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AWARENESS OF JUST-IN-TIME PRINCIPLES IN THE NIGERIAN CONSTRUCTION INDUSTRY

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Abstract

This study investigates the awareness of Just-in-Time (JIT) principles within the Nigerian construction industry, focusing on construction professionals in Edo and Delta States. The construction sector is plagued by inefficiencies, including material overstocking and project delays, prompting the exploration of JIT as a potential solution to enhance efficiency and reduce waste. Utilizing a quantitative research design, data were collected through structured questionnaires administered to 324 registered construction professionals with 203 of them returned, achieving a 62.65% response rate. The findings reveal a significant awareness of JIT principles among respondents, with a mean score of 3.89 for the concept of JIT management in construction. Factor analysis identified two key components: a 'Productivity factor' and a 'Performance factor,' accounting for 41.362% of the total variance. Despite the positive awareness, challenges remain in the practical implementation of JIT, necessitating robust awareness campaigns and educational initiatives to further enhance understanding and application of JIT in construction projects. The study concludes that while awareness exists, further efforts are required to translate this knowledge into effective practice, ultimately improving project delivery and efficiency in the Nigerian construction industry.

Keywords: Awareness, Construction, Just-in-Time, principles, Waste

1 Introduction

The construction industry is characterized by complex processes, high levels of resource consumption, and significant waste generation (Albert *et al.,* 2021). Traditional construction project management often suffers from inefficiencies such as material overstocking, delays, cost overruns, and poor coordination among stakeholders (Mansouri and Moshiri, 2022; Bhattacharya and Chatterjee, 2022). These issues contribute to reduced productivity and project performance. In recent years, construction professionals and researchers have explored different methods to improve efficiency and reduce waste within the industry. One such method is Just-in-Time (JIT) principles, a strategy initially developed in manufacturing to streamline inventory management and minimize waste (Mansouri and Moshiri, 2022; Vaka, 2024). Just-in-Time (JIT) is a

management philosophy that originated in the manufacturing sector, particularly in the Japanese automotive industry, with the aim of minimizing waste and maximizing efficiency (Azhar *et al.,* 2023). JIT emphasizes delivering the right materials, in the right quantity, at the right time, and at the right place, thereby reducing inventory costs and improving workflow efficiency (Kumar *et al*., 2022).

The construction industry has shown increasing interest in adopting JIT principles to streamline operations and enhance productivity. By applying JIT in construction, materials are delivered to the site only when needed, reducing storage requirements and minimizing the risk of damage or theft (Li and Taylor, 2021; Gómez-Cabrera *et al*., 2024). Furthermore, JIT fosters better coordination between suppliers, contractors, and project managers, leading to improved scheduling, reduced lead times, and enhanced project control (Nolz, 2021). JIT has lot of potentials for managing movement of construction materials from manufacturing yard to construction site (Shou *et al.*, 2020). Organizations are expected to create high quality at reduced production cost that can reach their customers in the shortest possible time (Hussein and Zayed, 2021). The JIT production system is one of these initiatives that is focused on cost reduction by eliminating non-value-added activities (Azhar *et al.,* 2023). JIT has tremendous effect on quality and effective material delivery operation, and during its implementation, organizations are required to effect desirable decisions aimed at achieving its optimum benefits (Fagbenle *et al*., 2023).

However, implementing JIT in construction presents unique challenges compared to manufacturing, such as weather unpredictability, dynamic site conditions, multiple subcontractors (Han *et al*., 2022), and there are reports of dearth in the awareness of JIT among construction professionals, especially in Nigeria (Anozie *et al.,* 2024; Oke *et al.,* 2023), signaling a possible decline in its usage. These complexities necessitate a tailored approach to JIT, supported by effective planning, reliable logistics, and strong communication among stakeholders. The study is aimed at assessing the awareness of the JIT principles in construction projects, and understanding this aspect is essential for project managers and construction firms seeking to improve efficiency, reduce costs, and deliver projects on time and within budget.

