators for biodiversity, social value, circularity and long-term regenerative performance.

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CHALLENGES FACED BY FEMALE PROFESSIONALS IN THE BUILDING INDUSTRY: EVIDENCE FROM BAUCHI STATE, NIGERIA

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Abstract

The construction industry remains one of the most gender-segregated sectors globally, with women continuing to experience significant barriers to participation and career advancement. In Nigeria, particularly in the northern region, socio-cultural norms and workplace practices further constrain women's opportunities within the building industry. This study examined the challenges faced by female professionals in Bauchi State's construction industry and identified strategies to enhance their participation and career progression. A descriptive survey research design was adopted, targeting female professionals, including engineers, architects, builders, quantity surveyors, and project managers operating within Bauchi metropolis. Using Yamane's sampling formula, a sample size of 171 respondents was determined from a population of 300 professionals. A structured questionnaire was administered, yielding 160 valid responses, representing a response rate of 93.6%. Data were analysed using descriptive statistics, including frequencies, percentages, and mean scores. The findings revealed that female professionals experience persistent barriers such as limited access to leadership positions, wage disparities, exclusion from high-profile projects, and workplace discrimination. Work–life balance challenges (Mean = 3.84) and gender discrimination in hiring and career progression (Mean = 3.79) emerged as the most significant barriers affecting women's professional advancement. Cultural expectations and gender stereotypes were also found to exert considerable influence on women's participation and career development within the industry. Respondents strongly supported interventions such as mentorship programmes, leadership development initiatives, gender-inclusive policies, professional networking opportunities, scholarships, and targeted educational programmes. The study contributes empirical evidence from northeastern Nigeria, where socio-cultural norms strongly influence professional participation. The findings provide practical guidance for policymakers, construction firms, professional associations, and educational institutions seeking to promote gender inclusivity in the built environment. The study concludes that addressing structural, organisational, and socio-cultural barriers is essential for improving female representation, enhancing workforce diversity, and promoting sustainable growth within the construction sector.

Keywords: Bauchi State; Career advancement; Construction industry; Female professionals; Gender inequality; Women in construction

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1. INTRODUCTION

The building industry is globally recognised as a male-dominated sector, with women facing significant barriers to entry and advancement. Women remain substantially underrepresented within the Nigerian construction workforce (Jimoh et al., 2016; Adeyemi et al., 2006). While women have made strides in other sectors such as education, health, and banking, they remain underrepresented in construction, where cultural norms, gender stereotypes, and structural barriers reinforce inequality (Jimoh et al., 2016).

Bauchi State presents a unique case for examining gender disparities in construction. As the capital of northeastern Nigeria, Bauchi has experienced substantial growth in its construction industry, driven by population growth, real estate development, and government infrastructure projects (Bauchi State Government, 2022; National Bureau of Statistics, 2023). Despite these opportunities, women remain marginalised due to persistent challenges, including limited access to training and mentorship, exclusion from leadership roles, wage disparities, and difficulties balancing family and professional responsibilities (Jwasshaka and Amin, 2020; Asadian et al., 2024).

Scholars emphasise that societal and cultural expectations play a critical role in shaping women's career paths, often pressuring them to prioritise domestic responsibilities over professional advancement (Eagly and Karau, 2002; Akanji et al., 2020). In northern Nigeria, where Bauchi is located, such norms are particularly strong, further restricting women's participation in male-dominated professions (Okeke, 2017). Although national frameworks such as the Federal Ministry of Women Affairs (2006) advocate for gender equity, implementation within the construction sector remains limited (Para-Mallam, 2006).

This study addresses this gap by examining the specific challenges faced by female professionals in Bauchi's building industry and proposing strategies to foster inclusivity.

Aim: The study investigates the challenges faced by female professionals in Bauchi State's building industry and proposes solutions to mitigate these barriers.

Research questions:

1. What challenges affect women's participation and career advancement in Bauchi's building industry?
2. How do gender stereotypes and biases shape women's opportunities?
3. What role do cultural and social norms play in restricting women's progression?
4. What strategies can increase women's representation and retention?
5. How can education and training support women's entry and advancement?

2. LITERATURE REVIEW

2.1 Gender and the Construction Industry

Globally, the construction industry is among the least gender-diverse, with women often excluded from technical and managerial roles due to stereotypes and discrimination (Asadian et al., 2024). Research indicates that women constitute less than 10% of the construction workforce in Nigeria, highlighting a significant gender gap (ILO, 2020). While female participation in professions such as education and healthcare has increased, their presence in construction remains constrained by cultural expectations, workplace discrimination, and structural barriers (Jimoh et al., 2016; Adeyemi et al., 2006).

2.2 Cultural Norms and Gender Roles

Cultural and social norms play a critical role in restricting women's involvement in male-dominated industries. In Nigeria, prevailing cultural expectations continue to assign

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domestic and caregiving responsibilities to women, thereby affecting their career progression and work–life balance (Akanji et al., 2020). In northern regions such as Bauchi, conservative cultural values reinforce the perception that construction is unsuitable for women, further reducing their participation (Jwasshaka and Amin, 2020). These norms discourage women from pursuing leadership positions and lead to criticism of those who enter the industry (Jimoh et al., 2016).

2.3 Workplace Discrimination and Barriers

Discrimination remains a major obstacle for female professionals in construction. Studies reveal that women are less likely to be hired, promoted, or fairly compensated compared to men, even when equally qualified (Navarro-Astor et al., 2017). They are often excluded from high-profile projects and challenging assignments due to stereotypes about physical ability and technical competence (Bridges et al., 2020). Moreover, workplace cultures in construction are frequently male-dominated, fostering harassment and bias that discourage women from pursuing long-term careers (Oyewole, 2021).

2.4 Education, Training, and Mentorship

Access to education and professional development is essential for women's advancement in construction. However, women in Nigeria often face barriers to vocational training and mentorship opportunities, limiting their skills and career growth (Anakor et al., 2025). The lack of female role models in engineering and construction education further reduces retention (Francis and Prosser, 2014). Initiatives such as Women in Construction Nigeria (WICN) and the Association of Professional Women Engineers of Nigeria (APWEN) seek to address these gaps by providing mentorship and networking opportunities (Tunji-Olayeni et al., 2024).

2.5 Policies and Support Systems

At the policy level, frameworks such as Nigeria's National Gender Policy aim to promote inclusivity in employment. However, enforcement within the construction industry has been inconsistent, with cultural resistance and weak institutional support limiting effectiveness (Oyiana, 2021). International best practices suggest that affirmative action policies, mentorship programs, and inclusive workplace cultures can significantly increase women's representation in male-dominated fields (International Labour Organisation and UN Women, 2020).

2.6 Theoretical Framework

This study is underpinned by Role Congruity Theory developed by Eagly and Karau (2002). The theory posits that prejudice arises when there is perceived incongruity between societal expectations associated with a gender and the attributes required for particular occupational or leadership roles. In male-dominated industries such as construction, leadership, technical competence, and physical capability are often stereotypically associated with men. Consequently, women may be perceived as less suitable for construction-related responsibilities regardless of their qualifications or performance.

The theory provides a useful framework for understanding the challenges experienced by female professionals in Bauchi State. It explains how gender stereotypes influence recruitment decisions, promotion opportunities, access to leadership positions, and assignment to high-profile projects. Furthermore, it highlights the societal and cultural expectations that pressure women to prioritise domestic responsibilities over career advancement.

By applying Role Congruity Theory, this study examines how organisational practices and cultural norms interact to shape the

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experiences of women in the building industry and identifies strategies to reduce gender-based barriers.

2.7 Identified Gaps

Despite increasing attention to gender issues in Nigeria's workforce, limited research has examined the specific experiences of female professionals in Bauchi State's building industry. Most studies generalise findings across Nigeria without accounting for regional cultural dynamics (Ajemba, 2023; Akanji et al., 2020). There is also a lack of empirical evidence on how education, mentorship, and policy initiatives directly impact women's participation in Bauchi's construction sector (Haruna et al., 2016). This study addresses these gaps by investigating barriers, societal influences, and potential strategies to improve female representation in Bauchi's construction industry.

3. METHODOLOGY

3.1 Research Design

The study adopted a descriptive survey design, which is appropriate for identifying and analysing the challenges faced by female professionals in Bauchi State's building industry. This approach enabled the collection of quantitative data to explore workplace barriers, cultural influences, and gender-related issues.

3.2 Study Area

The research was conducted in Bauchi metropolis, the capital of Bauchi State in northeastern Nigeria. Bauchi has experienced rapid growth in construction activities due to government infrastructure investment and real estate development (Bauchi State Government, 2022; National Bureau of Statistics, 2023)

3.3 Population and Sample Size

The target population comprised 300 female professionals working in the Bauchi building industry, including engineers, architects, builders, quantity surveyors, and project managers. Using Yamane's finite population formula with a 5% margin of error, the sample size was determined to be 171 respondents.

3.4 Sampling Technique

A combination of purposive and simple random sampling was employed. Purposive sampling ensured that only women actively engaged in the building industry were selected, while random sampling provided equal opportunity for participation across different professional roles.

3.5 Data Collection

Primary data were collected using a structured questionnaire comprising multiple-choice and Likert-scale questions. The instrument covered demographic information, workplace challenges, cultural influences, gender discrimination, and support systems. Questionnaires were administered both physically and electronically.

3.6 Validity and Reliability

The questionnaire was pre-tested with a small group of respondents to ensure clarity and relevance. Necessary modifications were made before full administration. Reliability was enhanced through consistent administration and standardised coding of responses.

3.6.1 Validity and Reliability Assessment

To ensure content validity, the questionnaire was reviewed by three experts in construction management, gender studies, and research methodology. Their observations informed modifications relating to clarity, relevance, and adequacy of the measurement items. A pilot study involving 20 female construction professionals from outside the study area was conducted to evaluate the instrument's suitability.

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The reliability of the questionnaire was assessed using Cronbach's Alpha coefficient (Nunnally and Bernstein, 1994). The overall reliability coefficient obtained was 0.84, exceeding the minimum threshold of 0.70 recommended by Hair et al. (2019), indicating satisfactory internal consistency of the instrument. The pilot responses were excluded from the final analysis to prevent bias.

Ethical considerations were also observed throughout the study. Participation was voluntary, respondents were informed about the purpose of the study, and confidentiality of responses was assured. No personal identifiers were collected, and informed consent was obtained before questionnaire administration

3.7 Data Analysis

Data were analysed using descriptive statistics, including frequencies, percentages, and means. Cross-tabulation was used to examine relationships among demographic variables and to identify challenges. Results are presented in tables and interpreted in relation to the research objectives.

4. RESULTS

This section presents the findings from the survey of female professionals in Bauchi State's building industry. Results are organised around the research questions, with descriptive statistics summarised in tables.

4.1 Response Rate

Out of the 171 questionnaires distributed, 160 were returned, representing a **93.6% response rate**. This high participation demonstrates strong engagement among female professionals in Bauchi (Table 1).

Table 1. Questionnaire Distribution and Response Rate

Distribution Status	Frequency	Percentage (%)
Total distributed	171	100.0
Responses received	160	93.6
Responses not received	11	6.4

Source: Field Survey (2024)

4.2 Demographic Profile of Respondents

Table 2 summarises respondents' demographic characteristics. The majority were aged 31–40 years (35.6%), with most holding at least a Bachelor's degree (46.9%). Engineers (35.0%), project managers (23.1%), and architects (17.5%) made up the largest professional groups. More than half of respondents were married (52.5%), and the majority had 6–10 years of experience (38.1%).

