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APPLICATION OF JUST-IN-TIME DELIVERY IN THE CONSTRUCTION INDUSTRY: A CASE STUDY OF LAGOS STATE, NIGERIA

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Abstract

This study investigates the application of Just-In-Time (JIT) delivery in the construction industry in Lagos State, Nigeria, with a focus on its impact on material management, quality control, inventory control, waste reduction and overall productivity. A quantitative research design was adopted, employing questionnaires administered to 203 registered construction professionals. Data analysis, conducted using SPSS, indicated that JIT is reasonably implemented in Lagos State construction projects, with waste reduction emerging as the most significant area of application. Exploratory factor analysis revealed two principal components: the quality factor, which includes material and supply chain management, quality control, labor management, technical challenges, regulatory requirements, and construction scheduling; and the waste reduction factor, which comprises inventory control, storage space management, waste minimization, and efficiency enhancement. The findings demonstrate that JIT implementation improves project efficiency and reduces waste, though challenges such as unreliable supply chains and coordination difficulties remain. To maximize the benefits of JIT in construction, the study recommends strengthening supply chain networks, enhancing project management competencies, and promoting a culture of collaboration and continuous improvement.

Key words: Construction, inventory, material, supply, waste

INTRODUCTION

The construction industry is a complex and resource-intensive sector, characterized by high variability, fragmented supply chains, and the constant pressure to deliver projects on time and within budget (Albert *et al*., 2021). Traditionally, construction practices involve large buffer stocks of materials, long lead times, and redundant processes that often result in inefficiencies, material wastage, and increased project costs. In response to these challenges, the construction industry has been exploring lean construction principles, among which Just in Time (JIT) has gained significant attention (Azis *et al*., 2023; Gbadamosi & Oyewobi, 2022). Just in Time (JIT) is a production and inventory management strategy that originated in the manufacturing sector, particularly from the Toyota Production System in Japan (Wayrah *et al*., 2021). Its core principle is to produce or deliver the right item at the right time in the right quantity, thereby reducing waste and increasing efficiency. While JIT has been extensively implemented in manufacturing with remarkable success, its application in construction presents both opportunities and unique challenges due to the dynamic, on-site nature of construction projects (García Alcaraz *et al*., 2016; Wynn & Eckert, 2017).

In recent years, construction firms have begun adapting JIT principles to reduce storage needs, improve material flow, and streamline project timelines. For example, scheduling materials to arrive exactly when needed can reduce clutter on job sites, minimize theft and damage, and lower inventory holding costs. Moreover, improved coordination with suppliers and subcontractors can lead to enhanced project management and productivity (Albert *et al*., 2021; Xing *et al*., 2021). However, the successful implementation of JIT in construction is not without obstacles. The variability of weather conditions, the complexity of supply chain logistics, and the lack of integration among project stakeholders can hinder the timely delivery and utilization of materials (Fagbenle *et al*., 2023). In addition, the industry often deals with customized, non-repetitive work, making standardization difficult another challenge to JIT principles (Zhu *et al*., 2021; Idowu & James, 2025). Despite these issues, the potential benefits of JIT in construction including cost savings, improved workflow, and better-quality control make it a valuable area for study and innovation. Various pilot projects and case studies worldwide have demonstrated that, with proper planning, training, and technological support, JIT can lead to substantial improvements in construction performance. This study seeks to explore the application of JIT in the construction industry, particularly in how it affects material management, project timelines, cost control, and overall productivity. By understanding these dynamics, the research aims to provide insights into best practices and strategies for successful JIT implementation in the construction sector. The hypothesis for this study is Just-in-Time management system is not adequately implemented in construction projects in Lagos State.

LITERATURE REVIEW

Application of JIT in the construction industry

The adoption of JIT in construction projects has significantly enhanced project efficiency and resource management. Several key aspects define its application:

1. *Timely Delivery of Materials*: JIT ensures materials are delivered precisely when required, minimizing onsite storage costs and reducing material waste (Xing *et al*., 2021). Modern logistics tools such as RFID tracking and automated scheduling improve material arrival accuracy (Dallasega, 2018). The integration of GPS-enabled supply chain tracking systems enables real-time material monitoring, reducing errors and enhancing delivery efficiency. Additionally, automated inventory replenishment systems allow seamless restocking based

on predictive analytics, ensuring that materials arrive exactly when needed (Daniel & Archie, 2024).