2 Literature Review

Principle of Just in Time (JIT)

Just in Time (JIT) is a production strategy designed to minimize waste, enhance efficiency, and guarantee the prompt delivery of materials. Just-in-Time (JIT) in construction entails the timely delivery of materials to minimize storage expenses and mitigate project delays (Si *et al*., 2020). Green *et al*., (2014) assert that JIT facilitates process optimization by eradicating surplus inventory and enhancing overall resource efficiency. Just-In-Time (JIT) originated in Japan, originally developed by Toyota in the 1950s as an integral component of its lean manufacturing methodology (Gbadamosi and Oyewobi, 2022). The principle emphasizes ongoing enhancement and the eradication of non-value-adding operations (Shou *et al.*, 2020). In construction, Just-In-Time (JIT) strictly adheres to lean construction principles, facilitating timely material movement to avert surplus inventories and delays. Pitkänen, (2024) assert that JIT optimizes material delivery and improves workflow efficiency, hence minimizing labor downtime and superfluous handling. Moreover, JIT diminishes dependence on conventional bulk ordering, which frequently results in material degradation and inefficiencies. Conversely, construction companies implementing JIT

utilize sophisticated forecasting and supplier collaboration to ensure consistent, on-demand resource availability (Dallasega, 2018). Albert *et al*., (2025) assert that JIT promotes a proactive construction management strategy, hence improving quality control and cost efficiency.

A critical component of JIT focuses on quality assurance. As resources are supplied in a just-in-time fashion, the risk of quality deterioration from extended storage is minimized (Anozie *et al*., 2024). Moreover, JIT promotes regular inspections and anticipatory problem-solving, guaranteeing the swift identification and replacement of defective materials, which results in superior quality output. JIT is a strategy methodology that enables construction organizations to augment efficiency, minimize expenses, and optimize project delivery schedules. Successful implementation necessitates precise planning, dependable suppliers, and the incorporation of contemporary technologies to optimize operations and facilitate a seamless flow of resources during the construction process (Albert *et al*., 2018; Garcia-Buendia *et al*., 2021).

3 Research Method

This study used the quantitative research design approach, with the help of questionnaires comprising a preformatted, well-structured set of information that bordered on the awareness of the principles of JIT in Edo and Delta states. Quantitative research emphasizes measuring variables that can be expressed numerically and analysed using statistical methods (Duckett, 2021). A questionnaire survey was developed for all registered construction professionals (Architects, Builders, Engineers, Quantity Surveyors, and Project managers) within the construction industry in Edo State and Delta State who formed the sample frame for the study.

To provide an equal chance for every member of the research population, the random sampling procedure was used. The questionnaire was administered to registered engineers, architects, builders, quantity surveyors and project managers in the construction sectors in Edo State and Delta State. The structured questionnaire contained a sequence of questions divided into two sections. Section A gathered demographic information from the respondents and Section B assessing the aawareness of Just-In-Time in Construction Projects by using a five-point Likert scale in rating the opinions of respondents. Collins (2010) recognised that Likert scales are useful for gathering participants' views on different statements. To ensure the validity of the research instrument, a pilot survey was carried out involving four industry professionals and two academic lecturers. The purpose was to evaluate whether the awareness of Just-In-Time in Construction Projects, as identified in the literature, is applicable to the Nigerian context. Findings from the pilot survey confirmed that the identified variables are relevant and clearly understood by the professionals. The help of colleagues and friends were employed in the distribution and collection of the questionnaire after properly putting the respondents through the contents of the questionnaire. Three hundred twenty-four (324) of the construction professionals in Edo and Delta States, were aadopted as the sample size for this study, out of which 203 of them credibly responded, representing 62.65% response rate. The data collected were analysed for the study using SPSS 23.0, utilising various statistical methods and tools, including frequency distributions (percentages), mean score, exploratory factor analysis and the T-test.

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4 Results and Discussion

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 Awareness of Just-In-Time in Construction Projects

Table 2: Awareness of JIT in Construction Projects

S/N	Awareness of JIT	Mean	Df	Standard Deviation	T-value	p-value (2-tailed)	Rank
1	The concept of JIT management in construction	3.89	202	.951	89.291	<0.001*	1
2	JIT can help reduce waste and improve productivity in construction projects	3.45	202	.852	88.296	<0.001*	6
3	Principles of JIT on construction projects to improve efficiency	3.77	202	.746	87.465	<0.001*	2
4	JIT can be beneficial for managing material delivery and inventory in construction projects	3.65	202	.333	92.113	<0.001*	5
5	Training or education on JIT management system	3.68	202	.616	72.220	<0.001*	4

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6	Performance monitoring for effectiveness of JIT in construction projects	3.32	202	1.221	81.007	<0.001*	7
7	Innovation integration to enhance JIT in construction projects	3.12	202	1.027	88,296	<0.001*	10
8	Practical awareness of JIT to advance hands-on experience in material and time management for construction projects	3.30	202	.761	82.111	<0.001*	8
9	JIT can help in minimizing on-site storage space on construction project	3.73	202	1.101	63.018	<0.001*	3
10	JIT encourage partnership with supplier for better communication and timely deliveries	3.21	202	.902	71.990	<0.001*	9