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Table 2. Demographic Characteristics of Respondents

Variable	Category	%
Age	31–40 years	35.6
	21–30 years	26.3
	41–50 years	23.1
	Others	15.0
Education	Bachelor's degree	46.9
	Master's degree	23.1
	Others	30.0
Professional Role	Engineer	35.0
	Project Manager	23.1
	Architect	17.5
	Others	24.4
Marital Status	Married	52.5
	Single	40.6
	Others	6.9

Source: Field Survey (2024)

4.3 Challenges in Career Advancement

Respondents identified several barriers to career advancement. Limited access to leadership roles (Mean = 3.55), underpayment compared to men (Mean = 3.78), and restricted opportunities for high-profile projects (Mean = 3.75) were widely reported. Work–life balance was considered a significant obstacle (Mean = 3.84), and gender discrimination in hiring was strongly acknowledged (Mean = 3.79) (Table 3).

Table 3. Career Advancement Challenges

Statement	Mean	Remark
Limited access to leadership roles	3.55	Agreement
Difficulty balancing work and family responsibilities	3.84	Strong agreement
Underpayment compared to male colleagues	3.78	Agreement
Limited opportunities on high-profile projects	3.75	Agreement
Gender discrimination in hiring	3.79	Strong agreement

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4.4 Gender Stereotypes and Biases

Findings show strong agreement that stereotypes and biases undermine women's opportunities. Women were often perceived as less capable than men in project delivery (Mean = 3.86) and were excluded from challenging tasks (Mean = 3.90). Stereotypes were also seen as limiting women's leadership opportunities (Mean = 3.80) (Table 4).

Table 4. Gender Stereotypes and Biases

Statement	Mean	Remark
Stereotypes limit women's leadership opportunities	3.80	Strong agreement
Biases undermine women's technical skills	3.77	Agreement
Perception that women are less capable than men	3.86	Strong agreement
Exclusion from challenging or high-risk tasks	3.90	Strong agreement

4.5 Cultural and Social Norms

Cultural and social factors also restricted women's participation. Respondents strongly agreed that social pressures prioritise family responsibilities over careers (Mean = 3.95). Cultural norms discouraged women from entering construction (Mean = 3.88), and many reported facing criticism for working in the sector (Mean = 3.80) (Table 5).

Table 5. Cultural and Social Norms Affecting Women

Statement	Mean	Remark
Cultural norms discourage women in construction	3.88	Strong agreement
Social pressures prioritise family over careers	3.95	Strong agreement
Criticism for working in construction	3.80	Strong agreement
Societal expectations discourage physically demanding roles	3.84	Strong agreement

4.6 Strategies for Improving Women's Participation

There was strong support for interventions to enhance women's representation in construction. Respondents favoured mentorship programs (Mean = 4.10), gender quotas (Mean = 4.03), and leadership training (Mean = 4.05). They also highlighted the importance of female-focused networks (Mean = 4.00) and targeted initiatives to attract more women (Mean = 4.15) (Table 6).

Table 6. Recommended Strategies for Female Inclusion

Strategy	Mean	Remark
Mentorship programs	4.10	Strong agreement
Gender quotas	4.03	Strong agreement
Leadership training	4.05	Strong agreement
Targeted initiatives to attract women	4.15	Strong agreement
Female-focused professional networks	4.00	Strong agreement

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4.7 Education and Training Support

Respondents strongly emphasised the role of education in improving women's participation. Suggested measures included female-specific training opportunities (Mean = 4.05), scholarships (Mean = 4.15), and career guidance programs in schools (Mean = 4.20) (Table 7).

Table 7. Education and Training Initiatives

Initiative	Mean	Remark
Female-specific training opportunities	4.05	Strong agreement
Women-centered scholarships	4.15	Strong agreement
Specialised programs for construction skills	4.10	Strong agreement
Training in project management skills	4.05	Strong agreement
Career guidance for girls in schools	4.20	Strong agreement

5. DISCUSSION

This study investigated the challenges faced by female professionals in Bauchi State's building industry, focusing on career advancement, gender stereotypes, cultural norms, and strategies for improvement. The findings highlight persistent gender inequalities despite women's growing educational attainment and professional presence.

5.1 Career Advancement Barriers

The results show that women encounter limited access to leadership roles, underpayment, and exclusion from high-profile projects (Table 3). These findings align with Navarro-Astor et al. (2017), who reported that women in construction globally face systemic barriers in promotion and wage equity. The difficulty of balancing professional and family responsibilities (Mean = 3.84) echoes the findings of Akanji et al. (2020), who reported that female professionals frequently experience work–life conflict arising from competing domestic and occupational responsibilities.

5.2 Gender Stereotypes and Biases

The study confirms that stereotypes significantly undermine women's opportunities. Women were widely perceived as less capable than men in managing construction projects and often excluded from challenging tasks (Table 4). These results support Bridges et al. (2020), who found that women are frequently judged by gendered expectations rather than competence. Eagly and Karau's (2002) role congruity theory also explains how stereotypes limit women's acceptance in leadership, particularly in technical fields.

5.3 Cultural and Social Norms

Cultural norms in Bauchi strongly discourage women from construction careers and prioritise domestic roles (Table 5). This finding reinforces earlier studies by Jwasshaka and Amin (2020), who noted that conservative northern Nigerian norms significantly restrict women's professional participation. Similar cultural barriers have been documented within the construction industry, where women often encounter stereotypes, exclusion, and criticism for entering traditionally male occupations (Navarro-Astor et al., 2017).

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5.4 Strategies for Inclusion

Respondents strongly endorsed mentorship programs, gender quotas, leadership training, and women-focused networks as key strategies (Table 6). These align with best practices recommended by the International Labour Organisation and UN Women (2020) and Tunji-Olayeni et al. (2024), who emphasised mentorship and policy interventions as critical to improving female representation. The support for gender quotas highlights the need for structural reforms to address systemic imbalances.

5.5 Role of Education and Training

Education and targeted training were seen as crucial to long-term inclusion (Table 7). Respondents emphasised scholarships, career guidance for girls, and technical training. This finding is consistent with Anakor et al. (2025), who argued that women's participation improves significantly when educational barriers are addressed. APWEN's initiatives in Nigeria similarly demonstrate that targeted programs can increase women's interest in construction careers (Tunji-Olayeni et al., 2024).

5.6 Comparison with International Evidence

The findings of this study are consistent with international evidence regarding the underrepresentation of women in the construction industry. Studies conducted in the United Kingdom, Australia, Canada, and South Africa similarly report that women face barriers, including workplace discrimination, unequal access to leadership opportunities, and exclusion from critical decision-making roles (Navarro-Astor et al., 2017). The prevalence of gender stereotypes identified in this study also aligns with global research demonstrating that women in construction are frequently required to prove their competence more rigorously than their male counterparts.

However, the findings suggest that cultural and religious expectations may exert a stronger influence in Bauchi State than in many developed economies. While work-life balance challenges are commonly reported worldwide, respondents in this study identified socio-cultural pressures and community perceptions as significant constraints on professional advancement. This indicates that interventions designed for developed countries may require adaptation to reflect local socio-cultural realities. Consequently, policies aimed at improving female participation in northern Nigeria should combine workplace reforms with broader community-based awareness programmes.

5.7 Contribution to Knowledge

This study contributes to the growing body of literature on gender inequality within the construction industry by providing empirical evidence from Bauchi State, a region that has received limited scholarly attention despite its distinctive socio-cultural environment. Unlike previous studies that examined gender challenges at a national level, this research demonstrates how local cultural norms, workplace practices, and societal expectations collectively shape the experiences of female professionals in northern Nigeria.

The study further contributes by identifying context-specific interventions that can improve female participation and career progression. The findings provide evidence-based recommendations for policymakers, professional bodies, educational institutions, and construction firms seeking to promote gender inclusivity. The integration of organisational and socio-cultural dimensions offers a more comprehensive understanding of gender inequality within the construction sector. It extends the application of Role Congruity Theory within the Nigerian construction context.

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5.8 Practical Implications

The findings of this study have important implications for policymakers, construction firms, professional associations, and educational institutions. Government agencies and regulatory bodies can utilise the results to strengthen the implementation of gender-inclusive employment policies and establish monitoring mechanisms for equitable recruitment, remuneration, and promotion practices. Construction organisations can develop mentorship programmes, leadership development initiatives, and flexible work arrangements that support female professionals throughout their careers. Professional bodies such as the Nigerian Institute of Building (NIOB), the Nigerian Society of Engineers (NSE), and the Association of Professional Women Engineers of Nigeria (APWEN) can leverage the findings to expand networking opportunities and advocacy efforts to increase women's representation in leadership positions. Educational institutions can use the evidence to design targeted scholarship schemes, career awareness programmes, and technical training initiatives that encourage more young women to pursue careers in the built environment. Collectively, these interventions can contribute to a more inclusive construction industry, improved workforce diversity, enhanced innovation, and sustainable sectoral growth.

5.9 Limitations and Future Research

This study is subject to certain limitations. First, the research focused exclusively on female professionals within Bauchi State, which may limit the generalisability of the findings to other regions of Nigeria. Second, the use of a cross-sectional survey design captures perceptions at a single point in time and does not account for changes that may occur over time. Third, the study relied primarily on self-reported data, which may be influenced by respondent bias. Future studies should consider comparative investigations across multiple states or geopolitical zones to identify regional variations in gender-related challenges. Longitudinal research may also provide deeper insights into career progression patterns among female professionals. Furthermore, qualitative approaches such as interviews and focus group discussions could offer richer understanding of the lived experiences underlying the statistical findings reported in this study.

6. CONCLUSION AND RECOMMENDATIONS

This study examined the challenges faced by female professionals in Bauchi State's building industry, highlighting barriers to career advancement, the impact of gender stereotypes, and the influence of cultural norms. Despite their education and professional experience, women continue to face limited access to leadership roles, wage disparities, and exclusion from high-profile projects. Societal expectations that prioritise domestic responsibilities further constrain women's participation.

The findings confirm that gender inequality in construction is both structural and cultural. Women are constrained not only by discriminatory workplace practices but also by cultural norms that discourage their involvement in male-dominated professions. However, respondents strongly supported interventions such as mentorship programs, gender quotas, leadership training, and targeted educational initiatives.

Recommendations:

1. **Policy Action** – Government and professional bodies should enforce gender equity policies, including affirmative action and transparent recruitment processes.
2. **Mentorship and Networking** – Establish formal mentorship programs and female-focused professional

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networks to support women's career growth.

3. **Leadership Training** – Provide capacity-building programs to prepare women for managerial and leadership roles.
4. **Educational Initiatives** – Introduce scholarships, technical training, and career guidance programs to encourage young women to pursue construction careers.
5. **Cultural Reorientation** – Community sensitisation programs should challenge stereotypes and promote the value of women's contributions to the building industry. By implementing these measures, Bauchi's construction sector can become more inclusive and equitable. Empowering women will not only enhance gender equality but also strengthen innovation, productivity, and sustainability within the industry.