2. *Reduced wastes*: JIT minimizes construction waste by promoting efficient resource utilization and reducing excess inventory (Green *et al.,* 2014). This approach aligns with sustainable construction practices, reducing environmental impact. Lean construction principles integrated with JIT have led to a 30% reduction in material waste in several case studies. Moreover, recycling and reuse initiatives, supported by digital tracking systems, help construction firms optimize their material consumption, lowering overall project costs (Green *et al.,* 2014).

3. *Reduced costs*: By lowering storage and handling costs, JIT helps in reducing the overall project cost (Dallasega, 2018). A study by Akintokunbo and Arimie (2021) indicates that JIT-driven cost savings can reach up to 20% in large-scale projects. The reduction in overordering and excess storage expenses translates into significant financial efficiency (Ikpe & Shamsuddoha, 2024). According to Bhattacharya and Chatterjee (2022), construction firms that implement JIT report lower procurement costs due to bulk purchasing agreements with reliable suppliers, ensuring competitive pricing and just-in-time availability of materials.

4. *Enhanced scheduling and coordination*: Proper scheduling and supplier collaboration enable seamless material flow and workforce management (Albert *et al*., 2018; Ikpe & Shamsuddoha, 2024). Project management software, such as BIM, plays a crucial role in ensuring timely execution (Shou *et al*, 2020). AI-driven scheduling tools enhance coordination by predicting potential project bottlenecks and providing optimized work sequences. In addition, collaborative planning platforms that link contractors, suppliers, and project managers improve transparency and streamline decision-making processes, ensuring better adherence to project timelines (Xing *et al*., 2021).

5. *Quality control*: JIT emphasizes strict quality standards, reducing defects and rework (Pinto *et al*., 2018). Continuous inspection and supplier performance tracking contribute to maintaining high-quality project outcomes. According to García-Alcaraz *et al*., (2016), adopting JIT-based quality control mechanisms reduces material defects by 25%, leading to fewer project delays. Additionally, integrating automated defect detection technologies and digital twins enhances real-time monitoring of construction quality, ensuring compliance with industry standards (Shou *et al*, 2020).

6. *Improved cash flow*: Reduced inventory levels improve cash flow by preventing excess capital from being tied up in materials (Dallasega, 2018). Firms employing JIT report improved financial liquidity and budget adherence. Just-in-time procurement reduces the need for large upfront material purchases, freeing up working capital for other project investments. Additionally, financial modelling tools integrated with JIT help project

managers anticipate cash flow fluctuations, allowing better allocation of resources and risk mitigation strategies (Panova & Hilletofth, 2018).

7. *Collaboration with suppliers*: JIT necessitates strong collaboration with suppliers to ensure timely and accurate deliveries. Establishing long-term partnerships with vendors enhances supply chain reliability (Aziz *et al.,* 2023). The implementation of vendor-managed inventory (VMI) and digital procurement platforms strengthens supplier relationships, ensuring steady material flow. Furthermore, blockchain-based smart contracts in construction supply chains enhance transaction security, ensuring that suppliers adhere to delivery commitments with minimal delays (Singh & Kumar, 2022).

8. *GPS and IoT-enabled tracking systems*: Global Positioning System (GPS) and IoT sensors provide live updates on material movement, preventing delays in delivery. These technologies offer: i. Real-time material tracking: IoT devices, such as RFID tags and smart sensors, enable project managers to track material shipments and detect potential supply chain disruptions. ii. Predictive maintenance for equipment and transport: IoT-powered fleet management helps detect potential issues in construction vehicles, reducing downtime due to unexpected breakdowns (Kumar *et al*., 2022; Zhang *et al*., 2023).

