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Impacts of the Just-in-Time Management System in Construction Projects in Nigeria

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Abstract
The construction industry is a very robust sector of any nation as it is responsible for all the infrastructural developments. In order to better achieve these, it is important to use the Just-In-Time (JIT) management system as construction projects rely on large inventories of materials, leading to high storage costs, wasted resources and the risk of obsolescence or material damage. Therefore, this study assesses the impacts of JIT management system in construction projects in the Nigerian construction industry, focusing on Edo and Delta States, with a view to improve efficiency and reduce construction wastages within the construction industry. For the methodology, the convenience sampling technique was used to elicit information from construction professionals in the study area. A well-structured questionnaire was distributed to the 324 conveniently selected respondents with 203 of them returned, representing a 62.65% return rate. Descriptive tools such as percentages and statistical tools such as mean score, standard deviation, factor analysis and t-test were employed for the study. It was discovered from the study that there are significant positive impacts of the adoption of JIT in construction projects as acknowledged by the construction professionals in the study area. It is therefore recommended that there should be the incorporation of technology in construction activities to further improve the inherent impacts.

Keywords: Construction, Impact, Just-in-Time, Management, Waste

1. Introduction

Construction projects often face significant challenges related to material management, including excessive inventory costs, material wastage, site congestion, and delays caused by untimely deliveries (Albert *et al*., 2021; Gómez-Cabrera *et al*., 2024). Traditionally, construction projects rely on large quantities of materials being ordered in advance and stored on-site, leading to high storage costs, the risk of material obsolescence, and inefficient utilization of resources (Chigara and Mudzengerere, 2013). In many cases, construction materials arrive in bulk or too early, resulting in excess inventory that occupies valuable space and ties up capital that could be used elsewhere (Lanau *et al*., 2019; Monem, 2024). Moreover, delays in the delivery of materials or equipment due to logistical problems can cause significant disruptions to the construction schedule, leading to costly project delays (Panova and Hilletofth, 2018). By reducing the need for extensive on-site storage, JIT seeks to minimize costs, avoid overproduction, and optimize resource use, which could be particularly beneficial in the resource-intensive and complex field of construction (Alaloul *et al*., 2022; Pitkänen, 2024; Idowu and James, 2025).

Several studies have suggested that adopting JIT delivery in construction projects could lead to significant improvements in terms of cost savings, schedule adherence, and overall project efficiency (Akintokunbo, and Arimwhatie, 2021). Successful implementation of JIT could lead to better material flow, reduced material wastage, and more streamlined project operations (Hussein and Zayed, 2021; Koskela *et al*., 2021). Despite the proven benefits of Just-In-Time (JIT) inventory management in manufacturing, its application in the construction industry remains limited due to the sector's inherent complexities such as variable project schedules, unpredictable site conditions, and dependency on multiple suppliers (Ahmad *et al*., 2022). Limited research exists that specifically evaluates the potential impacts of JIT management systems in the construction industry. This gap leads to inefficiencies, increased costs, and project delays. Hence, this study examines the impacts of JIT management system in construction projects in Nigeria, with particular focus on Edo and Delta States. It will investigate whether JIT can contribute to improving material flow, reducing waste, and enhancing overall project performance.

2. Literature Review

2.1 Impacts of Just-in-Time (JIT) on construction projects

JIT significantly reduces project timelines by ensuring uninterrupted workflows, preventing material shortages, and optimizing resource allocation. By eliminating excessive inventory storage and ensuring real-time material delivery, JIT minimizes construction downtime and enhances productivity. The synchronization of supply chain activities with construction schedules ensures that all resources are available precisely when required (Chileshe and Rameezdeen, 2022; Gao *et al*., 2023; Albert *et al*., 2025). By eliminating waste, reducing storage costs, and optimizing procurement, JIT minimizes overall project expenditure. Lower inventory costs, reduced rework expenses, and enhanced workforce efficiency contribute to significant cost savings. JIT also allows construction firms to reallocate financial resources to other critical project areas, improving overall financial flexibility (Cooper, 2024). Furthermore, JIT improves construction quality by ensuring that materials and labor are utilized efficiently, reducing errors, and enhancing workmanship.

