EVALUATION OF THE CONSTRUCTION LOGISTICS CHALLENGES IN MINNA, NIGER STATE, NIGERIA.

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Abstract. Building construction projects have faced numerous obstacles throughout the years, which may be related to logistics problems such as lack of access to procured resources, material shortages, and insufficient transportation infrastructures, among other things. This difficulty has led to inefficiency in the building construction project, which may result in abandonment. For these reasons, the study evaluated the logistics challenges of building constructions in Minna Metropolis, Nigeria. The study utilised a descriptive research design to report the features of the study population. Two hundred questionnaires were purposefully distributed among employees in the building construction sites in Minna using simple random techniques. The theories of constraints and the institutional and resource-based view were adopted in this article. The collated data was analysed using descriptive statistics (i.e., mean, charts, percentages and frequencies), whereas T-test statistics were used to test the hypothesis. The results show that the logistics challenges faced by workers in the building construction industry in Minna, among others, include damages to the construction materials due to inadequate space in the site, Construction materials being delivered late, material shortage due to poor order, Construction materials are delivered far from the site due to inadequate access and the challenges of poor transport infrastructure. In addition, the hypothesis tested shows statistical significance among the workers' perceptions of the construction logistics challenges in the building construction projects in Minna. The study concluded that the inability of the players involved in the construction industry to manage these challenges adequately would result in poor labour productivity in the building construction industry. The study suggests, among others, that contractors or building owners should establish adequate communication with the suppliers of construction materials to ensure timely delivery of construction materials.

Keywords: Building, Challenges, Construction, Evaluation, Logistics, Minna.

Introduction

Infrastructure or building construction projects are the physical assembly of a structure in civil engineering and architecture. It is not one activity; instead, it is a collection of little initiatives. Building construction initiatives of a vast scale involves human multitasking. Therefore, one of the most important aspects of a building construction project's success is the appropriate sequencing of labour, materials, and equipment. Project managers oversee resources, including labour, supplies, and machinery, to ensure that a high-quality building is completed on schedule, within budget, and without problems. (Umar, 2023). The cost of private building construction is enormous throughout the world. For instance, the average building value factor in the United Kingdom is £1,000,000; in the USA, it costs around $332,376; in Nigeria, the average value factor is estimated at N15,000,000 ($15,000) (Zagame, 2023; Cost modelling, 2023; Raymond, 2022). This shows that building construction is expensive and that waste should be avoided. Eliminating waste of all kinds will increase productivity in the construction industry, and productivity may be achieved when difficulties in the construction logistics process are minimised or eliminated.

Logistics components such as inventory management, adequate construction materials storage, transport infrastructure and access to the construction zone influence productivity and service quality and raise market share (Kiromo, 2015). Agapiou et al. (1998) state that improving labour productivity requires effective logistics management as a critical component. An effective logistic management system facilitates the incorporation and level of coordination amongst the contractors, suppliers and sub-contractors, which can ultimately enhance the productivity of construction workers (Caron et al., 1998). According to Sobotka et al. (2005), construction logistics encompass three main areas: project logistics, supply logistics, and on-site logistics. Within this framework, procurement and supply chains are crucial, influencing a construction company's market competitiveness and the efficient use of labour on construction sites (Mason & Leek, 2008).

The construction industry throughout Europe, Asia, North America, and Africa faces difficulties in its construction sector. The African construction industry, particularly the Nigerian construction sector, faces logistics challenges in building construction. These challenges include unclear work division, inadequate data, poor supply chain planning, poor access and transport infrastructure, poor work coordination, and inadequate storage facilities (Tracey, 2021; Peiris et al., 2021). Late delivery of construction materials, poor order processing, and wrong delivery locations are other challenges facing the construction industry. However, Niger state, particularly Minna being, one of the cities of Nigeria, faces similar challenges. Against this backdrop, this research aims to evaluate Minna's construction logistics issues. The study presents a single null hypothesis, according to which the logistical difficulties encountered throughout the building project in Minna are not statistically different.