9. *Managing Logistics and Transportation*: Efficient logistics and transportation management play a pivotal role in ensuring materials arrive on-site precisely when needed, preventing project delays and excess inventory storage (Ahmad *et al.,* 2022; Albert *et al*., 2021). JIT in construction requires precise scheduling, real-time tracking, and strong supplier-transportation partnerships to optimize logistics.

10. *Automated Warehouse and Inventory Managemen*t: The adoption of technology-driven solutions in logistics and real-time tracking significantly enhances JIT implementation in construction projects. The use of BIM, ERP, IoT sensors, cloud-based platforms, and AI-driven logistics tools ensures that materials and resources are efficiently managed, minimizing delays and optimizing workflow. Moreover, reliable transportation partnerships, prefabrication techniques, and automated inventory management further enhance project efficiency and cost savings. As construction firms continue to embrace smart technologies and lean construction methodologies, JIT will play a pivotal role in shaping the future of efficient and sustainable construction management.

11. *Minimizing Worksite Delays*: Just-In-Time (JIT) principles help mitigate potential delays in construction projects by ensuring that necessary resources, including materials and labour, arrive precisely when needed. Worksite delays often stem from inefficient scheduling, poor material planning, or unforeseen disruptions such as supply chain bottlenecks, labour shortages, and adverse weather conditions (Aibinu & Jagboro, 2021).

12. *Employee and Workforce Management*: Effective workforce management is critical to ensuring smooth construction operations under JIT principles. A well-trained, agile

workforce enhances efficiency by executing tasks within the scheduled timeline while adapting to dynamic project demands (Koskela *et al*., 2021).

JIT workforce management involves strategic labour allocation, skill enhancement, and performance monitoring. Investing in comprehensive training programs helps equip workers with technical expertise, safety protocols, and lean construction principles, thereby minimizing errors and inefficiencies. Cross-training employees in multiple roles ensures workforce flexibility, reducing dependency on specific individuals and mitigating disruptions due to unexpected absences (Oke *et al*., 2023).

13. *Monitoring and Continuous Improvement*: Regular assessment of JIT processes enables firms to identify bottlenecks, improve workflows, and implement corrective measures for better efficiency (Albert *et al*., 2025). Construction firms adopt Key Performance Indicators (KPIs) to evaluate JIT effectiveness, such as material delivery time, inventory turnover rate, defect rates, and labour productivity (Venkatesh & Mohamed-Mustafa, 2024).
14. *Risk Management*: JIT involves proactive risk assessment, addressing potential supply chain disruptions, labour shortages, and external environmental factors that could impact project delivery. Construction firms implement risk mitigation strategies such as maintaining buffer stocks for critical materials, diversifying suppliers, and leveraging predictive analytics to forecast potential disruptions (Cooper, 2024). Risk management in JIT construction also involves employing digital tracking systems to monitor supply chain fluctuations and mitigate possible delivery failures.

RESEARCH METHOD

This research adopted a quantitative design, utilizing questionnaires that contained a structured set of items focused on application of Just in Time delivery in the construction industry in Lagos State. Quantitative research focuses on the measurement of variables in numerical form, which are then analysed through statistical techniques (Duckett, 2021). A questionnaire survey was designed and administered to registered construction professionals including Architects, Builders, Engineers, Quantity Surveyors, and Project Managers in Lagos State, who constituted the study's sample frame. To ensure every member of the research population had an equal opportunity to participate, a random sampling method was employed. The questionnaires were distributed to registered engineers, architects, builders, quantity surveyors, and project managers within the construction industry in Lagos State. The structured instrument consisted of a series of questions organized into two sections. Section A collected demographic details from the respondents, while Section B examined the application of Just-In-Time practices in construction projects using a five-point Likert scale to rate their opinions. According to Collins (2010), Likert scales are effective for capturing participants' perspectives on various statements. To validate the research instrument, a pilot survey was conducted with four industry professionals and two academic lecturers. This exercise aimed to determine whether the awareness of Just-In-Time in construction projects, as highlighted in existing literature, is relevant within the Nigerian context. The pilot survey results confirmed that the identified variables were both relevant and clearly understood by the professionals. With assistance from colleagues and friends, the questionnaires were distributed and retrieved after respondents had been adequately guided on their contents. A total of 324 construction professionals in Lagos State were selected as the sample size using the Yamane formula, with a 95% confidence level and a 5% margin of error. Participants were selected through random sampling, with 203 providing valid responses, resulting in a response rate of 62.65%. The collected data were analysed using SPSS version 23.0, applying statistical techniques such as frequency distributions (percentages), mean scores, standard deviation, exploratory factor analysis, and the T-test.