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EXAMINING THE FACTORS INFLUENCING THE IMPLEMENTATION OF INTERNET OF THINGS IN THE NIGERIAN CONSTRUCTION SITE: A SEM APPROACH

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Abstract
The implementation of IoT in the Management of Building Production changed the trajectory of the industrial revolution; it comprises several technologies, with the Internet of Things forming the basis of this revolution. However, there is a widening gap between traditional building production management and digital, data-driven building production management. Hence, the implementation of IOT in the management of building production will increase productivity. Consequently, factors influencing IOT implementation at Nigerian construction sites need to be understood by practitioners for effective implementation. This study was conducted to identify factors influencing IoT implementation at construction sites in Nigeria. It will also serve as a benchmark for analysing the significant relationships between the construct and its items and for confirming the effect of the construct on the effective implementation of IoT in the Nigerian construction site, using the SEM-AMOS approach as the data analysis method. Hence, a model is proposed based on SEM-AMOS. The primary data from participants across the selected 6 North-Central States, totalling 220 responses, were retrieved using a convenience sampling approach, and the analysis was carried out using the Statistical Package for the Social Sciences (SPSS) Version 22.0 and AMOS Version 22.0 for modelling. This paper identified four factors that are influential in the effective implementation of the Internet of Things (IoT). They are referred to as latent constructs, namely: Technology (FAR), Security (SAR), Organisation (FEM) and Environment (ERM). The results showed a significant relationship between IOT influential factors. This paper enhances construction practitioners' knowledge of implementing IOT for effective building production management and suggests to Builders, facility managers, Architects, and engineers the need to implement IOT for effective management of building sites.
Keyword: Construction site, Building production management, Internet of things, implementation,

1.0 Introduction

Effective building production management is considered a critical issue in every building construction site due to a high number of reported cases of low-quality production and worker injuries (Rathnansinghe, 2021). However, existing data indicate that there are over 60,000 construction-site fatalities and several instances of poor-quality building products worldwide (Ojo, 2021). The paper

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further revealed that construction sites were responsible for over 20% of the total fatalities in Europe, whereby this figure is higher in developing countries, which stood at 30-40%. In addition. It is generally agreed that the construction sector contributes greatly to the economic development of any country. Willar (2012) described that "the construction industry worldwide is one of the major contributors to the Gross Domestic Product (GDP) as well as playing an important role in determining a nation's economic growth, to this end, the Nigeria construction sector plays a significant role in meeting the desires of the country's infrastructural and economic development; thus, making it one of the foremost economic pointers that control the development of the Nigerian economy. The Internet of Things concept involves connecting various devices to a network over the Internet. This concept conceals the dream of a world in which physical equipment and digital items of daily use will interact with each other (mostly without human intervention) through a wide range of new applications and services, as well as the right structure (Ojo, 2022). New developments in the construction sector have been observed, indicating an increased role of information technology and automation across many areas of the economy (Bowen, 2021). The IoT field is a long-range technological area that offers significant opportunities for growth. The Internet of Things is a comparatively new area of knowledge that involves a high level of uncertainty, including IoT technologies and the related economic, social, legal, and technological dimensions (Oke, 2020).

The IoT is enormously important to the built environment (Dilakshan, Rathnasinghe, Seneviratne, 2021). Liu, Hong, and Jiang (2023) insisted that carpenters, welders, and painters on the worksite might not discuss the IoT in casual discussions. Nevertheless, a significant number of industry-leading builders are using IoT devices to monitor equipment, machinery, and workers, enabling better real-time decision-making. Consequently, there are 367 IoT-related projects identified worldwide, whereas industrial-related projects are 265, and IoT-related building projects are 193 (Lueth, 2019)

Therefore, the benefits of implementing IoT-based technologies across various aspects of Construction Site management cannot be overemphasised; acceptance of these technologies remains in its early stages, even in developing countries. There is a lack of research that identifies and analyses the factors affecting the implementation of IoT-based technologies to enhance activities within the construction sector. Therefore, this study aims to achieve the following objectives: identify factors that influence the effective implementation of the Internet of Things, establish significant relationships among IOT influential factors, and develop a valid structural equation model. The novelty of this research lies in the factors influencing the implementation of IoT in Nigerian construction sites, using SEM Amos as an analytical tool. The remaining parts of the research are structured as follows: Part Two reviews the literature relating to the use of IoT-based technologies in the construction sector. Part Three details the research methodology used to achieve the research objectives. Part Four presents and discusses the research findings. Finally, the concluding remarks of the study, the implications of the findings, the limitations, and the directions for future work are presented

1.2 Purpose of the Study

The study aims to establish factors influencing the implementation of IoT in Nigerian construction sites. It will also serve as a benchmark for analysing the significant relationship between IoT implementation and its influencing factors, and for confirming the construct's effect on effective

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implementation, with particular application to Nigeria, using structural equation modelling. Based on the literature review, the following hypotheses are formulated.

H1: Technology has a significant effect on IoT implementation

H2: Security has a significant effect on IoT implementation

H3: Organisation has a significant effect on IoT implementation

H4: Environment has a significant effect on IoT implementation

2.0 Literature Review

The Internet of Things (IoT) is an emerging technology that has enhanced the integrity and effectiveness of all stages of construction, including the design, construction, and post-construction stages of buildings (Tabatabaee, Mohandes, Ahmed, Mahdiyar, Arashpour, Zayed, & Ismail, 2022). Intelligent design with 3D modelling brings precision and enhances productivity efficiency. This improves plan updates, which occur in real-time. The problem of lag time between the delivery of new information and updates on the job site has been resolved. This lessens the valuable resources and time that is being spent and improves the implementation of new design components speedily. IOT is a more useful and sophisticated software used beyond the design and building phases. During construction and after construction, and when the structure is in use, IOT provides benefits for construction managers, such as trends/patterns in energy usage. Most modern buildings have IoT sensors installed on walls that monitor various building systems. Collected data will be analysed regularly to identify trends and patterns in building usage. This makes building managers empowered to enhance energy efficiency, strategically handle operations, know particular trends or patterns, and effectively make use of the capabilities of a building's security, cooling and heating system, access, and water supply (Joshua, 2020)

2.1 Internet of Things

The International Telecommunication Union (Ryan, 2012) defined IoT as "A global infrastructure for the information society, allowing progressive services by connecting (physical and virtual) things based on existing and developing interoperable information and communication technologies, Specifically, IoT is identified as a system of 'Things' using the Internet or a private network to connect and communicate with each other (Censis, 2019). In particular, 'Things' are defined as 'smart devices' connected to a network and communicating with one another with minimal human engagement (Oke, 2020). The basic idea is that objects of day-to-day life can be equipped with detection, sensing, networking, and processing capabilities that enable them to communicate over the Internet with one another and with other devices and services to achieve a common goal (Ogunsemi, 2021). In such a context, the IoT allows people and Things to be connected anytime, anyplace, with anything and anyone, ideally using any path/network and any service (Oke,2020). The system enables acquiring, processing and responding to real-world data in real time (Viswanatha; Ramachandra; Venkata Siva Reddy; Ashwini Kumari; Srinivasa Murthy; Sathisha, 2022)

The implementation of interaction and communication with the physical environment is supported by IoT devices (sensors and actuators), with information gathered and judiciously handled to derive valuable interpretations. Examples of *sensors* include mobile phones and internet-enabled phones because they can provide input concerning their current state. An *actuator* is a device used to effect a change in the environment, such as the temperature controller of an air conditioner (Joshua,

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2020). Information dispensation and storage can be affected on a remote server. The output of information processing by a device is often stored on a nearby device if the device has the capability to process it. The accessibility of limited resources is often a constraint on IoT devices due to size, processor, and computational constraints. According to Pallavi and Smruti (2017), "the main study challenge is to ensure that we get the right kind of data at the desired level of accuracy" (Nimlyat, Audu, Ola-Adisa, and Gwatau, 2017). Again, adding to the problem of data gathering and handling, there are communication issues as well because communication between IoT devices is mainly wireless, and they are generally installed at geographically discrete locations" (Pandit and Tripathi, 2019). However, well-defined standards are needed to ensure interoperability among such varied devices (Oke, Arowoiya, and Akomolafe, 2022). Calibration is impossible due to the varying requirements of applications and devices. Pallavi and Smruti(2017) concluded that "the heterogeneity of devices and applications implies the development of a middleware platform performing the task of software interface between the *things* and *applications"* (Hawash, Mokhtar, Yusof, Mukred, and Gaid,2021). In summary, an Application Programming Interface (API) is provided through the abstraction of the hardware by the middleware for communication, data management, computation, security, and privacy (Joshua, 2020)

2.2 IoT and Its Prospects in the Nigerian Construction Industry

As a result of developments in the IoT and the notable benefits accrued by developed countries worldwide from its use, there is no doubt that its prospects in Nigeria's construction industry, as a developing country, are bright. Nigeria faces several management problems, especially in the construction industry and other key areas of the economy, such as agriculture, education, health, transportation, and water and waste management. Despite the huge annual budgetary allocation, the government has not been able to achieve equivalent results.

The Nigerian state and federal governments are not showing interest in the new Technology that is taking over every aspect of the lives of citizens of other developed nations of the world. IoT is a complementary development of ICT and has found applications in the economy, construction, smart cities, transportation, and security. However, according to Joshua (2020), at the international level, IoT is a hot topic with great potential. It is getting support from individuals and organisations, but you cannot really say that in Nigeria, as the subject is still considered strange. Currently, media reports show that the government is willing to discover the connected world; however, it is still far from what is expected (Moodley, 2019). Indifference is one of the reasons Nigerians have not keyed into the new Technology. Nigerians are not yet persuaded about the new Technology and its applications. Companies have also not invested seriously in IoT, and the failure rate for device connectivity is high. Security concerns are another related issue, as advancements in Technology have also led hackers to upgrade their attack methods. Already, the risk of performing e-transactions in Nigeria is very high, and investors have been wary of losing their funds. Banks have also declared losses in Millions of naira as a result of e-transactions to fraudsters. However, the good news is that manufacturers of these devices have gone a long way in curtailing the activities of these hackers (Hawash et al, 2021)

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2.3 Factors affecting the implementation of IoT

Intensive literature which was carried out to determine the Xray the factors influencing the implementation of IoT and are basically built on theories, models and frameworks which include TOE framework, TOE designed by Tornatzky and Fleischer (1990) as a rigorous techniques known as the Technology, organisation, and Environment (TOE) framework which analytically pragmatic in numerous studies in developed and developing countries and turned out to be the most significant organisational theory for measuring the implementation and reception of new technology " (Hawash et al, 2021), (Tripathi et al, 2019), and (Oke, 2020). The TOE framework has been globally accepted by many researchers in the IS field to test the effect of critical success factors on the implementation. There are other theories that have been influential in measuring the influence of the organisation to accept new Technology, which are "technology acceptance model (TAM) and diffusion of innovation (DOI)", which were not chosen for this study. The link between the implementation and the factors in the Technology, organisation, and environment settings was statistically significant; however, some factors were undesirable. Therefore, there are numerous aspects within these dimensions; for example, internal or external factors included under the technological dimension should ensure that the Technology works precisely (Oke, 2020). Furthermore, there are barriers to the implementation and use of IoT, including privacy, security, data verification, access control, user privacy, and business processes. Also, enabling the exchange of operations and services through IoT in the building industry has security benefits and makes it much easier for organisations to carry out their daily operations. This study uses dimensions to test the factors affecting IoT implementation in the building construction industry using the SEM approach. These dimensions are Technology, Organisation, Environment and Security (TOES). Each dimension includes significant factors identified in previous studies through content analysis.