2.0 Literature Review

2.1 Concept of Construction Logistics

Logistics management is a collection of techniques that effectively integrate manufacturers, suppliers, warehouses, and retail establishments (Simchi-Levi, 2000; Onaolapo & Ajiboye, 2012). This ensures that goods are produced and distributed at the appropriate quantities to the appropriate locations and times, minimising system costs and meeting service level requirements. Lourenço (2005) defines logistics management as the administration of all logistics-related tasks within an organisation and across the supply chain. Furthermore, "the control of the flow of materials, tools, and equipment (and any connected object) from the point of discharge to the site of use or installation" is another definition of construction logistics (The European Construction 1994). In the context of private building construction, construction logistics refers to all the various activities, such as material management, procurement, construction design and so on, undertaken by the construction professionals to ensure that the construction project is executed at the right time. However, construction materials management as a logistics factor creates a derived demand for physical distribution since there is a need for physical distribution, storage and selling the produced products to customers (Janné & Fredriksson, 2019; Ajiboye et al., 2024).

2.2 Theoretical review

The theory of limitations is among the hypotheses that most effectively explain the previous research. A management approach known as the theory of constraints (TOC) holds that a small collection of restrictions prevents every managed system from achieving more of its objectives. TOC employs a concentrating approach to identify the restriction and reorganise the rest of the organisation. TOC was developed by Eliyahu Goldratt in 1984. The TOC was introduced by Eliyahu (1984). According to the TOC, constraints prevent the system from achieving its goals. Limitations can take many forms, but a core principle of TOC is that there should not be dozens or hundreds of restrictions. There must always be one, but hardly ever more than a few in any system. In the context of the foregoing study, difficulties in any construction process may negatively influence the success of the building construction project.

Another theory that is significant to the foregoing study is the system theory. The theory was introduced by Udwig von Bertalanffy (Adams et al., 2013). Systems are logical groups of related interdependent components that may be produced artificially or spontaneously. Systems theory is the study of systems. Each system is defined by its structure, purpose, and role. It also has causal limits, is impacted by its surroundings, and interacts with other systems through these interactions. Changes to one of the components of construction logistics may affect the entire construction process. Difficulties for building construction sites in receiving the procured construction materials for a long time may delay project delivery.

Institutional theory is another theory which has an impact on the forgoing study. The theory was introduced by Meyer and Rowan (1977). More so than market forces, the institutional context significantly impacts how formal structures evolve (Meyer & Rowan, 1977). The construction industry's supply chain and procurement performance are impacted by institutional theory. The institutional theory emphasises the need to follow protocols to guarantee equitable treatment for all parties participating in the construction industry's procurement process. According to Scott (2008), institutional theory is a widely accepted theoretical posture emphasising productivity, ethics, and legitimacy (Scott, 2004). Researchers building on this perspective emphasise that a critical insight of institutional theory is ethics: rather than necessarily optimising their decisions, practices, and structures, organisations look to their peers for clues to appropriate behaviour (Marquis & Tilcsik, 2016).

Another essential idea in this study is the resource-based perspective hypothesis. A management paradigm known as the resource-based view (RBV) helps identify the strategic resources that a business might employ to create a long-term competitive advantage. Barney (1991) proposed the resource-based perspective. According to the RBV, companies might have diverse strategies since their resource mixes differ, which implies that firms are

heterogeneous because they have heterogeneous resources (Lavie, 2008). To find the resources, skills, and talents that have the most potential to provide the company with a significant competitive advantage, the RBV directs managerial attention to its internal resources. In the construction industry context, contractors with enough resources may create a system that can supply all the materials required for a building construction without relying on a third party, thereby increasing the contractor's competitive edge.

2.3 Briefly assessing some of the components of construction logistics

Material procurement is a vital component of logistics, ensuring that the organisation does not stop production. It involves selecting the appropriate suppliers and making sufficient decisions to guarantee that resources are purchased from the appropriate source, at the appropriate price, in the appropriate amount, and at the appropriate time (Ghanem et al., 2018; Almohsen & Ruwanpura, 2013). Tunji-Olayeni et al. (2017) argue that the material procurement process used by the construction industry adheres to a set of guidelines to guarantee that sufficient materials of the right quality are made available on-site at the appropriate time. These guidelines include material inventories, vendor searches, vendor interviews and comparisons, vendor selection, order placement, and vendor performance evaluation. Most materials used on building sites are delivered to the site from other locations rather than being made there.