PRESENTATION OF RESULTS

Demographic Information of the Respondents

For the professional Designation of the respondents, 21.7% of the respondents are architects, 15.3% are quantity surveyors, 18.2% are builders, 33.0% are engineers while only 6.4% are project managers. This is indicative that the respondents are relevant professionals in the construction industry. Regarding their academic qualification, B.Sc./B.Tech degree holders make up 51.2% while HND holders are 31.5%. M.Sc./M.Tech holders constitute 8.9%, OND holders being 7.4% while those that have bagged their Ph.D. are 1.0% of the respondents. It shows that all the respondents are educationally sound in construction, hence relevant for the research purpose. Furthermore, for the years of experience of the respondents, 49.3% of the respondents have 1-5 years of experience, 34.5% possess 6-10 years and 9.3% have 11-15 years of experience. However, 5.9% of the respondents possess 16-20 years while 1.0% has more than 20 years of experience. This shows that the respondents are well knowledgeable about construction. Also, is the rating scale of the organization where the respondents work. 31.0% of the respondents are small-scaled organisations, 35.5% are medium-scaled, 12.3% are large-scaled while 16.3% are regional organizations. Only 4.9% are multinational organizations. For the type of projects the respondents have participated in, 25.1% of them have participated in TETFund projects, 22.2% in NDDC projects while 37.9% participated in SUBEB projects. 12.8% of the respondents have participated in State government projects while 2.0% partook in Local government projects. This is indicative that the respondents participated in projects that are relevant to this study. Finally, on the number of projects where JIT is being utilised, 18.7% of the respondents have used JIT in less than 5 construction projects, 10.9% in 6-10 construction projects while 51.7% have used JIT in 11-15 projects. 5.4% of the respondents used JIT in 16-20 construction projects while 13.3% of the respondents have used it in 21-30 construction projects. This shows that the respondents are well knowledgeable about JIT and have applied same to the construction projects in which they have participated in.

Application of JIT management system in Construction projects

Table 1: Application of JIT management system in Construction projects

S/N	Application Areas	MS	df	SD	t-value	p-value (2-tailed)	Rank
1	Material Management	4.71	202	.858	37.622	<0.001*	3
2	Supply Chain Management	4.64	202	.888	24.928	<0.001*	6
3	Quality Control	4.74	202	.846	20.706	<0.001*	2
4	Labour Management	3.53	202	.778	25.126	<0.001*	13
5	Waste Reduction	4.78	202	.958	29.331	<0.001*	1
6	Construction Scheduling	4.37	202	.638	31.564	<0.001*	8
7	Inventory Control	4.69	202	.635	32.212	<0.001*	4
8	Management of Storage Spaces	3.68	202	.599	28.990	<0.001*	12
9	Real time tracking	3.37	202	.799	27.212	<0.001*	14
10	Sub-Contractor Management	4.67	202	.736	34.256	<0.001*	5
11	Good Communication	4.60	202	.677	23.494	<0.001*	7
12	Plant Management	3.86	202	.821	26.820	<0.001*	10
13	Promote Efficiency	3.77	202	.878	21.621	<0.001*	11
14	Promote Teamwork	3.87	202	.875	32.226	<0.001*	9
15	Better Project Planning	3.24	202	.836	29.817	<0.001*	15

Notes: SD: standard deviation; t: calculated t value; p-value: level of significance; MS: mean score of the application of Just-In-Time where 5=very high; 4=high; 3=neutral; 2=low; 1= very low. The higher the MS the more severe the impacts; df = degrees of freedom, *Significant at the 95% level (p<0.05)