Table 2.1: Factors Affecting IoT Implementation

S/no	Factors	Authors
1	Technology factor	(Oke, 2020). (Viswanatha; Ramachandra ; Venkata Siva Reddy ; Ashwini Kumari ; Srinivasa, 2022) , (Moodley, 2019), (Ojo, Ogunsemi, & Ogunsina, 2022)
2	Organisation factor	(Viswanatha; Ramachandra ; Venkata Siva Reddy ; Ashwini Kumari ; Srinivasa, 2022), (Moodley, 2019), (Ojo, Ogunsemi, & Ogunsina, 2022).
3	Environment Factor	(Moodley, 2019) , (Ojo, Ogunsemi, & Ogunsina, 2022).
4	Security Factor	(Moodley, 2019), (Lekan, D, Ojo,2022).

Table 2.1 lists all important factors explored through literature content analysis based on the TOE framework, with the addition of a new context (security). Accordingly, this study presents a unique model and examines the factors that influence IoT implementation at a Nigerian building construction site.

3.0 Research Methodology

This study was conducted to identify factors influencing the implementation of IoT in Nigerian construction sites. It will also serve as a benchmark for analysing the significant relationships among the constructs/items and defining the effects of the constructs on the effective implementation of IoT in Nigerian

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construction sites, using the SEM-AMOS approach for data analysis. The study population comprises 220 professionals in the building industry and IoT users, selected across the six (6) North-Central states of Nigeria. Two research questions were developed to guide the study. A structured questionnaire was used to collect data from participants and was duly validated by experts. The Cronbach's alpha reliability technique was used to determine the internal consistency of the questionnaire items, yielding 0.833. Data collected were analysed through Confirmatory Factor Analysis (CFA) using the Statistical Package for the Social Sciences (SPSS) and Analysis of Moment Structures (AMOS). The survey research design is appropriate for this study, as data were collected through a questionnaire on the factors influencing the implementation of IoT in Nigerian construction sites.

3.1 Justification for the Structural Equation Model

Structural Equation Modelling (SEM) is a multivariate statistical technique generally used to study relationships and to link latent constructs and observed variables in research (Qureshi, 2015). SEM's foothold rests in both factor analysis and multiple regression analysis. It is possible to estimate multiple, interrelated dependence relationships with SEM, representing unobserved constructs in the relationships and accounting for measurement error (Hair et al., 2017). A sample size of at least 200 normally distributed data is suggested when using SEM (Pallant, 2016). This study had 220 participants; therefore, SEM is applicable. The two important elements of SEM are the measurement model and the structural model. The measurement model in SEM shows the significant relationships between latent constructs and their observed indicators, while the structural model estimates the relationships between constructs. Confirmatory Factor Analysis (CFA) is a crucial method for testing the fit of the data to the hypothesised model (Qureshi, 2015). In this study, a preliminary analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 23 and AMOS version 22 as a modelling tool.

3.2 Kaiser-Meyer-Olkin (KMO)

The application of Likert scales in any research requires that such questionnaires be subjected to the Cronbach's alpha coefficient to establish the reliability and consistency of the constructs. Using SPSS version 22, Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity were conducted, and the findings, as indicated in Table 3.1, revealed that the KMO value is .000, indicating that the correlation matrix is not distinctive, and the data set is appropriate and acceptable, with a value of .833. Hence, a value above 0.6, as recommended by Kaiser (1977) and cited by Pallant (2016), indicates that factor analysis is suitable

.

Table 3.1: Results of KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-meyer-01kin measures of Sampling Adequacy		.833
Bartlett Test of Sphericity	Approximate Chi-square	14861.4
	df	1595
	sig	.0000

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4.0 Analysis of Results

4.1 In order to provide the required answers to the research questions in this paper, the researcher made use of IBM-SPSS and AMOS software to analysed the collected data from the field. Table 4.1 explains demographic information of the participants; these include Architects, Builders, Quantity Surveyors, IoT Users, and Civil Engineers.

Table 4.1: Demographics of the Participants

Parameter	Value	Frequency	Percentages%
Professionals Affiliation	NIA	52	24%
	NIOB	61	28%
	NSE	37	16.8%
	NIQS	41	18.6%
	OTHERS	29	13.2%
Academic qualification	National Diploma	77	35%
	Higher National Diploma	89	40%
	Bachelor Degree	34	15%
	Master Degree	17	7.7%
	PhD Degree	3	1.36%
Years of working experience	2- 6 years	98	44%
	7 – 10 years	69	31%
	11 – 15 years	22	10%
	16 – 25 years	16	7.3%
	26 years and above	15	6.8%
Total		220	

4.2 Confirmatory Factor Analysis

This section presents the measurement and Structural confirmatory factors analysis model, with the needed model fitness as shown in the Table

Table 4.2: The three types of model fitness and level of acceptance

	Name of Category	**Name of Index**	**Level of Acceptance**
1	Absolute Fit	Chi-square	P-value<0.05
		RMSEA	RMSEA < 0.08
		GFI	GFI>0.090
2	Incremental Fit	CFI	CFI> 0.90
		TLI	TLI> 0.90
		NFI	NFI>0.90
3	Parsimonious Fit	Chisq/df	Chisq/df < 5.0

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4.3 Measurement Model Analysis

The outcomes of the measurement model were analysed using SEM-AMOS to determine construct validity, including convergent and discriminant validity (CV and DV). CV was evaluated using factor loadings, composite reliability (CR), and the average variance extracted (AVE). The test was carried out, and the results of factor loadings were statistically significant. In addition, the CR values for all factors ranged from 0.902 to 0.920, exceeding the minimum criterion of 0.7, indicating that the CR and CV of the scales were satisfactory. The analysis results for the CV are presented in Table 4.3. The results revealed that the constructs' AVE values ranged from 0.692 to 0.841, exceeding the recommended threshold of 0.5. As shown in Table 4.3, the AVE, CR, Cronbach's alpha, and factor loadings were significant, and the factors influence the Implementation of IoT in Nigerian construction sites.

Table 4.3: Results of Reliability and Validity Analysis

Item description	No of Items	Variables	Factor loading	Cronbach Alpha Above 0.7	Composite reliability (CR) Above 0.6	Average Value (AVE). Above 0.5
Technology (FAR)	FAR1	ICT Infrastructure	90	0.833	0.913	0.732
	FAR2	Numbers of data center	79			
	FAR3	Efficiency data recording	84			
	FAR4	ICT Training	76			
	FAR5	Network connectivity	76			
	FAR6	Knowledge of ICT	91			
	FAR8	Develop IoT Standard	61			
Organisation (FEM)	FEM1	Organisational scope	76	0.836	0.951	0.692
	FEM2	Top Management support	84			
	FEM3	I T skill	86			
	FEM4	Continuous monitoring	55			
	FEM5	Organisational policy	72			
	FEM6	Effective power supply	90			
Security (SAR)	SAR1	Security information	88	0.872	0.964	0.841
	SAR4	Security cooperation	84			
	SAR5	Safety hazard	85			

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	SAR6	Data privacy	88			
	SAR7	Social-economic policy	83			
	SAR8	Security risk	86			
Environmental (ERM)	ERM1	Government policy	62	0.894	0.952	0.753
	ERM2	Awareness	75			
	ERM3	Social-political motivation	92			
	ERM4	Physical interaction	80			
	ERM5	The right IoT Vendor	77			
	ERM6	Infrastructure	69			

4.4 Analysis of Structural Model

The structural model represents the relationships existing between the latent constructs. Based on the theory, the latent constructs from the measurement model were classified into second-order latent constructs, namely FAR (Technology), FEM (Organisation), SAR (Security), and ERM (Environmental), and 24 sub-latent constructs. Using AMOS, model validation is essential to transform the measurement model into a structural model for analysis. Figure 4.1 presents the results of the final structural equation model of the components of effective IoT implementation in Nigeria. The final output of the model had the following: Chi-square= 558.488, df =247, P=0000, Ratio =2.261, CFI = .946, IFI= .947, TLI= .940, RMSEA=. 060.The summary of factor loadings and the validity of the components of the effective IoT implementation construct in Nigeria.

Table 4.4: Factor loading and validity

Item description	No of Items	Variables	Factor loading	Composite reliability (CR) Above 0.6	Average Value (AVE). Above 0.5
Technology (FAR)	FAR1	ICT Infrastructure	73	0.925	0.832
	FAR2	Numbers of data center	70		
	FAR3	Efficiency data recording	91		
	FAR4	ICT Training	71		
	FAR5	Network connectivity	78		
	FAR6	Knowledge of ICT	64		
	FAR8	Develop IoT Standard	52		

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Organisation (FEM)	FEM1	Organisational scope	79	0.967	0.792
	FEM2	Top Management support	85		
	FEM3	I T skill	97		
	FEM4	Continuous monitoring	56		
	FEM5	Organisational policy	72		
	FEM6	Effective power supply	90		
Security (SAR)	SAR1	Security information	78	0.971	0.853
	SAR4	Security cooperation	83		
	SAR6	Data privacy	80		
	SAR7	Social-economic policy	83		
	SAR8	Security risk	85		
Environmental (ERM)	ERM1	Government policy	82	0.972	0.854
	ERM2	Awareness	72		
	ERM3	Social-political motivation	92		
	ERM4	Physical interaction	79		
	ERM5	The right IoT Vendor	75		
	ERM6	Infrastructure	66		

Table 4.5: Summary of the fitness indices results for measurement and structural equation model

Category's Name	Parsimonious Fit	Absolute Fit	Incremental Fit	Incremental Fit	Absolute Fit	Remark
Fitness indexes	Chisq/df	CFI	IF	TLI	RMSEA	
Acceptance level	Chisq/<3.0	CFI >0.90	NFI > 0.90	NFI > 0.90	RMSEA <0.08	Fitness level required
Measurement model	562.073	0.952	0.915	0.945	0.58	Fitness level achieved
Structural model	558.488	0.946	0.908	0.940	0.60	Level required is achieved
MODEL IS ACCEPTED						

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4.5 Discussion of Results

The final result in Figure 4.1 shows the collaboration effect of all the constructs in the path diagram. This study used standardised regression weights along with squared multiple correlations (R2), given their advantage for interpreting interactions among the constructs in the model. As noted by Awang (2014), R2 represents the percentage of variation in the dependent variable (s). Hereafter, the model's explanation improves as the R2 value increases. Generally, R2 values are described as follows: 0.75 as strong, 0.5 as moderate, and 0.25 as weak (Henseler, Ringle, & Sinkovics, 2009; Wong, 2013). In Table 4.5, all Fitness Indexes met the mandatory level, thereby indicating the validity of the constructs in the model. The model in Table 4.6 shows that all p-values are highly significant, with $p < 0.005$. Figure 1 result reveals that the correlation between the constructs is below the threshold of 0.85, indicating that redundancy does not exist among the components. All factor loadings are positive and high, indicating that all items are important for measuring the respective constructs. The research hypotheses were formulated, and the structural model was used to test them. The structural model results, along with path coefficient values, are presented for each relationship between independent and dependent constructs, using the standardised regression weights in SEM-Amos. The structural model was analysed by testing the hypothesised relationships among the constructs across all factors. The proposed relationships in this study have been measured using standardised path coefficients at the $p < 0.05$ level, which will be considered satisfactory. Therefore, all the relationships were found to be significant. The results from SEM-Amos revealed the effects of all constructs in the path diagram, as presented in Table 4.6. Hypothesis testing was conducted, and the hypotheses were analysed based on the relationships among factors. Therefore, the relationships among the factors and the correlations, as estimated from standardised structure coefficients, are presented. Furthermore, the hypothesised relationship between influential IoT factors and IoT implementation was tested at the 0.05 significance level ($p < 0.05$). The results revealed that the hypotheses were supported and significant, as presented in Table 4.6. From these outcomes, all hypotheses are accepted. Therefore, the factors in this study significantly affect the implementation of IoT on Nigerian construction sites. Therefore, the relationship between all factors and the implementation of IoT is significant and positive. The results indicated that C.R values used to test the relationships between factors and IoT implementation are significant, and the P-values for all factors are significant and less than 0.05. The hypotheses are thus statistically supported. Table 4.6 shows that the four research hypotheses H1, H2, H3, and H4 are significant and have positive effects on IoT Implementation factors. Therefore, the hypotheses are all supported