The continuous monitoring of construction processes and real-time inspection mechanisms help maintain quality standards. Additionally, adopting precision-based procurement ensures that only high-quality materials are used, reducing defects and enhancing durability (Zhu *et al*., 2021). Moreso, traditional inventory management methods are prone to inefficiencies such as overstocking, misplacement, or material shortages. Modern construction projects leverage Radio-Frequency Identification (RFID), IoT-based sensors, and cloud-based inventory platforms to monitor stock levels and automate replenishment orders (Kumar *et al*., 2022). These systems ensure materials are available precisely when needed, reducing storage costs and waste. Proper site logistics prevent material congestion, which can hinder workflow efficiency. Geo-spatial mapping and Just-in-Time Delivery Zones (JIT-DZ) help in directing materials straight to designated work areas rather than storing them on-site unnecessarily (Zhang *et al*., 2023).

Also, the adoption of prefabrication and modular construction significantly aligns with JIT principles by manufacturing building components off-site and delivering them just-in-time for assembly (Sacks *et al*., 2023). This approach reduces waste, improves quality control, and accelerates construction timelines. Additionally, JIT emphasizes reducing excess material usage and implementing recycling initiatives. Construction and Demolition Waste Management (CDWM) systems help track material utilization, ensuring that surplus resources are either repurposed or recycled efficiently (Han *et al.*, 2022; Albert, 2023). The adaptation of JIT in construction projects significantly enhances efficiency, minimizes waste, and ensures optimal resource allocation. By implementing detailed project planning, fostering supplier and subcontractor collaboration, and optimizing material management, construction firms can effectively execute JIT methodologies.

Digital technologies such as BIM, AI-driven forecasting, RFID tracking, and cloud-based communication tools further support seamless project execution. Despite the challenges of uncertainty and supply chain variability, robust contingency planning and stakeholder collaboration ensure that JIT remains a viable strategy for modern construction projects (Gbadamosi and Oyewobi, 2022). To further improve the synergy between construction professionals and work processes, 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.

3. **Research method**

This research adopted a quantitative design, utilizing questionnaires that contained a structured and prearranged set of questions focused on assessing the impacts of Just-In-Time (JIT) Management System in Edo and Delta states. 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 for registered built environment professionals such as project managers, engineers, architects, quantity surveyors and builders within the construction industry in Edo and Delta States, forming the study's sample frame. A convenience sampling technique was adopted for the study due to the huge cost implication of covering the entire locations within the sample frame and the limited timeframe involved in conducting the research process. The questionnaire was distributed to registered construction professionals in both states such as architects, builders, engineers and quantity surveyors. The structured questionnaire was organized into two sections.

Section A focused on collecting demographic details from the respondents, while section B assessed impacts of Just-In-Time in Construction Projects. This was done using a five-point Likert scale to measure respondents' opinions. According to Collins (2010), Likert scales are effective tools for capturing participants' perspectives on various statements. To confirm the validity of the research instrument, a pilot survey was conducted with four industry professionals and two academic lecturers. The aim was to assess whether the impacts of Just-In-Time (JIT) in construction projects, as outlined in existing literature, was applicable within the Nigerian context. Results from the pilot survey indicated that the identified variables were both relevant and clearly understood by the participants. Assistance from colleagues and friends was utilized in distributing and collecting the questionnaires, after thoroughly briefing the respondents on its contents. A total of 324 construction professionals from Edo and Delta States were selected as the sample size for the study, out of which 203 provided valid responses, resulting in a response rate of 62.65%. The collected data were analysed using SPSS version 23.0, applying a range of statistical techniques such as frequency distributions (percentages), mean scores, standard deviation, exploratory factor analysis, and the T-test.