This section highlights the application of JIT management system in construction projects in the study area as shown in Table 1. The variable, "Waste Reduction" has the highest mean (M=4.78), which indicates that waste reduction is the most vital area in which JIT is applied in construction projects. This is followed by "Quality Control" (M=4.74); "Material Management" (M=4.71); "Inventory Control" (M=4.69); "Sub-Contractor Management", (M=4.67); "Supply Chain Management" (M=4.64); "Good Communication" (M=4.60); "Construction Scheduling" (M=4.37); "Promote Teamwork" (M=3.87) while the variable "Plant Management", (M=3.86) comes next in the order of precedence.

Additionally, the variable, "Promote Efficiency" is ranked next with mean value (M=3.77), followed by the variable, "Management of Storage Spaces" with mean (M=3.68); "Labour Management" with mean (M=3.53); "Real time tracking" (M=3.37) while "Better Project Planning" (M=3.24) is the least ranked in that order. For the significance of the variables, all the constructs have a high t-values (Min=20.706; Max=37.622) with p-values (<.001). This indicates that the various constructs under the application areas of JIT are statistically significant.
For the hypothesis, since all the p-values (<0.001) for all the variables in this construct is less than the significance level (p=0.05), the null hypothesis which states that, *"Just in Time delivery technique is not adequately implemented in construction projects in Lagos State"* is rejected while the alternative hypothesis which states that *"Just in Time delivery technique is adequately*

implemented in construction projects in in Lagos State" is accepted. This implies that the construction professionals in the study area to a great extent, apply JIT in the construction projects they are handling or in charge of.

Application of JIT management system in Construction projects (Factor Analysis)

Table 2: KMO and Bartlett's Test for the Application of JIT

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.684
Bartlett's Test of Sphericity	Approx. Chi-Square	982.627
	df	224
	Sig.	0.000

The KMO measure indicates whether the data provided for the factor analysis is suitable for the factor analysis. The Bartlett's test of sphericity shows if the data under consideration can be used for factor analysis. The Table 2 shows the generated Kaiser-Meyer-Olkin value to be 0.684 (68.4%) which exceeds Kaiser's criterion recommended value of 0.6 (60.0%). Also, the Bartlett's Test of Sphericity shows a statistical significance of 0.000 ($p < 0.001$). This backs the factorability of the variables within the correlation matrix (Bartlett, 1954), hence the suitability of the variables and data from the construct for factor analysis.

Table 3: Total Variance Explained for the Application of JIT

Factor	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.245	61.635	61.635	9.127	60.849	60.849
2	1.611	10.737	72.372	1.728	11.523	72.372
5	0.753	5.017	92.816			
6	0.427	2.844	95.661			
7	0.216	1.441	97.102			
8	0.168	1.121	98.223			
9	0.122	0.811	99.034			
10	0.066	0.440	99.474			
11	0.036	0.239	99.712			
12	0.031	0.204	99.916			
13	0.013	0.084	100.000			
14	0.000	0.000	100.000			
15	0.000	0.000	100.000			

The Table 3 shows the total variance explained of the eigenvalues of the variables in the data set. The Kaiser's criterion which entails retaining factors with eigenvalues that are above 1.0 was employed. It reveals the presence of two (2) components with initial eigenvalues exceeding 1 for the rotated loadings, explaining the 60.849% and 11.523% variances respectively. These two clusters of factors represent 72.372% of the total variance and which highlights the importance of most variables measured.

Table 4: Rotated component matrix for the Application of JIT

Application of JIT	Components	
	1	2
Material Management	.875	
Supply Chain Management	.880	
Quality Control	.930	
Labour Management	.854	
Technical Challenges	.895	
Difficulties in historical preservation	.819	
Regulatory Hurdles	.756	
Construction Scheduling	.970	
Inventory Control		.823
Management of Storage Spaces		.765
Waste Reduction		.924
Promotes efficiency		.795

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 3 iterations.