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Table 4.6: Significant effect of influential factors on IoT implementation in the Nigerian construction Site

Construct	Path	Dependent Variable	Std.Estimate	S. E	C.R	P-Value	Result
FAR	_<------	IoT Implementation (FSM)	.148	.049	20.875	****	Significant
FEM	<------	IoT Implementation (FSM)	.122	.065	13.603	****	Significant
SAR	<-------	IoT Implementation (FSM)	.180	.064	16.160	****	Significant
ERM	<-------	IoT Implementation (FSM)	.150	.064	14.850	****	Significant

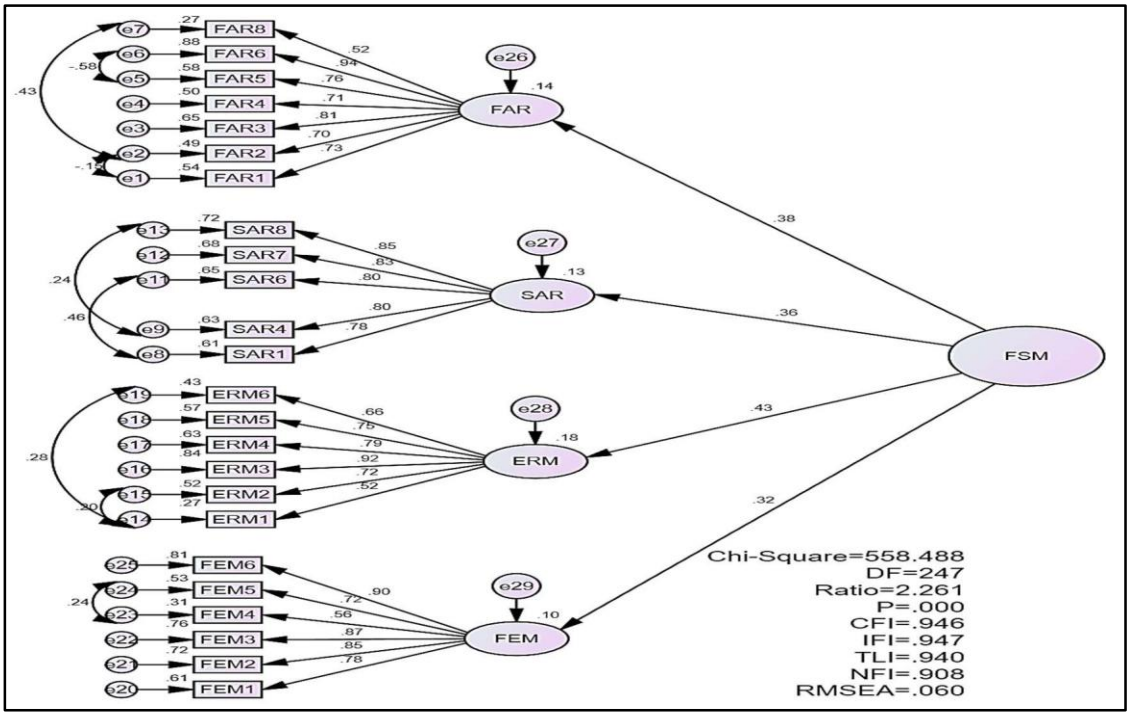


Figure 4.1: Structural Model

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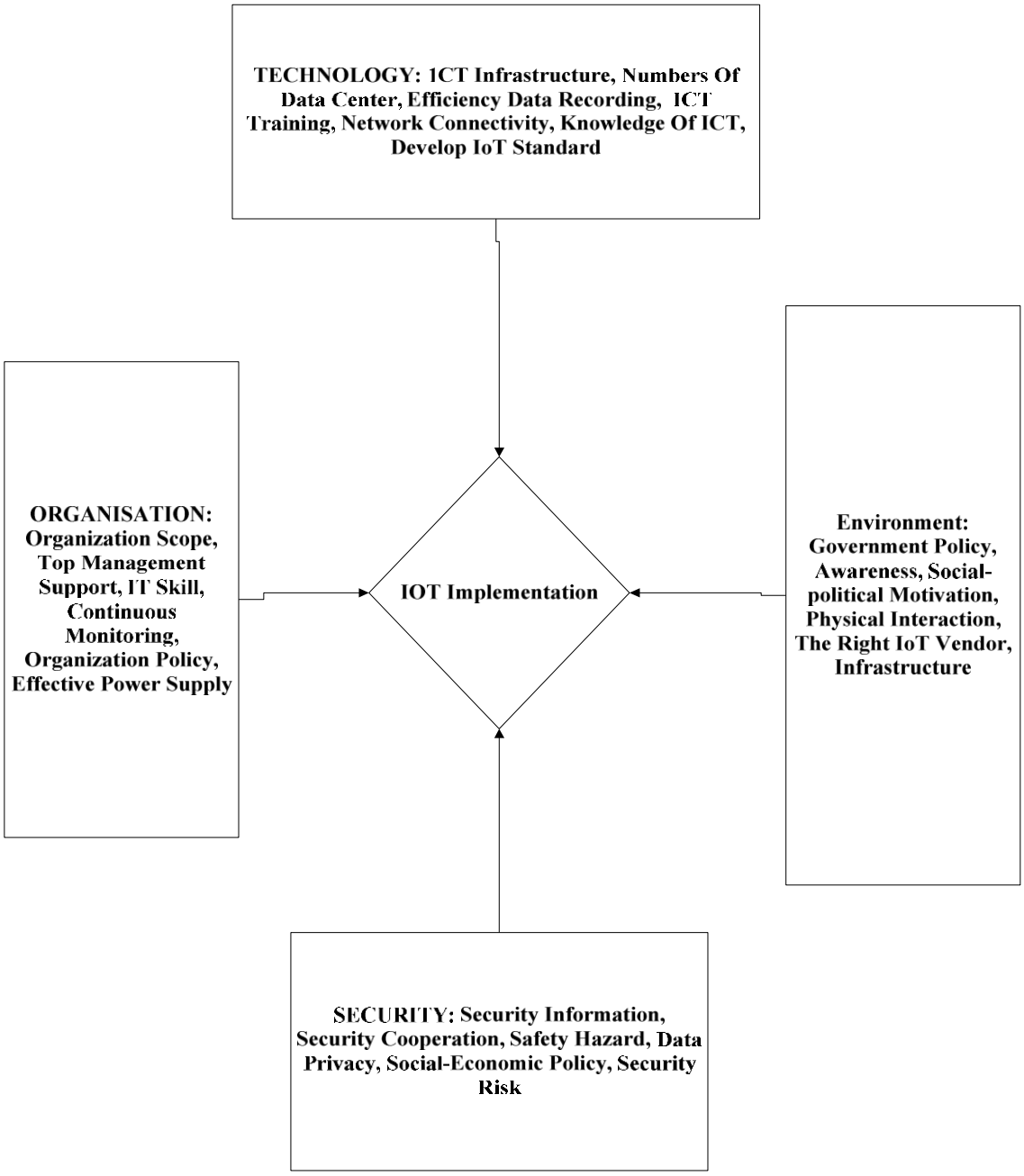


Figure2: Proposed Model IoT model for Building construction professionals

5.0 Conclusion

This study examines the effect of four main factors, such as Technology (FAR), Organisation (FEM), Security (SAR), and Environment (ERM), which were explored from an intensive literature review on the implementation of the IoT in the Nigerian construction site. This study seeks to provide empirical insight into the feasibility of integrating the explored factors and their items into a framework/model for the effective implementation of IoT technology in the management of building construction sites. Data were collected from highly

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educated professionals in the Nigerian building industry and IoT users and analysed using the SEM-AMOS approach, which is considered by many researchers to be ideal for testing significant relationships of multiple variables and is capable of determining the effect of dependent variables on independent variables, especially in the case of multiple data. The results of this study provide new insights into the significant factors that impact the adoption of IoT in Nigerian construction sites. The proposed framework in this study can be used as a guideline for the implementation of IoT Technology in the construction site.

Furthermore, the findings of this study will provide suggestions for Builders, Facility managers, Quantity Surveyors, Architects, and other Building stakeholders to support the effective implementation of IoT on construction sites. The study focused on data from professionals in the building industry and IoT users; therefore, the conclusions may differ in other areas of application.

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LABOUR RELATIONS AND CONSTRUCTION CRAFTSMEN PRODUCTIVITY IN ABUJA, NIGERIA

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Abstract:
The pervasive labour exploitation in Nigeria is affecting labour productivity, resulting in poor performance of construction projects. Hence, this study investigates the effect of labour relations on the productivity of construction craftsmen in Abuja, Nigeria, with a view to improving project performance. The study adopted a quantitative approach using exploratory and descriptive methods. The study had a sample frame of 250 construction professionals; 155 questionnaires were conveniently administered, yielding a 94.83% response rate. Data were subjected to descriptive and inferential statistics. Twenty-two drivers of craftsmen-employer cordiality were identified; adherence to statutory daily breaks and craftsmen commitment to their duties were ranked very important (4.50-5.00) drivers, while mutual respect between craftsmen & employer, the right to join trade unions, access to pension benefits, effective reward & promotion schemes, and others were ranked as important drivers (3.50-4.49). Availability of tools & equipment for craftsmen's tasks and avoiding craftsmen fatigue by curtailing overtime were ranked as very effective (4.50-5.00) factors that enhance craftsmen's productivity. Assurance of job security, avoiding shortages and late supply of materials, clarity in craftsmen's work specifications, craftsmen's comprehension of the adopted construction method, cordiality among the project workforce, and others were ranked as effective (3.50-4.49). Moreover, drivers of craftsmen-employer cordiality have a significant positive effect on construction craftsmen's productivity ($\rho = 0.726$, $p < 0.01$), explaining approximately 52.71% of the variation in productivity. The study recommends adherence to drivers of craftsmen-employer cordiality, with emphasis on the two most important drivers, and promotes factors that enhance craftsmen's productivity, with attention to the two most effective factors.
***Keywords*:** Cordiality, Craftsmen-employer, labour relations, productivity

1.0 INTRODUCTION

The construction industry remains one of the most labour-intensive sectors globally and contributes significantly to economic development, employment generation, and infrastructural growth. Previous studies have consistently reported that labour productivity remains one of the most critical determinants of project success and organisational competitiveness within the construction industry (Naoum, 2015; Rathnayake & Middleton, 2023). In developing countries such as Nigeria, the construction industry plays a strategic role in national development by delivering housing, transportation systems, commercial buildings, and public

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infrastructure. However, poor labour productivity remains a persistent challenge affecting project delivery, construction cost, time performance, and overall project quality (Usman et al., 2024).

Construction productivity is strongly influenced by the nature of labour-management relationships existing within project environments. Effective labour relations improve workers' morale, trust, communication, commitment, and cooperation, thereby creating favourable conditions for enhanced productivity and project performance (Ajay and Anandan, 2023). Conversely, poor labour relations often lead to labour disputes, absenteeism, dissatisfaction, low morale, workplace conflicts, and reduced productivity (Ogundele and Majekodunmi, 2024).