One central element influencing how effectively material logistics operate is transportation. According to Bowersox et al. (2000), a significant portion of logistics costs are incurred in transportation. Transportation plays a vital role in the construction logistics by transporting the procured materials to the construction site. To stress the importance of transport in project construction site, in 2020 research, Bešinović gave the example of how, at the height of building on the reconstruction of the Utrecht train station in the Netherlands, it was estimated that 250 trucks were driven toward the site every day. Moreover, the European Environment Agency (EEA, 2022) disclosed that building materials account for half of all road transportation in Europe. The data demonstrate transportation's critical role in the flow of materials across a building site. The more the movement of delivery trucks in a project construction site, the more significant risks the project environment may be. Transport, however, causes severe negative impacts on the surrounding community. These negative impacts include pollution, threats to safety, and traffic congestion.

However, few studies have demonstrated the influence of logistics on construction labour productivity. However, logistics significantly influences construction labour productivity in material delivery. The material shortage has been traced to significantly impacting project delivery. However, material shortage most of the time is because of the inability of the supplier to deliver building construction materials on time, which may result in a stoppage of operation in the project construction sites. According to Ruiz-Torres and Farzad (2006) and Inemek and Tuna (2009), a supplier's late delivery might cause operational disruptions and postpone project completion. According to Van der Rhee et al. (2009) study, one of the most important considerations when selecting a supplier is the provider's delivery record, and on-time delivery of products is crucial.

2.4 Brief challenges of construction logistics

Purchasing, transporting, processing, and storing materials can be complex logistics tasks for building projects. Material procurement is a highly sophisticated industry; therefore, it calls for specialised skills (Ibegbulem & Okorie, 2015). The steps involved in procuring materials are as follows: identifying, characterising, and defining the demand; looking into and choosing a vendor; placing an order for materials; receiving and inspecting the delivered items; checking bills; and concluding the transaction (Tunji-Olayeni et al., 2017).

One of the critical components of construction project management is labour force productivity enhancement, which often lowers costs and raises production. Logistics management is crucial in raising labour productivity (Agapiou et al., 1998). The challenges associated with construction logistics management are numerous. The claim made by Tracey (2021) is that the supplier chain and the site have an unclear line of duty. As a result, there are adverse impacts, such as traffic near building sites, since cars are frequently unable to be loaded and unloaded immediately. Due to a lack of data and supply chain planning, incoming transports are not coordinated, resulting in an unnecessarily large number of transport movements being dispatched to the site (Peiris et al., 2023).

Additionally, poor contractor delivery performance results in a shortage of goods and resources when needed, impeding project development and necessitating express transports, which raises the total number of transports near the building site. However, planning for the availability and effective coordination of supplies, instruments, and machinery is challenging (Liu et al., 2007; Jha & Iyer, 2006). However, effective management of these resources is necessary to guarantee the success of any building project (Muehlhausen, 1991).

2.5 Empirical Review

Kiromo (2005) investigated the variables influencing Nairobi-based construction companies' supply chain and procurement performance. Her study aimed to investigate Nairobi-based building construction companies' supply chain and procurement procedures and the variables influencing these processes' effectiveness. Her study's findings, however, show that many of them had trouble getting from supply depots to building sites. The author concluded that businesses faced transportation-related issues, such as the distance between supply depots and building sites and inadequate road infrastructure, significantly impairing their ability to provide services.

Almohsen and Janaka (2011) modelled Canadian construction sector logistics management. Their report suggested creating a new platform for the construction sector to use contemporary technology. The paper aimed to provide mobile application technologies to the construction sector and to increase construction productivity by improving logistics management techniques. The authors collected information from several construction sites using direct observation, interviews, and questionnaires. The investigation's findings show that several constriction specialists have given favourable assessments. Another disclosed outcome was facilitating communication between project participants, suppliers, subcontractors, and contractors.

Bullen (2020) studied site logistics factors affecting construction sites' resources and their relationship with embodied energy in Texas, USA. The authors used the Delphi method to obtain opinions from a selected panel of experts to achieve a reliable consensus. The author uncovered that material aspects of site logistics (location, circulation, and sequencing) might impact resource use on a construction site and, therefore, initial embodied energy. An engineering construction project site logistics management paper by Chen et al. (2014) was published in the United States. According to the authors, the efficient functioning of the physical distribution is guaranteed by creating a particular physical distribution management group and management engineering elements of fundamental construction physical distribution. The writers conclude by differentiating between the primary duties of owners, designers, main contractors, speciality contractors, manufacturers, suppliers, and vendors in logistics management.