4. Results

4.1 Demographic Information of the Respondents

Table 1: Demographic Information of the Respondents

Demographic Information		Frequency	Percentage (%)
Professional Designation	Architect	55	27.1
	Builder	37	18.2
	Engineer	67	33.0
	Quantity Surveyor	31	15.3
	Project Manager	13	6.4
	Total	203	100.0
Academic Qualification	OND	15	7.4
	HND	64	31.5
	BSc/BTech	104	51.2
	MSc/MTech	18	8.9
	PhD	2	1.0
	Total	203	100.0
Years of experience (years)	1 - 5	100	49.3
	6 - 10	70	34.5
	11 - 15	19	9.3
	16 - 20	12	5.9
	Above 20	2	1.0
	Total	203	100.0
Scale of Organization rating	Small	63	31.0
	Medium	72	35.5
	Large	25	12.3
	Regional	33	16.3
	Multinational	10	4.9
	Total	203	100.0
Projects participated in	TETFund	51	25.1

	NDDC	45	22.2
	SUBEB	77	37.9
	State Government	26	12.8
	Local Government	4	2.0
	Total	203	100.0
Number of projects where JIT is used	0 - 5	38	18.7
	6 - 10	22	10.9
	11 - 15	105	51.7
	16 - 20	11	5.4
	21 - 30	27	13.3
	Total	203	100.0

Table 1 shows the demographics of the respondents to the study. 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.

4.2 Impacts of Just-In-Time in Construction Projects

Table 2: Impacts of JIT in Construction Projects

S/N	Impacts of JIT	MS	df	S.dev	t-value	p-value (2-tailed)	Ranking
1	Reduced delays	4.51	202	0.410	35.126	<0.001*	3
2	Increased productivity	4.88	202	1.370	39.121	<0.001*	1
3	Improved scheduling	3.77	202	1.429	41.316	<0.001*	7
4	Increase in efficiency	3.20	202	1.375	42.703	<0.001*	10
5	Continuous improvement of construction processes	4.66	202	1.367	49.566	<0.001*	2
6	Improved cash flow	3.09	202	1.435	45.213	<0.001*	13
7	Reduced inventory costs	3.15	202	1.444	50.055	<0.001*	12
8	Increased flexibility in response to cost changes	3.27	202	1.417	70.760	<0.001*	9
9	Increase in value of project	3.02	202	1.277	51.390	<0.001*	15
10	Decrease in budget for materials procurement	3.18	202	1.364	61.278	<0.001*	11
11	Reduction of construction wastes	3.34	202	1.439	67.819	<0.001*	8
12	Reduced environmental impact	3.03	202	1.405	48.662	<0.001*	14
13	Improved quality control	3.87	202	1.380	38.367	<0.001*	6

14	Enhanced workmanship	3.95	202	1.288	37.092	<0.001*	5
15	Reduced material damage	4.24	202	1.346	55.197	<0.001*	4

Notes: S.dev: standard deviation; t: calculated t value; p-value: level of significance; MS: mean score of the impacts 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)

Table 2 highlights the impacts of JIT in construction projects. The variable with the highest mean value "Increased productivity" (M=4.88) indicates that JIT is very impactful in improving and advancing the productivity of construction projects when used appropriately. This is followed by "Continuous improvement of construction processes" (M=4.66); "Reduced delays" (M=4.51); "Reduced material damage" (M=4.24); "Enhanced workmanship", (M=3.95); "Improved quality control" (M=3.87); "Improved scheduling" (M=3.77); "Reduction of construction wastes" (M=3.34); "Increased flexibility in response to cost changes" (M=3.27) while the variable "Increase in efficiency", (M=3.20) comes next in the order of precedence.

Furthermore, the variable, "Decrease in budget for materials procurement" is ranked next with mean value (M=3.18), followed by the variable, " Reduced inventory costs" with mean (M=3.15); "Improved cash flow" with mean (M=3.09); "Reduced environmental impact" (M=3.03) while "Increase in value of project" (M=3.02) is the next ranked. Also, all the variables have mean scores above the threshold of 3.00, indicating that the respondents are in agreement with the identified impacts of JIT in construction projects. However, in terms of the significance, all the constructs have a high t-values (Min=35.126; Max=70.760) with p-values (<.001), indicating that the various constructs 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, *"JIT management system does not have much impact on construction projects in Edo State and Delta State"* is rejected while the alternative hypothesis which states that *"JIT management system does have much impact on construction projects in Edo State and Delta State"* is accepted. This majorly means that the adoption of JIT in construction projects in the study area has a lot of positive impacts that engenders the construction professionals to utilize it in their construction processes.