In Nigeria, labour exploitation, poor remuneration, weak occupational safety practices, delayed wage payments, and inadequate welfare provisions continue to affect construction craftsmen adversely. Construction projects in northern Nigeria continue to experience workforce and project delivery challenges that adversely affect productivity and labour management practices (Shehu et al., 2019). These challenges contribute significantly to poor productivity and underperformance in construction projects (Okezie and Kuroakegha, 2025; Olughu et al., 2025). Construction craftsmen, including masons, carpenters, steel fixers, electricians, plumbers, and tilers, are central to the successful execution of construction activities. Consequently, cordial relationships between employers and craftsmen are essential for improving construction performance and achieving organisational objectives.

Several studies have investigated labour productivity within the construction industry. However, limited studies have specifically examined the effects of labour relations and cordiality between craftsmen and employers on craftsmen's productivity in the Nigerian construction context (Van Tam et al., 2021). Existing studies have focused mainly on productivity factors, workforce management, occupational safety, and project performance, without adequately addressing labour cordiality as a critical determinant of productivity (Pimpong, 2023).

Contemporary studies emphasised the growing importance of employee wellbeing, workforce engagement, occupational health and safety, and labour-management collaboration in improving productivity in construction projects (Dumitriu et al., 2025; Huynh et al., 2025; Rani et al., 2022). In addition, post-COVID-19 construction management studies have further highlighted the need for improved workforce welfare and labour sustainability strategies to enhance construction productivity and resilience.

Therefore, this study investigates the effect of labour relations on the productivity of construction craftsmen in Abuja, Nigeria, with a view to improving project performance. In this light, the study outlined the following objectives:

i. To assess the drivers of cordiality between craftsmen and employers in Abuja, Nigeria.
ii. To assess factors that enhance the productivity of craftsmen in Abuja, Nigeria.
iii. To determine the effect of the drivers of craftsmen-employer cordiality on craftsmen's productivity in Abuja, Nigeria.

The study tests the following hypotheses on the corresponding aforementioned objectives:

i. There is no statistically significant difference in the mean rankings of the two groups of respondents regarding the drivers of craftsmen-employer cordiality in Abuja, Nigeria.
ii. There is no statistically significant difference in the mean rankings of the

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two groups of respondents for the factors that enhance craftsmen's productivity in Abuja, Nigeria.

iii. Drivers of cordiality between craftsmen and employers do not affect craftsmen's productivity in Abuja, Nigeria.

2.0 LITERATURE REVIEW

2.1 Theoretical Construct

This study is anchored on Herzberg's Two-Factor Theory, developed by Frederick Herzberg in 1959. The theory explains that two major categories of factors influence employee motivation and productivity: hygiene factors and motivator factors. Hygiene factors include salary, job security, working conditions, organisational policies, and interpersonal relationships, while motivators include recognition, achievement, responsibility, growth, and advancement. Several studies have validated Herzberg's theory in contemporary work environments and demonstrated its relevance in explaining employee motivation and workplace productivity (Yusoff et al., 2013; Lim & Ahmad, 2021).

According to Herzberg's theory, poor hygiene factors result in dissatisfaction among workers, whereas strong motivator factors improve morale and productivity. In construction project environments, cordial labour relations, occupational safety, welfare provisions, adequate remuneration, and effective communication serve as important hygiene factors that influence craftsmen's productivity.

Recent studies have applied Herzberg's Two-Factor Theory to explain workforce motivation, job satisfaction, and productivity in construction environments. Employee welfare provisions, organisational support, occupational health and safety practices, recognition, and opportunities for professional development have been identified as significant factors influencing construction workers' engagement and productivity (Wokoma and Obasi, 2023; Juba, 2024). Similarly, labour-management cooperation, effective communication, and workplace motivation have been found to positively influence workforce performance and project outcomes in the construction industry (Rajhans, 2012). The theory is therefore suitable for this study because it explains how cordial labour relations and welfare practices can improve craftsmen's productivity and overall project performance.

Labour productivity refers to the efficiency with which labour inputs are converted into construction outputs. Productivity improvement remains a major concern in construction management because labour accounts for a substantial proportion of total project costs and significantly influences project performance, profitability, and competitiveness (Huynh et al., 2025). Construction productivity has been extensively investigated in both developed and developing countries, with management practices, supervision, and workforce motivation identified as major determinants (Naoum, 2015; Elazzazy, 2020; Rathnayake & Middleton, 2023). In developing countries, low labour productivity is often associated with poor working conditions, inadequate welfare provisions, ineffective supervision, labour disputes, and weak occupational health and safety practices (Odesola and Idoro, 2014). Consequently, improving labour productivity has become a strategic priority for construction organisations seeking to enhance project delivery and operational efficiency.

Labour productivity in construction is influenced by multiple organisational, managerial, and worker-related factors, including motivation, supervision quality, occupational safety, work environment, remuneration, communication, and management practices (Jian et al., 2025; Huynh et al., 2025). Recent evidence further

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demonstrates that employee wellbeing, workforce engagement, welfare provisions, and effective safety management significantly enhance productivity and overall project performance in construction organisations (Juba, 2024). Construction productivity directly affects project cost, duration, profitability, and quality.

Recent studies have emphasised the importance of labour welfare, organisational culture, workforce engagement, occupational health and safety practices, and effective management systems in improving construction productivity (Rani et al., 2022; Wong et al., 2023; Jian et al., 2025). In Nigeria, low labour productivity has been associated with poor working conditions, labour exploitation, inadequate supervision, insufficient welfare facilities, delayed material supply, limited training opportunities, and weak labour-management relationships (Hamza et al., 2022; Odesola and Idoro, 2014). These challenges continue to undermine workforce efficiency and construction project performance.

2.2 Nature of Craftsmen Employment in Nigeria

Construction craftsmen may be employed through formal or informal labour arrangements depending on the nature of construction projects and organisational employment policies. Formal employment generally offers workers contractual security, legal protection, pension benefits, insurance coverage, occupational safety provisions, and access to welfare programmes. Conversely, informal employment is frequently associated with precarious working conditions, irregular remuneration, limited social protection, and weak regulatory oversight. The International Labour Organization (ILO, 2022) reported that informal employment continues to dominate labour markets in many developing countries, particularly within labour-intensive sectors such as construction. In Nigeria, the widespread reliance on informal construction labour exposes craftsmen to occupational risks, job insecurity, inadequate welfare provisions, and limited opportunities for career development, thereby affecting productivity and overall project performance (Ozigbo et al., 2025).

Recent studies have further shown that improving employment conditions, social protection systems, and occupational safety measures significantly enhances craftsmen's productivity and job satisfaction (Ejohwomu et al., 2021).

2.3 Drivers of Craftsmen-Employer Cordiality

Cordiality refers to warm, respectful, cooperative, and professional relationships existing between employers and employees. Positive labour relations are essential for promoting trust, teamwork, communication, and organisational commitment. Employee welfare provisions, organisational justice, and sound human resource management practices have been found to strengthen employee relations and improve organisational performance (Bajaj et al., 2013; Tiwari, 2014; Akanbi & Adebayo, 2021).

Several studies have identified interpersonal relationships, occupational health and safety, employee welfare provisions, organisational justice, effective communication, and continuous training opportunities as critical drivers of cordial labour relations in construction organisations (Ajay and Anandan, 2023; Jian et al., 2025). Such positive labour relations foster trust and cooperation among project stakeholders, reduce workplace conflicts, absenteeism, stress, and employee turnover, and ultimately enhance workers' morale, organisational commitment, and productivity (Rani et al., 2022).

In construction environments, cordial labour relations are particularly important due to the collaborative and labour-intensive nature of

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construction activities. The successful execution of construction projects depends heavily on effective interaction among employers, supervisors, and craftsmen. Empirical studies have demonstrated that mutual respect, effective grievance and dispute resolution procedures, prompt payment of wages, reward and recognition systems, occupational health and safety practices, and employee welfare provisions significantly contribute to positive labour-management relationships and workforce commitment (Rajhans, 2012; Ajay and Anandan, 2023; Wong et al., 2023). Such practices foster trust and cooperation among project participants, thereby enhancing morale, reducing workplace conflicts, and improving productivity performance (Rani et al., 2022). Delayed wage payments and labour-related safety concerns have been identified as significant factors affecting workers' welfare and productivity on construction sites (Okoye et al., 2022).

2.4 Factors Enhancing Craftsmen Productivity

Construction craftsmen productivity is influenced by several technical, managerial, environmental, and motivational factors. Attar et al. (2012) identified supervision, labour management, materials availability, communication, safety management, and motivation as key productivity factors. Recent reviews have further emphasised the importance of labour productivity management systems, occupational safety, and welfare practices in enhancing construction productivity (Hamza et al., 2022; Tafese and Mengistu, 2026).

Extant studies have highlighted additional determinants of construction labour productivity, including workforce wellbeing, labour welfare provisions, occupational health and safety management, effective communication systems, and supportive work environments (Rani et al., 2022; Wong et al., 2023). Jian et al. (2025) further reported that the availability of adequate tools and equipment, effective project planning, occupational safety practices, prompt remuneration, and job security significantly improve workforce productivity. Within the Nigerian construction industry, labour productivity remains constrained by delayed material supply, poor supervision, inadequate welfare facilities, insufficient training opportunities, and unfavourable working conditions, all of which adversely affect project performance and workforce efficiency (Odesola and Idoro, 2014).

2.5 Effect of Labour Relations on Craftsmen Productivity

Labour relations involve the interaction between employers and employees regarding rights, responsibilities, communication, welfare, and organisational policies. Effective labour relations promote workers' satisfaction, motivation, and commitment.

Recent empirical studies have consistently reported positive relationships between labour cordiality and workforce productivity. Positive labour-management relationships foster trust, cooperation, communication, and employee commitment, which collectively enhance productivity and project performance (Ajay and Anandan, 2023). Furthermore, organisational support systems, employee welfare provisions, occupational health and safety practices, and workforce engagement have been identified as critical drivers of employee satisfaction and productivity in construction organisations (Rani et al., 2022; Wong et al., 2023).

Similarly, Ejohwomu et al. (2021) observed that occupational safety management, labour welfare, and communication practices significantly influence productivity within construction projects. The reviewed literature therefore suggests that cordial labour relations are critical determinants of

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craftsmen productivity and construction project performance.

3.0 METHODOLOGY

3.1 Research Design

This study adopted a quantitative research design using exploratory and descriptive survey approaches. A quantitative research design is appropriate because the study seeks to measure and analyse the relationship between labour relations and craftsmen productivity using statistical techniques. Previous construction management studies have successfully applied quantitative survey methods in investigating labour productivity and workforce management issues (Hamza et al., 2022; Jian et al., 2025). The exploratory approach enabled the study to identify relevant variables from existing literature, while the descriptive survey design facilitated the collection of perception-based data from construction professionals and craftsmen. The use of quantitative survey methods is widely recommended for investigating relationships among measurable variables in social and construction research (Creswell and Creswell, 2018).

3.2 Study Area

The study was conducted in Abuja, Nigeria. Abuja was selected because it hosts significant construction activity and infrastructure development projects, making it one of Nigeria's most active construction hubs.