Okoth (2013) examined the factors that affect supply chain and procurement performance. These factors included bureaucracy and time-consuming procurement methods, training on cost-effectiveness and timely project delivery, stakeholder involvement, and the failure to involve suppliers early in the design and specification stage, frequently resulting in changes to the design and specifications and contract cancellations. The author criticises the drawn-out processes that do not help reduce costs by implementing Just-in-Time delivery, lean supply chain management, and early supplier participation.

Through the viewpoint of vehicle mobility, Fei Ying and Johannes (2014) explored successful building logistics. Their research advances our understanding of the factors that reduce the effectiveness of moving plants and building materials to a construction site. The writers used interviews and on-site observations as a case study methodology. Observations were made on-site from the beginning of construction until the "handover" to the building owner. The investigation's findings show that both monetary and non-monetary cost-related aspects that affected construction logistics were not quantified or were generally disregarded, particularly the potential social and/or environmental effects of truck movement. Their research also shows that a lack of knowledge and use of CSCM is the primary cause of poor building logistics.

3. Methodology

The survey design used in the study was descriptive. A descriptive survey was used to report on the characteristics of the investigated population. According to Shield & Rangarajan (2013), a survey's goal is to reach a large population; the generality of the survey results depends on the samples' representativeness. 200 questionnaires were purposefully distributed among the construction workers in Minna using simple random techniques. However, only 168 copies (i.e., 84%) of questionnaires were retrieved and analysed. The questionnaires were made of the construction workers' socioeconomic and demographic features. In contrast, the second part consists of the various challenges the construction works face. The questionnaires were designed so respondents could rate using a five-point Likert scale, with five representing strongly agreed and one representing strongly disagreed. The gathered data from the survey were analysed using charts, frequency, percentages and mean index scores. The study hypothesis was tested using t-test statistics.

4. Results And Discussions

4.1 Socioeconomic and demographic features

Figure 1 shows the gender of the private building professionals in Minna. The analysis showed that a more significant proportion (i.e., 98%) of the construction professionals were males. In comparison, only 2% of the

construction professionals who participated in the survey were females. This implies significant gender disparity and suggests that the building construction industry in Minna is predominantly male-dominated, with women having very little representation. The study covers the construction industry in Minna and Nigeria.

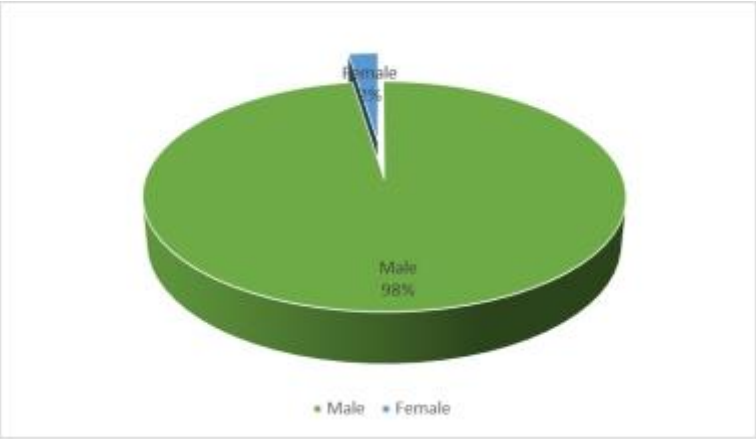

Figure 1: Gender of the respondents

Figure 2 shows the age of the professionals in the construction industry in Minna. Figure two shows that the majority (i.e., 34.5%) of the construction workers were between the age group of 31 and 40 years, and about 27.9% of the construction professionals were between the ages of 20 and 30. Only 16.7% of construction workers were between 41 and 50 years old. Similarly, Figure 2 shows that about 13.7% of the construction workers reveal that they are less than 20 years old, and only 7.2% said they are 51 years of age or older. However, the analysis of the age of the construction professionals in Minna enables the author to conclude that the Minna construction industry is composed of diverse age brackets of people. This outcome is in line with the work of Maqsoom et al. (2022), who concluded that a worker's age does not lower productivity levels in the construction industry. Still, the experience of a worker in any age bracket influences the value of labour productivity.