* Significant at 95% interval

Table 2 shows the awareness of the concepts of JIT in the construction industry. In terms of the statement 'The concept of JIT management in construction', the mean score (M=3.89) is the highest amongst all other variables and indicates an agreement among the respondents on the use of JIT in construction. This is followed by the variable, "Principles of JIT on construction projects to improve efficiency" (M=3.77) which indicates an agreement from the respondents on the efficiency of JIT. Others in that order are "JIT can help in minimizing on-site storage space on construction project" (M=3.73); "Training or education on JIT management system" (M=3.68); "JIT can be beneficial for managing material delivery and inventory in construction projects" (M=3.65); and "JIT can help reduce waste and improve productivity in construction projects", (M=3.45).

Furthermore, the variable "Performance monitoring for effectiveness of JIT in construction projects" (M=3.32) came next in that order, followed by "Practical awareness of JIT to advance hands-on experience in material and time management for construction projects" (M=3.30); "JIT encourage partnership with supplier for better communication and timely deliveries" (M=3.21) and lastly, "Innovation integration to enhance JIT in construction projects" (M=3.12). Given that all the variables have mean scores above 3.00, it shows that all the respondents agree that they are aware of JIT usage in the construction industry. However, in terms of the significance level, all the variables have a high T-values (Min=63.018; Max=92.113) with p-values (<.001). This indicates that the various variables under the awareness of JIT are 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, *"There is no awareness of JIT management system in construction projects among construction professionals in Edo State and Delta State"* is rejected while the alternative hypothesis which states that *"There is awareness of JIT management system in construction projects among construction professionals in Edo State and Delta State"* is accepted. By implication, it means that in the study area, the construction professionals have adequate knowledge of JIT in construction projects.

4.3 Factor Analysis of the Awareness of JIT in Construction Projects

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

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.791
Bartlett's Test of Sphericity	Approx. Chi-Square	622.439
	Df	157
	Sig.	.001

The table 3 shows the KMO and the Bartlett test for the various concepts of the awareness of JIT in construction projects. 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 KMO coefficient is 0.791 (79.1%) which is above the required 0.70 (70%). This shows that the data are very sufficient for factor analysis to be done. Also, the p-value of the Bartlett's test of sphericity (0.001) falls within the required 5% significance level of ($p<0.05$) at a degree of freedom of 157 and an approximate chi square of 622.439. This shows that exploratory factor analysis is adequate for the identified data.

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

Table 4: Total Variance Explained for the Awareness of JIT

	Initial Eigenvalues			Rotation Sums of Squared Loadings		
S/N	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	3.932	19.659	19.659	2.644	25.497	28.141
2	2.431	12.157	31.816	2.499	13.221	41.362
3	0.999	11.546	43.362			
4	0.986	10.246	53.608			
5	0.980	9.305	62.913			
6	0.961	5.408	76.177			
7	.953	4.764	85.974			
8	.645	3.226	92.807			
9	.190	.952	98.982			
10	.001	.005	100.000			

Extraction method: Principal Component Analysis.

Table 4 indicates the Total Variance explained the concepts of awareness of JIT in construction projects with the Principal Component Analysis (PCA) extraction method. It shows the presence of two components with initial eigenvalues exceeding 1, explaining the 28.141% and 13.221% variances respectively. These two ccomponents for the awareness of JIT together have a total cumulative percentage of 41.362% of the total importance which highlights their significance from the ten principles of JIT shown.

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

Table 5: Rotated Component Matrix for the awareness of JIT

	Component	
Awareness of JIT	**1**	**2**
The concept of JIT management in construction	.710	
JIT can help reduce waste and improve productivity in construction projects	.910	
Principles of JIT on construction projects to improve efficiency	.756	
JIT can be beneficial for managing material delivery and inventory in construction projects	.595	
Practical awareness of JIT to advance hands-on experience in material and time management for construction projects	.692	
JIT can help in minimizing on-site storage space on construction project		.608
JIT encourage partnership with supplier for better communication and timely deliveries		.695
Performance monitoring for effectiveness of JIT in construction projects		.804

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 9 iterations.

Table 5 shows the rotated component matrix of the various concepts of the awareness of JIT in construction projects. After nine iterations, the rotation converged in relation to the initial eigenvalues of 1. The rotated correlation matrix revealed that the variables had a coefficient of 0.500 and above. The assessment of factor loadings of the varimax rotation matrix revealed a pattern of correlation of two components or factors, explaining the 41.362% of the total variance.