4.3 Factor Analysis of the impacts of JIT in Construction Projects

Table 3: KMO and Bartlett's Test for the impacts of JIT in construction projects

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.733
Bartlett's Test of Sphericity	Approx. Chi-Square	531.433
	Df	105
	Sig.	.041

Table 3 presents the KMO and Bartlett's test results for the impacts of JIT in construction projects. The KMO measure assesses the suitability of the data for factor analysis, while Bartlett's test of sphericity determines whether the data is appropriate for this analysis. The KMO value is 0.733 (73.3%), exceeding the minimum acceptable threshold of 0.70 (70%), indicating the data is adequate for factor analysis. Additionally, the Bartlett's test has a p-value of 0.041, which is below the 5% significance level (p < 0.05), with 105 degrees of freedom and an approximate chi-square value of 531.443. These results confirm that exploratory factor analysis is appropriate for the data concerning the impacts of JIT.

4.4 Total Variance Explained for the impacts of JIT in construction projects

Table 4: Total Variance Explained for the impacts of JIT

	Initial Eigenvalues			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.140	18.652	18.652	3.111	9.450	9.450
2	3.500	10.631	29.283	3.021	12.287	21.737
3	2.991	9.087	38.370	3.181	25.001	46.738
4	2.754	8.368	46.738			
5	2.569	7.804	54.542			

6	2.332	7.086	61.628			
7	2.233	6.782	68.410			
8	2.052	6.235	74.645			
9	1.685	5.119	79.764			
10	1.555	4.725	84.489			
11	1.289	3.917	88.406			
12	1.216	3.695	92.101			
13	.920	2.796	94.897			
14	.880	2.673	97.570			
15	.800	2.430	100.000			

Extraction method: Principal Component Analysis.

Table 4 shows the total variance explained of the areas of the impacts of JIT in the construction industry with the Principal Component Analysis (PCA) extraction method. It shows the presence of three components with initial eigenvalues, explaining the 9.450%, 12.287% and 25.001% variances respectively, explaining the 46.738% of the total variance which highlights the significance of the ffifteen impacts of JIT shown.

4.5 Rotated Component Matrix for the Awareness of JIT in Construction Projects

Table 5: Rotated Component Matrix for the impacts of JIT

	Components		
	1	2	3
Increased productivity	.557		
Improved scheduling	.662		
Reduced inventory costs		.581	
Reduced delays		.995	
Reduced environmental impact		.776	
Decrease in budget for materials procurement			.653
Reduction of construction wastes			.641
Improved quality control			.883
Enhanced workmanship			.921
Continuous improvement of construction processes			.812
Increase in value of project			.701
Reduced material damage			.903
Increased flexibility in response to cost changes			.512

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 5 iterations.

Table 5 presents the rotated component matrix for the different impacts of JIT in the construction industry. After five iterations, the rotation reached convergence based on the initial eigenvalue. The highlighted values represent the factors with the smallest variation relative to the initial eigenvalue, accounting for 46.738% of the variance from the variables, thereby emphasizing their significance.

The Table 6 shows the variables are groupings of the impacts of JIT in construction projects. The impacts are grouped according to the factor loadings of the rotated component matrix of the construct. The pattern matrix displays the coefficients for the linear combinations of the measured variables. Each factor was assigned a name that represents all its variables; if choosing an appropriate name was challenging, the variable with the highest factor loading among those associated with the factor was used to name it.