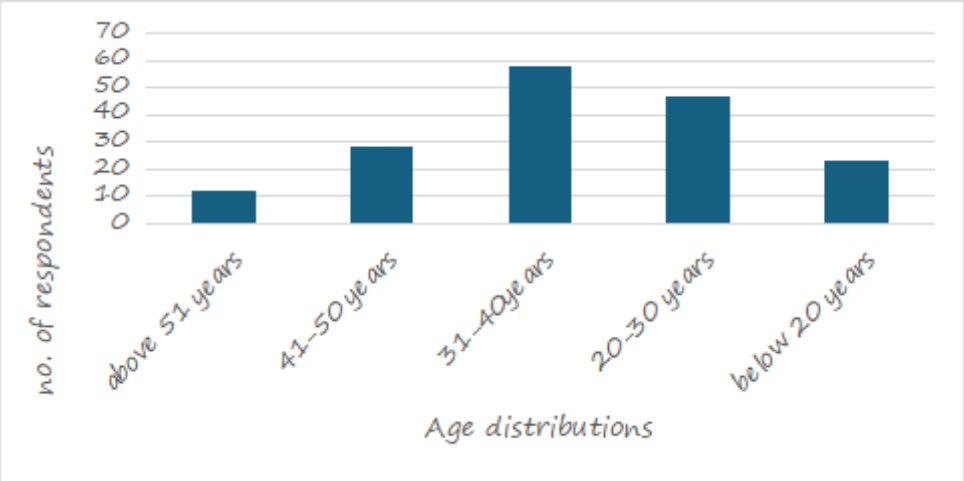

Figure 2: Age of the construction professionals

The analysis of the educational level attained by the construction professionals is shown in Figure 3. From the analysis, a more significant proportion (i.e., 31.5%) of the construction workers possess a West African Examination Council certificate (WAEC), about 24.4% of the construction workers have primary school certificates, and only 14.9% of the construction workers have national diploma certificate or national certificate of education. Similarly, the analysis in Figure 3 reveals that 12.5% of the construction workers had no primary education, about 10.1% had higher national diploma certificates/Bachelor of Science, and only 6.6% possessed postgraduate certificates. However, the analysis of the education certificate possessed by the construction workers indicates that labourers involved in private building projects are composed of secondary school certificate holders. It is crucial to remember

that training and education in the construction sector are necessary if the interest is to increase the productivity and efficiency of the sector in Minna and Nigeria as a whole.

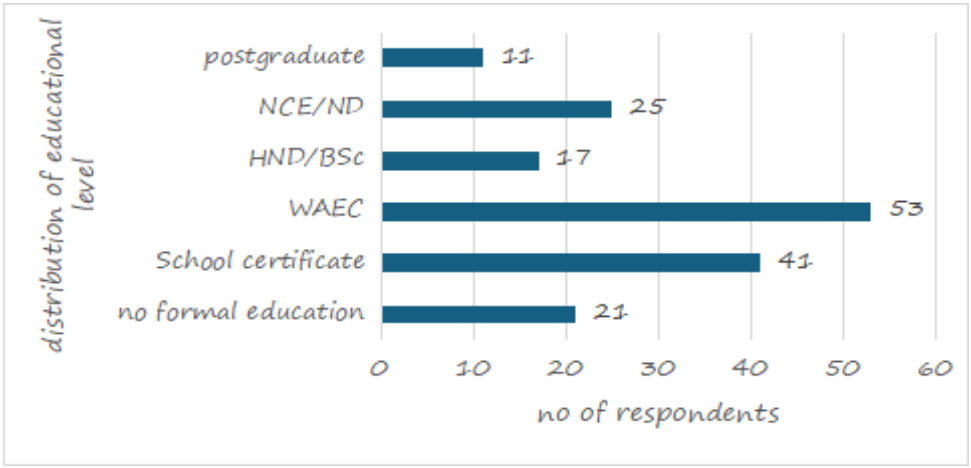

Figure 3: Educational level attained

Figure 4 shows the marital status of the construction workers in Minna. The analysis revealed that more than half of the construction workers were married, 37% were still single, and only 10% were divorced. In conclusion, the analysis of marital status indicates that there are more married people in the Minna construction industry than those who are single or divorced.