3.3 Population and Sampling Technique

The study targeted construction professionals and craftsmen involved in construction project management within Abuja. The accessible population consisted of 250 respondents, including architects, builders, engineers, quantity surveyors, construction managers, and construction craftsmen. The sample size of 155 respondents was determined using Krejcie and Morgan's (1970) sample size determination table. A convenience sampling technique was adopted because it facilitated access to experienced and readily available respondents in active construction environments. Similar sampling approaches have been used in previous construction management studies involving industry practitioners (Creswell and Creswell, 2018)

3.4 Data Collection Instrument

Data were collected using a structured questionnaire developed from previous studies on labour relations and construction productivity. The questionnaire consisted of three sections:

Section A: Respondents' demographic information.

Section B: Drivers of craftsmen-employer cordiality.

Section C: Factors enhancing craftsmen productivity.

A five-point Likert scale was adopted because it is suitable for measuring respondents' perceptions and attitudes in social science and construction management research.

3.5 Reliability and Validity of Instrument

The reliability of the questionnaire was assessed using Cronbach's alpha coefficient. The constructs recorded Cronbach's alpha values of 0.806 and 0.891, respectively, indicating good reliability. Content validity was ensured through an extensive literature review and expert assessment. Construct validity was achieved by ensuring that the questionnaire items adequately measured the intended study variables.

3.6 Data Analysis Techniques

Data were analysed using the Statistical Package for Social Sciences (SPSS). Descriptive statistics, including frequencies, percentages, mean scores, and standard deviations, were used to analyse demographic data and respondents' perceptions. Independent sample t-tests were used to

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determine differences in respondents' rankings, while Spearman's rank-order correlation analysis was employed to determine the relationship between craftsmen-employer cordiality and craftsmen productivity. Spearman's correlation was considered appropriate because the study variables were ordinal and measured using Likert scales.

4.0 RESULT AND DISCUSSION

4.1 Respondents Profiles

Table 1 shows respondents' demographic profiles. All the respondents are construction professionals who ply their trades in either the public sector (35%) or private sector (65%) of the Nigerian economy. This result fully captures the nature of the Nigerian economy, which is a mixed economy. About 15% of the respondents work in a physical planning unit, a little above 16% work in a maintenance unit, nearly 15% are into consulting, while a little above 19% work in contracting firms. The rest of the respondents work in the company's estate department (slightly over 14%), and as craftsmen (a little over 20%). This result shows that the respondents work in the construction industry. Virtually all the respondents are management staff in their various organisation (91.84%): top management (24.49%), middle management (44.22%), lower management (23.13%), and craftsmen (8.16%). Their highest educational qualification is Certificate (12.24%), National Diploma (ND) (3.40%), Higher National Diploma (HND) (20.41%), Postgraduate Diploma (PGD) (12.93%), Bachelor of Science/Bachelor of Technology degrees (BSc/B.Tech.) (28.57%) and Master of Science (MSc) (22.45%). The respondents' educational specialisations are: Architecture (16.33%), Building (15.65%), Construction management (15.65%), Engineering (17.00%), Quantity surveying (15.65%) and craftsmen (19.72%).

These results show that the respondents are educationally qualified and are mostly core construction professionals involved in the management of construction projects. A little above 8% of the respondents are registered with architects' registration council of Nigeria (ARCON), 18.37% are registered with the council of registered builders of Nigeria (CORBON), 15.65% are registered with the council for the regulation of engineering in Nigeria (COREN), while about 12.93% are registered with the quantity surveyors' registration board of Nigeria (QSRBN), craftsmen are 5% and those that have no registration are 38.77%. This reveals that most of the respondents are professionally certified to practice their respective construction professions and, as such, helps the study ensure that all variables that may influence the accuracy of the data have been analysed. By implication, this ensures that the respondents used for the study are an appropriate sample (Inuwa, Joseph, and Musa, 2019).

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Table 1: Respondents' Demographic Profiles

Economic Sector		**No.**	**%**	**Cumulative %**
Public		51	35	35
Private		96	65	100
Total		147	100	
Unit within the Public /Private sector area of operation		No.	%	Cumulative %
physical planning		22	14.96	14.96
maintenance unit		24	16.33	31.29
consultancy firm		22	14.96	46.25
contracting firm		28	19.05	65.30
company estate department		21	14.29	79.59
Others		30	20.41	100
	Total	147	100	
Management level		No.	%	Cumulative %
Top management		36	24.49	24.49
Middle management		65	44.22	68.71
Lower management		34	23.13	91.84
Others		12	8.16	100
	Total	147	100	
Educational qualifications		No.	%	Cumulative %
Certificate		18	12.24	12.24
National Diploma		5	3.40	15.64
Higher National Diploma		30	20.41	36.05
Bsc/B.Tech		42	28.57	64.62
PGD		19	12.93	77.55
Msc		33	22.45	100
	Total	147	100	
Professional specialisation		No.	%	Cumulative %
Architecture		24	16.33	16.33
Building Technology		23	15.65	31.98
Construction Management		23	15.65	47.63
Quantity Surveying		23	15.65	63.28
Engineering		25	17.00	80.28
Others		29	19.72	100
	Total	147	100	
Construction craftsmen supervisor		Yes	57	77
		No	17	23
		Total	74	100
Professional registration		No.	%	Cumulative %
ARCON		13	8.84	8.84
CORBON		27	18.37	27.21
COREN		23	15.65	42.86
QSRBN		19	12.93	55.79

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Economic Sector	No.	%	Cumulative %
No registration	57	38.77	94.56
Others	8	5.44	100
Total	147	100	

4.1.1 Respondents' Work Experience in the Industry

Table 2 shows respondents' work experience in the construction industry. Forty-six per cent of the respondents have 11 years or more of industry experience. Overall, the respondents have an average of nearly 11 years' experience in the construction industry. This result revealed that the respondents are qualified and experienced to respond to an enquiry of this nature.

Table 2: Work Experience of Respondents in the Industry

Work experience (in years)	Mid value	F	% F	FX
Less than 5	5	19	12.93	95
5-10	7.5	60	40.82	450
11-15	13	42	28.57	546
16-20	18	12	8.16	216
Over 20	20	14	9.52	280
Total		147	100	1587

Mean years of experience = $\sum FX/\sum F = 1587/147 = 10.8 \approx 11$ years

4.2 Drivers of Craftsmen-Employer Cordiality

Table 3 presents the respondents' evaluation of the factors that drive cordiality between craftsmen and employers. Respondents ranked adherence to statutory daily breaks and craftsmen's commitment to their duties as very important drivers (4.50-5.00). while mutual respect between craftsmen and employer, the right to join trade unions, access to pension benefits, effective reward and promotion schemes, transportation provisions, collective bargaining rights, the right to strike, respect for organisational authority, proper leave and overtime pay, dispute resolution mechanisms, discipline processes, periodic training, prohibition of gender discrimination, adequate remuneration, health care services, occupational safety management, insurance and compensation for injuries or death, monetary incentives for holidays, and adherence to working hours and weekly holidays were ranked as important factors (3.50-4.49). The analysis further reveals that there is no statistically significant difference in the mean rankings between the two groups of respondents ($p > 0.05$), leading to the acceptance of the null hypothesis. This indicates consensus among respondents regarding the factors that drive cordiality between craftsmen and employers.

The findings revealed that adherence to statutory daily breaks and craftsmen's commitment to duties were the most significant drivers of cordiality between craftsmen and employers. Other important drivers included mutual respect, pension benefits, reward systems, transportation support, collective bargaining rights,

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occupational safety management, dispute resolution mechanisms, and healthcare services. The independent-samples t-test revealed no statistically significant difference in respondents' perceptions of the identified drivers of cordiality ($p > 0.05$). This indicates consensus among respondents concerning the importance of cordial labour-management relationships.

The findings align with recent studies demonstrating that organisational support systems, effective workplace communication, employee welfare provisions, and positive labour-management relationships significantly improve workforce morale, commitment, and interpersonal relationships within construction organisations (Rajhans, 2012; Ajay and Anandan, 2023; Wong et al., 2023; Rani et al., 2022). The findings further support Herzberg's Two-Factor Theory, which emphasises the importance of hygiene factors such as welfare provisions, occupational health and safety practices, remuneration, job security, and interpersonal relationships in reducing employee dissatisfaction and enhancing workforce performance. The results suggest that construction organisations that invest in these factors are more likely to experience improved labour relations, higher productivity, and better project outcomes.

Table 3: Drivers of Craftsmen-Employer Cordiality

SN	Factors	Mean scores		*t-stat*	Lev. Sig	Dec
		Pub. sec.	Priv. Sec			
1	Adherence to the employee's statutory daily working break	4.51	4.50	0.07	0.94	NS
2	Employee's effective commitment to his/her schedule of duty	4.57	4.54	0.20	0.84	NS
3	Employee-employer mutual respect	4.41	4.43	0.11	0.91	NS
4	Employee's right to belong to a trade union	3.76	3.88	0.61	0.55	NS
5	Employee's right to benefits from contributory NS pension scheme	4.27	4.15	0.76	0.45	NS
6	Effective organisation's employee reward promotion scheme	4.37	4.15	1.64	0.10	NS
7	Employer provision of transportation or transport allowance to employees	4.84	4.04	1.24	0.21	NS
8	Right for employee-employer collective bargaining	3.88	4.06	1.13	0.26	NS
9	Employee right to strike to press for their rightful demands	3.88	3.65	1.18	0.24	NS
10	Employee respect for organisation's constituted authority	4.31	4.39	0.44	0.66	NS
11	Honour employee statutory leaves provision & payments	4.37	4.32	0.35	0.72	NS
12	Honour statutory remuneration for employee overtime services	4.25	4.18	0.51	0.61	NS
13	Impartial dispute resolution mechanism	4.24	4.21	0.18	0.86	NS
14	Impartial organisation's discipline mechanism	4.31	4.19	0.76	0.45	NS
15	Periodic employee training for quality service delivery	4.27	4.23	0.29	0.77	NS
16	Prohibition of gender biased discrimination	4.25	4.21	0.27	0.78	NS

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SN	Factors	Mean scores		*t-stat*	Lev. Sig	Dec
		Pub. sec.	Priv. Sec			
17	Provision of adequate employee remuneration	4.27	4.29	1.32	0.19	NS
18	Provision of effective employee health care services	4.41	4.39	0.17	0.86	NS
19	Provision of effective occupational safety management	4.41	4.33	0.55	0.58	NS
20	Provision of insurance and compensation for injuries and death	4.25	4.45	1.32	0.19	NS
21	Provision of monetary incentives for statutorily recognised festive periods	3.78	3.79	0.04	0.97	NS
22	Respect for statutory working hours and NS weekly holidays	4.18	4.27	0.61	0.54	NS

4.3 Factors that Enhances Craftsmen Productivity

Table 4 presents respondents' assessment of the factors that enhance construction craftsmen productivity. Availability of tools and equipment for craftsmen tasks and avoiding craftsmen fatigue by curtailing overtime were ranked very effective (4.50-5.00) in enhancing construction craftsmen productivity. While the following factors were ranked effective (3.50-4.49) in enhancing construction craftsmen productivity: assurance of job security, avoiding shortages and delays in material supply, clarity in craftsmen work specification, craftsmen comprehending adopted construction method, cordiality among project workforce, curtail excessive variation during project execution, effective communication in dispatching craftsmen task, effective craftsmen supervision, effective health and safety management practice, effective management of adverse weather condition on project site, effective project planning and scheduling, efficiency of workforce management, minimise risks in craftsmen task execution, periodic training of craftsmen on the industry's dynamism, provide craftsmen with accommodation or rent subsidy, providing free or subsidised meals in site staff canteen, provide social activity opportunities, prompt payment of craftsmen remuneration and other financial entitlements, reduce effects of craftsmen long distance travelling time and reward of hard work and experience through incentives and pay increase. Safety management practices have also been shown to significantly improve workforce productivity and project performance (Wong et al., 2023).Table 4 shows the significance levels of all ranked factors. It revealed that there is no statistically significant difference in the mean rankings of the two groups of respondents ($p>0.05$) for the factors that enhance craftsmen's productivity. Hence, the null hypothesis for Objective 2 was accepted.