4.6 Component Factors grouping for the impacts of JIT in construction projects

Table 6: Component factors groupings of the impacts of JIT in construction projects

S/N	**Component factors**	**Impacts**	**Factor loadings**
1	Improvement Factors	Increased productivity	.557
		Improved scheduling	.662
2	Reduction Factors	Reduced inventory costs	.581
		Reduced delays	.995
		Reduced environmental impact	.776
3	Enhancement Factors	Decrease in budget for materials procurement	.653
		Reduction of construction wastes	.641
		Improved quality control	.883
		Enhanced workmanship	.921
		Continuous improvement of construction processes	.812
		Increase in value of project	.701
		Reduced material damage	.903
		Increased flexibility in response to cost changes	.512

The three factor groupings are reported as follows:
As shown in table 4, a total of two (2) variables loaded onto factor 1. This factor loads: Increased productivity and Improved scheduling. This factor accounts for 9.450% of the total variance. All mentioned variables in this cluster can be said to relate with improvement. Therefore, this cluster can be termed Improvement factor. A total of three (3) variables are loaded in factor 2 as shown in table 4. These variables include: Reduced inventory costs, Reduced delays and reduced environmental impact. The stated variables in this cluster relates with reducing some excesses in construction processes. Therefore, this cluster can be named Reduction factor. This cluster accounted for 12.287% of the total variances. Loaded in factor 3 are nine (9) variables which includes: Decrease in budget for materials procurement, Reduction of construction wastes, reduced environmental impact, Improved quality control, Enhanced workmanship, Continuous improvement of construction processes, Increase in value of project, Reduced material damage and Increased flexibility in response to cost changes. The factors have a total variance of 25.001%. The general term that is specific to these variables is Enhancement factors.

5. **Discussion of Findings**

This section discusses the impacts of JIT in construction projects in the construction industry. The impacts of JIT are very numerous, especially in construction projects. The findings from this study indicates that the construction professionals are conversant with these impacts, which has helped in improving the outcomes of their respective construction projects, especially in terms of productivity. This is corroborated by the findings of Pitkänen, (2024), which asserted that JIT optimizes material delivery and improves workflow efficiency, hence minimizing labour downtime and superfluous handling. This implies that adopting JIT will bring about great improvements in construction project outcomes and lead to efficiency. Supportively, Zhu *et al*., (2021) posits that adopting precision-based procurement such as JIT ensures that only high-quality materials are used, reducing defects and enhancing durability.

Furthermore, JIT leads to a lot of reductions in avoidable excesses that characterises the contemporary construction sector. The delays and increased timeline for project completions are usually caused by errors and misgivings in the construction process, which JIT helps to positively impact for a better result. In support of this assertion, Ghodrati *et al*., (2022), indicates that cost reductions are further achieved through the adoption of automated procurement systems like JIT, which minimize errors in material ordering and prevent overstocking. In the same vein, Cooper (2024) stated that JIT also allows construction firms to reallocate financial resources to other critical project areas, improving overall financial flexibility. With these reductions and purposeful reallocation of resources, construction projects processes ar better enhanced while the final outcome is improved greatly.

6. **Conclusion and Recommendations**

This study aimed to evaluate the impacts of JIT in construction projects. Nigeria's construction sector is very large, as it is home to many construction firms and offers a wide range of employment opportunities to the general public.

It still has certain shortcomings in terms of innovation, though, as only few construction enterprises are prone to it. Even though the majority of the world's construction industries are swiftly adopting new techniques such as JIT and cutting-edge design and technologies to facilitate its use, the situation in Nigeria is tragically not so encouraging. According to this study, the impacts of JIT have also been shown to be extremely beneficial in all aspects of construction in guaranteeing that the project conclusion is sustainable socially, environmentally, and economically. This is sufficient justification for its inclusion, adoption, and implementation on all domestic construction sites, with the goal of promoting construction sustainability in line with generally accepted standards. It is concluded that there are significant impacts of the adoption of JIT in construction projects as acknowledged by the construction professionals in the study area. Some of these impacts include: increased productivity, reduced delays, continued improvement of construction processes, reduced materials damages, enhanced workmanship amongst others. It is therefore recommended that the incorporation of technology in construction activities should be widely publicised in all spheres of society as well as among professionals and stakeholders in the industry. This will ensure wider application and more positive impacts in all stages of construction. However, future research should be focused on the use of JIT in terms of stereotyped beliefs and attitudinal changes by construction professionals.

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