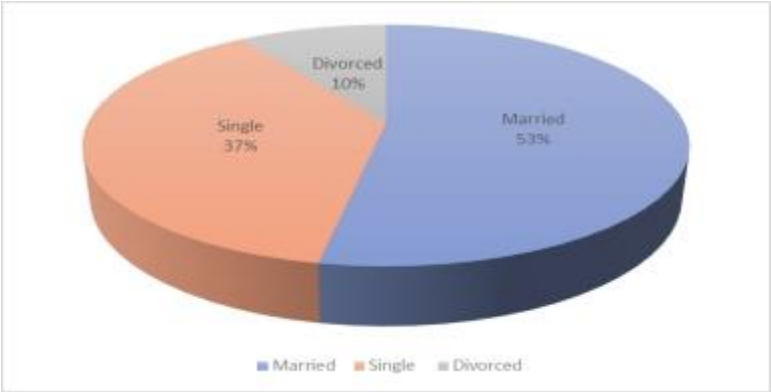

Figure 4: Marital status of construction professionals

The analysis of the monthly income earned by the construction professionals is shown in Table 1. From the analysis, it was recorded that a significant per cent (i.e., 30.9%) of the construction workers earned less than N30,000 monthly, about 26.8% of the construction workers earned between N30,000 and N60,000 monthly per cent (i.e., 30.9%) of the construction workers earned less than N30,000, about 26.8% of the construction workers earned between N30,000 and N60,000 monthly. Only 16.1% of the construction workers earned between N61,000 and N90,000 monthly. Similarly, the analysis in Table 1 points out that 12.5% of the construction workers earned between N91,000 and N120,000, and only 13.7% of them revealed that they earned above N121,000. Therefore, the analysis of the monthly income earned by the construction workers enables the author to conclude that there is a low-income level among Minna construction workers, and this is because of the underpayment of the construction workers. However, poor financial incentive harms the productivity of the construction project (Soetan et al., 2021).

Table 1: Monthly income earned by the construction workers

S/n	Criterion	Frequency	Percentage
1	Below N30,000	52	30.9
2	N30,000-60,000	45	26.8
3	N61,000-90,000	27	16.1
4	N91,000-120,000	21	12.5
5	N121,000 and above	23	13.5
Total		168	100.0

The analysis of the construction workers' years of experience is shown in Table 2. From the analysis, the majority (i.e., 42.9%) of the construction workers had between 10 and 20 years of working experience, 25.6% of the construction workers had less than 10 years of working experience, and only 31.5% of the construction workers had over 21 years of working experience in the construction industry. The analysis implies that the workforce's years of experience is a strength. Still, there is a need to attract younger workers and plan for generational transitions to ensure the industry's long-term sustainability.

Table 2: Construction workers' years of experience

S/n	Criterion	Frequency	Percentage
1	Less than 10 years	43	25.6
2	10-20 years	72	42.9
3	21 years and above	53	31.5
Total		168	100.0

The analysis in Table 3 shows the construction professionals in private building construction in Minna who participated in the survey. From Table 3, it was recorded that a more significant proportion (i.e., 39.9%) of the construction workers profession at the site were labourers, 19.6% of them were site managers, and only 19.1% of the construction workers were architects. In addition, the study in Table 3 demonstrates that around 11.9% of the construction workers were civil engineers, and just 9.5% were quantity surveyors. From this analysis, it can be concluded that many of the study respondents were labourers. This outcome impacts this study since construction productivity is measured in terms of the number of blocks layered per day and the number of hours spent on the current work, which the labourers have the direct knowledge to answer.

Table 3: Construction workers' professions

S/n	Criterion	Frequency	Percentage
1	Quantity surveyor	16	9.5
2	Architects	32	19.1
3	Labourer	67	39.9
4	Site Manager	33	19.6
5	Civil engineer	20	11.9
Total		168	100.0

4.2 Analysis of the Logistics Challenges faced at the construction site.

The analysis in Table 4 shows the logistics challenges faced at the construction site. The analysis noted that one of the challenges faced at the construction site is damage to the construction materials due to inadequate space (M= 3.1206). Insufficient space in the construction site may result in the stacking of construction materials, making movement around the site difficult. Insufficient space around the construction environment does not only damage materials; it also influences productivity and impacts the safety of construction workers (Elbeltagi et al., 2004). Another challenge at the construction site is that construction materials are delivered late (M= 3.2815). However, shortage of materials and late delivery are two notable factors that affect project delivery time in the U.K., Europe and the Middle East (Al-Kharashi & Skitmore, 2009; Rahman et al., 2017). Abd Majid and McCaffer (1998) found that out of 25 variables, delayed delivery and sluggish material mobilisation were the primary causes of non-excusable construction delays in the United Kingdom. Similarly, material shortage due to poor order (M= 3.2815) was observed in Table 4 as a significant challenge faced by the construction workers on the site.