This reveals that the respondents agree on the factors that enhance craftsmen's productivity. The findings established that the availability of tools and equipment and the reduction of excessive overtime were the most effective factors enhancing craftsmen's productivity. Other important productivity factors included: job security assurance, effective supervision, prompt remuneration, effective communication, occupational health and safety management, project planning and scheduling, workforce management, periodic training, accommodation support, and reduced travel stress. The t-test analysis further revealed no statistically significant difference in respondents' perceptions regarding productivity-enhancing factors ($p > 0.05$).

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These findings are consistent with the growing body of construction management literature that emphasises the critical role of labour welfare, resource availability, effective supervision, and occupational safety management in improving workforce productivity (Hamza et al., 2022; Jian et al., 2025). The results indicate that construction productivity depends not only on technical skills and project resources but also on organisational practices that enhance workers' welfare, motivation, and commitment. This reinforces the argument that sustainable productivity improvement requires an integrated approach combining effective labour relations, welfare support, and sound management practices.

Table 4: Factors that Enhance Craftsmen Productivity

SN	Factors	Mean scores		*t-stat*	Lev. Sig	Dec
		Pub. sec.	Priv. Sec			
1	Availability of tools and equipment for craftsmen's tasks	4.63	4.64	0.07	0.94	NS
2	Avoid craftsmen fatigue by curtailing overtime	4.08	4.09	0.93	0.93	NS
3	Assurance of job security	4.37	4.26	0.73	0.46	NS
4	Avoid shortage and late supply of materials	4.33	4.52	1.48	0.14	NS
5	Clarity in craftsmen's work specification	4.35	4.33	0.13	0.89	NS
6	Craftsmen's understanding of the adopted construction method	4.31	4.23	0.57	0.57	NS
7	Cordiality among project workforce	4.19	4.17	0.98	0.83	NS
8	Curtail excessive variation during project execution	4.08	4.02	0.11	0.71	NS
9	Effective communication in dispatching craftsmen's tasks	4.24	4.42	0.33	0.18	NS
10	Effective craftsmen supervision	4.37	4.32	0.46	0.75	NS
11	Effective health and safety management practice	4.47	4.31	0.16	0.27	NS
12	Effective management of adverse weather condition on the project site	3.98	3.93	0.41	0.74	NS
13	Effective project planning and scheduling	4.37	4.33	0.28	0.80	NS
14	Efficiency of workforce management	4.15	4.34	0.13	0.19	NS
15	Minimising risks during craftsmen's task execution.	4.09	4.21	0.85	0.48	NS
16	Periodic training of craftsmen on the industry's dynamism	4.09	4.26	0.19	0.27	NS
17	Provide craftsmen with accommodation or rent subsidy	3.69	3.79	0.60	0.58	NS
18	Provide free or subsidise meal in site staff canteen	3.76	3.63	0.34	0.46	NS
19	Provide social activity opportunities, e.g. sports and entertainment	3.55	3.30	0.36	0.23	NS
20	Prompt payment of craftsmen remuneration & other financial entitlements	4.29	4.36	0.82	0.63	NS
21	Reduce the effects of craftsmen long distance travelling time	3.92	3.95	0.46	0.88	NS
22	Reward of hard work and experience through incentives and pay increase	4.33	4.45	0.45	0.47	NS

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4.4 Effect of the Drivers of Craftsmen-Employer Cordiality on Craftsmen Productivity

Table 5 shows the result of Spearman's rank order correlation coefficient to determine the relationship between drivers of craftsmen-employer cordiality and construction craftsmen productivity. The drivers of the craftsman-employer cordial relationship (DCECR) are the independent variables, while the dependent variable is the factor enhancing construction craftsmen's productivity (FECCP). The DCECR factors is made of the followings: adherence to craftsmen statutory daily working break (AESDWB), craftsmen effective commitment to his/her schedule of duty (EECSD), craftsmen-employer mutual respect (EEMR), craftsmen right to belong to trade union (ERBTU), craftsmen right to benefits from contributory pension scheme (ERBCPS), effective organisations craftsmen rewards and promotion scheme (EOERPS), employer provision of transportation or transport allowance to craftsmen (EPTTAE), right for craftsmen-employer collective bargaining (REECB), craftsmen right to strike to press for their rightful demands (ERSPRD), craftsmen respect for organisations constituted authority (EROCA), honour craftsmen statutory leave provisions and pay (HESLPP), honour statutory remuneration for craftsmen overtime services (HSREOS), impartial disputes resolution mechanism (IDRM), impartial organisations discipline mechanism (IODM), periodic craftsmen training for quality service delivery (PETQSD), prohibition of gender biased discrimination (PGBD), provision of adequate craftsmen remuneration (PAER), provision of effective craftsmen health care services (PEEHCS), provision of effective occupational safety management (PEOSM), provision of insurance and compensation for injuries and death (PICID), provision of monetary incentives for statutorily recognise festive period (PMISRFP), respect for statutory working hours and weekly holidays (RSWHWH).

The relationship between DCECR and FECCP (as assessed by respondents) was investigated using Spearman's rank-order correlation coefficient (ρ). Preliminary analyses were conducted to ensure that the assumptions of monotonic relationships required for Spearman's rank-order correlation were satisfied. Table 5 shows a positive relationship between the two variables ($\rho = 0.32\text{-}0.49$, $n = 147$, $p < .001$), revealing that cordiality between construction craftsmen and employers enhances construction craftsmen's productivity performance. On average, DCECR had a positive effect on FECCP; $\rho = 0.52$, $n = 147$, $\rho < .01$. The corresponding coefficient of determination was 52.71%. This result indicates that drivers of cordiality between craftsmen and employers positively affect craftsmen's productivity. Moreover, the drivers of cordiality between craftsmen and employers have a 52.71% influence on construction craftsmen's productivity. This is because the coefficient of determination is a statistic that measures how much variation in the dependent variable is explained by the independent variable (Pallant, 2020). In view of this result, it is inferred that drivers of cordiality between craftsmen and employers explain 52.71% of the variance in factors that enhance construction craftsmen's productivity. The test on the null hypothesis at a 99% confidence level, which stipulates that drivers of craftsmen-employer cordiality have no effect on craftsmen productivity, was rejected because all the computed ρ values are less than 0.01 ($p<0.01$) (Pallant, 2020).

Spearman's rank-order correlation analysis revealed a strong positive relationship

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between craftsmen-employer cordiality and craftsmen productivity ($\rho = 0.726$, $p < 0.01$). The coefficient of determination ($\rho^2 = 0.527$) indicates that approximately 52.71% of the variation in craftsmen productivity is explained by cordial labour relations.The null hypothesis that cordiality between craftsmen and employers has no significant effect on craftsmen's productivity was therefore rejected.

The findings imply that cordial labour relationships significantly enhance construction productivity by improving workers' morale, commitment, communication, trust, and cooperation among project participants. This outcome reinforces the proposition that positive labour-management relations constitute a critical component of effective workforce management in construction projects. The findings are consistent with recent studies that reported significant positive relationships between employee welfare practices, occupational health and safety management, workforce engagement, and productivity performance in construction organisations (Ejohwomu et al., 2021; Rani et al., 2022; Wong et al., 2023). Such evidence suggests that construction firms that invest in labour welfare and healthy workplace relationships are more likely to achieve improved productivity and project outcomes

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Table 5: Relationship of Factors Enhancing Construction Craftsmen Productivity

Variables		**Inferences**			**Decision**
X (DCEC)	Y (FECCP)	Correlation (ρ)	(ρ^2 x 100)	LS *(p)***	
AESDWB	FECCP	0.41	16.81	0.00	Rejected
EECSD	FECCP	0.48	23.04	0.00	Rejected
EEMR	FECCP	0.49	24,01	0.00	Rejected
ERBTU	FECCP	0.36	12.96	0.00	Rejected
ERBCPS	FECCP	0.36	12.96	0.00	Rejected
EOERPS	FECCP	0.40	16.00	0.00	Rejected
EPTTAE	FECCP	0.36	12.96	0.00	Rejected
REECB	FECCP	0.42	17.64	0.00	Rejected
ERSPRD	FECCP	0.40	16.00	0.00	Rejected
AROCA	FECCP	0.42	17.64	0.00	Rejected
HESLPP	FECCP	0.33	10.89	0.00	Rejected
HSREOS	FECCP	0.42	17.64	0.00	Rejected
IDRM	FECCP	0.40	16.00	0.00	Rejected
IODM	FECCP	0.52	27.04	0.00	Rejected
PETQSD	FECCP	0.37	13.69	0.00	Rejected
PGBD	FECCP	0.32	10.24	0.00	Rejected

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Variables		Inferences			Decision
X (DCEC)	Y (FECCP)	Correlation (ρ)	(ρ^2 x 100)	LS *(p)***	
PAER	FECCP	0.43	18.49	0.00	Rejected
PEEHCS	FECCP	0.44	19,36	0.00	Rejected
PEOSM	FECCP	0.51	26.01	0.00	Rejected
PICID	FECCP	0.43	18.49	0.00	Rejected
PMISRFP	FECCP	0.38	14.44	0.00	Rejected
RSWHWH	FECCP	0.36	12.96	0.00	Rejected
DECCR	FECCP	0.726	52.71	0.00	Rejected

Key: DCEC-Drivers of Craftsmen-Employer cordiality, FECCP-Factors Enhancing Construction Craftsmen Productivity, LS-level of significance, H_0–null hypothesis, **-correlation is significant at the 0.01 level (1-tailed)

CONCLUSION

The study concludes that adherence to statutory daily breaks and craftsmen's commitment to duties are the most important drivers of cordiality between craftsmen and employers in Abuja, Nigeria. Other important drivers include mutual respect, pension benefits, reward systems, occupational safety management, healthcare services, and dispute resolution mechanisms.The study also concludes that the availability of tools and equipment and the reduction of excessive overtime significantly enhance construction craftsmen's productivity. Other important productivity-enhancing factors include effective supervision, prompt remuneration, workforce management, project planning, occupational safety, and job security. The cordiality between craftsmen and employers has a statistically significant positive effect on craftsmen's productivity. The findings indicate that cordial labour relationships account for approximately 52.71% of the variation in craftsmen productivity. The study therefore establishes that effective labour relations are critical for improving construction productivity and project performance in Nigeria.

RECOMMENDATIONS

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

1. Construction firms should ensure strict adherence to statutory labour welfare provisions, including daily breaks, overtime regulations, healthcare services, and pension schemes.
2. Employers should foster cordial relationships with craftsmen through effective communication, mutual respect, dispute-resolution mechanisms, and participatory management practices.
3. Construction organisations should provide adequate tools and equipment to improve craftsmen's efficiency and productivity.
4. Project managers should minimise excessive overtime to reduce craftsmen fatigue and improve productivity.
5. Government regulatory agencies should strengthen monitoring and enforcement of labour laws within construction projects.

6. Construction firms should organise regular training and development programmes to improve craftsmen skills and productivity.
7. Occupational health and safety practices should be strengthened across construction sites to improve workforce wellbeing and productivity.
8. Future studies should investigate labour relations and productivity across multiple states in Nigeria and explore qualitative dimensions of labour-management relationships.

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