4.6 Component Factors groupings for the awareness of JIT in construction projects

S/N	Component factors	Awareness of JIT	Factor loadings
1	Productivity factor	The concept of JIT management in construction	.710
		JIT can help reduce waste and improve productivity in construction projects	.910
		Principles of JIT on construction projects to improve efficiency	.756
		JIT can be beneficial for managing material delivery and inventory in construction projects	.595
		Practical awareness of JIT to advance hands-on experience in material and time management for construction projects	.692

2	Performance factors	JIT can help in minimizing on-site storage space on construction project	.608
		JIT encourage partnership with supplier for better communication and timely deliveries	.695
		Performance monitoring for effectiveness of JIT in construction projects	.804

This section shows the variables are grouped according to the factor loadings of the rotated component matrix of the construct. The pattern matrix expresses the coefficients for the linear combination of variables measured. Each factor was named by using a name that reflects all the variables and where there was a difficulty in picking a suitable name, the variable(s) that has the highest factor loading among all the variables that loaded onto a factor was used in naming that factor.

The two factor groupings are reported as follows:

A total of five (5) variables loaded onto factor 1. This factor loads: The concept of JIT management in construction; JIT can help reduce waste and improve productivity in construction projects; Principles of JIT on construction projects to improve efficiency; JIT can be beneficial for managing material delivery and inventory in construction projects and; Practical awareness of JIT to advance hands-on experience in material and time management for construction projects. This factor accounts for 28.141% of the total variance. All mentioned variables in this cluster can be said to relate with productivity improvement. Therefore, this cluster can be termed **Productivity factor.**

A total of three (3) variables are loaded in cluster 2. These variables include: JIT can help in minimizing on-site storage space on construction project; JIT encourage partnership with supplier for better communication and timely deliveries and; Performance monitoring for effectiveness of JIT in construction projects. The stated variables in this cluster relates with performance in construction. Therefore, this cluster can be named **Performance factor.** This cluster accounted for 13.221% of the total variances.

5 Discussion of Findings

This section discusses the awareness of JIT in construction projects in the Nigerian construction industry. The JIT concept is a very helpful aspect of construction as it streamlines procurement and promotes efficiency. The findings of this study indicate that construction professionals are conversant with the principles and concepts of JIT and most have applied same to their construction projects. This is in contrast with the findings of Xing *et al.* (2021) which stated that its application in construction projects has been slower and more complex. The awareness of JIT in construction projects is very encouraging, leading to great benefits that is akin to project efficiency and effectiveness. Corroborating this is the study of Demirkesen *et al.,* (2022) which emphasizes that the disconnect between material availability and actual project needs can lead to underutilization of labor and equipment, further exacerbating inefficiencies. This shows that material conservation, especially through the awareness and application of JIT, is a precursor to having a construction project delivered to quality and within budget. Also, adopting JIT in construction can only be possible when there is adequate awareness of its concepts, hence leading to quality productivity and performance. Oke *et al* (2023) reiterates this fact by indicating that JIT ensures workforce flexibility, reducing dependency on specific individuals and mitigating

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disruptions due to unexpected occurrences. The construction professionals in this study show utmost knowledge of JIT, though not to a very high level, but if further developed, can lead to a robust awareness that can improve implementation in construction projects.

6 Conclusion and Recommendations

This study aimed to evaluate the awareness of JIT in construction projects. Due to widespread non-compliance or non-conformity to the characteristics that assure its adoption, JIT has not been practically and technically examined and analysed in the majority of building projects. Despite the extensive regions of their application in the construction sector, the level of awareness and importance from this study is only slightly above average. The majority of studies are conducted based on the opinions of a select group of construction professionals. Despite the fact that it has been demonstrated that JIT have a significant favourable impact on the overall outcomes of construction operations, they are largely absent in reality. Regrettably, JIT are slowly but surely making their way into Nigerian construction operations. In practical, most building site one sees, the outdated, manual system of construction is still in use and determines the final product, signalling the absence of the awareness of the concept of JIT. It is therefore recommended that There should be robust awareness campaigns such as through more practically-oriented workshops, symposia amongst others, in order to improve the level of awareness by construction professionals. Also, practical workshop practise on the use of JIT should be incorporated into educational institutions in Nigeria as soon as possible for the benefit of aspiring construction professionals. However, future research should be centred on exploring the study to a wider scope involving other regions such as Southwest Nigeria, Southeast Nigeria and North Central Nigeria.

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