Construction materials are delivered far from the site due to inadequate access (M=3.4075), and poor transport infrastructure (M= 3.4987) is a severe challenge in private building construction in Minna. According to Olikagu et al. (2024), poor road infrastructure resulted in the delivery of construction freight materials in the wrong location, requiring other means of transport to access the site. In addition, challenges of work coordination on the site (M= 2.6783) also pose difficulties to site operations. Furthermore, Table 4 shows the challenges of poor storage facilities (M= 2.9598) in the Minna construction industry, particularly private building construction. On the other hand, inadequate storage might degrade the calibre of tools and building supplies. Construction materials must be handled, stored, and well-protected to prevent harm. Enough storage solutions will facilitate managing materials as your project progresses. Other challenges faced by the private building construction in Minna observed in Table 4 include communication difficulties (M= 1.9110), items not delivered at the right time (M= 1.8487), poor coordination of site activities (M= 1.9525) and poor project execution plan (M= 1.9555).

Table 4: Logistics challenges faced at the construction site

S/n	Criterion	Mean score
1	Damages of the construction materials due to inadequate space in the site	3.1206
2	Construction materials are delivered late	3.2815
3	Material shortage due to poor order	3.2815
4	Construction materials are delivered far from the site due to inadequate access	3.4075
5	Challenges of poor transport infrastructure	3.4987
6	Challenges of work co-ordination on the site	2.6783
7	Poor storage facilities	2.9598
8	Items are not delivered at the right time	1.8487
9	Communication barriers	1.9110
10	Poor coordination of site activities	1.9525
11	Poor project execution plan	1.9555
Total		

4.3 Hypothesis

The outcome of the study hypothesis tested is shown in Table 5. The result reveals that damages to the construction materials due to inadequate space in the site (Table value= 0.000), construction materials are delivered late (Table value= 0.000), material shortage due to poor order (Table value=0.000), construction materials are delivered far from the site due to inadequate access (Table value = 0.000), challenges of poor transport infrastructure (Table-value= 0.000), challenges of work co-ordination on the site (Table-value= 0.000) and poor storage facilities (Table-value= 0.000) are less than the confidence level of 0.05. Therefore, this study accepts the alternative hypothesis, which states that there is a statistical significance to the challenges faced by construction workers in private building construction.

Table 5: T-test

	Test Value = 0					
	t	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Damages of the construction materials due to inadequate space in the site	40.784	167	.000	3.57143	3.3985	3.7443
Construction materials are delivered late	39.042	167	.000	3.34524	3.1761	3.5144
Material shortage due to poor order	38.941	167	.000	3.40476	3.2321	3.5774
Construction materials are delivered far from the site due inadequate access	30.819	167	.000	3.15476	2.9527	3.3569
Challenges of poor transport infrastructure	29.567	167	.000	3.20238	2.9886	3.4162
Challenges of work co-ordination on the site	28.118	167	.000	3.26786	3.0384	3.4973
Poor storage facilities	28.592	167	.000	3.30952	3.0810	3.5380

Conclusion

The study assessed the construction workers' perception on the challenges faced in the logistics of building construction in Minna. The study outcome concludes by identifying seven major difficulties in the building construction logistics. The study also concluded that there is a statistically significance to the challenges faced in the building construction logistics. The study recommended that.

1. Contractors or building owners should establish adequate communication with the suppliers of construction materials to ensure timely delivery.

2. Wrong delivery locations should be prevented so as to reduce the time taken to transfer the materials to the site.

3. Adequate storage materials should be provided by the contractor in that way damages which may occur due to inadequate storage space will reduce.

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Author contributions

AOA and EMO conceived the study and were responsible for the design and development of the data analysis. KBA, RAI, and EM were responsible for data collection and analysis. AOA and RNA were responsible for data interpretation. AOA and EMO wrote the first draft of the article, while RNA edited it.