As showed in the Table 4, the rotated component matrix of the application of JIT in construction projects after 3 iterations converged in relation to the initial eigenvalue of 1. The correlation matrix revealed that all of the factors had a coefficient of 0.500 and above. Looking at the factor loadings of the varimax rotation matrix, a pattern of two components or factors, explaining the 72.372% of the total variance. The factor with cross factor loading less than 0.500 were dropped while some items were loaded together. The highlighted factor loadings are the ones that are significant to constitute the groupings.

Table 5 Factor loading of the Application areas of JIT

S/N	Components Factors	Application of JIT	Factor Loadings
1	Quality factor	Material Management	.875
		Supply Chain Management	.880
		Quality Control	.930
		Labour Management	.854
		Technical Challenges	.895
		Difficulties in historical preservation	.819
		Regulatory Hurdles	.756
		Construction Scheduling	.970
2	Waste Reduction factor	Inventory Control	.823
		Management of Storage Spaces	.765
		Waste Reduction	.924
		Promotes efficiency	.795

According to the two component factor groupings, the following are reported:
A total of eight (8) variables loaded onto component 1 as shown in table 5. This factor loads: Material Management, Supply Chain Management, Quality Control, Labour Management, Technical Challenges, Difficulties in historical preservation, Regulatory Hurdles and Construction Scheduling. This factor accounts for 60.849% of the total variance. All mentioned variables in this cluster can be said to relate with the quality appreciation in construction. Therefore, this cluster can be termed **Quality factor.**

As shown in table 5, a total of four (4) variables are loaded in component 2. These variables include: Inventory Control, Management of Storage Spaces, Waste Reduction and Promotes efficiency. The stated variables in this cluster relates with the reduction of wastes in construction. Therefore, this cluster can be named **Waste Reduction factor**. This cluster accounted for 11.523% of the total variances.

DISCUSSION OF FINDINGS

JIT in construction projects can be applied in diverse ways and in different areas of construction in order to achieve quality outcomes. Majority of construction projects, ongoing and already constructed, which records cost overshooting or poor quality of works can be attributed to non-usage of JIT at the initial stage of planning. In corroboration, Bhattacharya & Chatterjee (2022) specifically asserted that construction firms that implement JIT report lower procurement costs due to bulk purchasing agreements with reliable suppliers, ensuring competitive pricing. This is a key area where JIT application in construction can be very helpful in the actualization of the client's objectives. Inasmuch as quality is paramount, the humongous wastages incurred in majority of construction projects needs to be curtailed in the process. The findings of this study shows that the reduction of construction wastes is a vital application area of JIT. Green *et al*. (2014) agrees with this finding by indicating that JIT minimizes construction waste by promoting efficient resource utilization and reducing excess inventory. In addition to other applications of JIT in construction projects, its application in real-time tracking of inventories helps in record keeping and in further reducing construction wastages. Shou *et al*, (2020) supports this notion by stating that integrating automated defect detection technologies in JIT enhances real-time monitoring of construction quality, ensuring compliance with industry standards.

CONCLUSION AND RECOMMENDATIONS

The application of Just in Time (JIT) delivery in the construction industry presents a promising strategy for enhancing project efficiency, reducing waste, and improving overall cost-effectiveness. As construction projects often suffer from delays, material wastage, poor site management, and excessive inventory holding, JIT offers a systematic approach to address these inefficiencies by ensuring that materials and resources are delivered precisely when needed.

This study highlights that while JIT principles have been successfully applied in manufacturing, their adaptation to the construction industry requires careful consideration of the sector's unique characteristics such as its fragmented nature, variable project environments, and dependence on multiple stakeholders. The application of JIT falls in different aspects of construction processes and procedures in the study area to include in waste reduction, quality control, material management, inventory control, real-time tracking amongst others. However, several challenges remain. These include unreliable supply chains, lack of coordination among stakeholders, weather-related disruptions, and limited technological integration. Without proper planning, supplier collaboration, and real-time communication, the risks of late deliveries and project delays may outweigh the benefits of JIT. Ultimately, the successful implementation of JIT in construction depends on a strong supply chain network, skilled project management, and a culture of collaboration and continuous improvement

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