

INVESTIGATING THE AWARENESS AND BARRIERS OF JUST-IN-TIME CONCRETE DELIVERY ON CONSTRUCTION PROJECTS

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Abstract

In today's highly industrialized world, the amount of waste emanating from the construction industry is enormous. While the problem has been successfully curbed in developed countries through the adoption of innovative approaches such as Just-in-Time (JIT) delivery of construction materials, the challenge persists in developing countries like Nigeria. The use of ready-mix concrete represents the most prototypical example of JIT on construction projects. This study thus focuses on investigating JIT concrete delivery on construction projects in Nigeria, with a view to improve the awareness and adoption of the approach. Survey research design was adopted for this study, with the population being management staff of construction firms in Lagos State, Nigeria. Questionnaire was used to collect data and the targeted respondents were purposively selected from the population. A total number of 112 questionnaires were administered with a response rate of 51%. Percentage, mean, standard deviation and ANOVA were used to analyze the data. The result reveals that the level of awareness of JIT concepts is above average, that is, their mean value is above 3 on a Likert Scale of 5, while delay due to traffic congestion and preference of cost over quality are the most significant barriers to JIT implementation, with mean value of 3.75. It is concluded that although the awareness of JIT has improved, its implementation is still being hindered by at least 25 barriers in Nigeria. It is recommended that there should be continuous awareness campaign of lean construction principles via education and training by professional bodies and tertiary institutions to enhance its usage.

Key Words: Awareness, Barriers, Concrete, Just-in-Time, Lean

Introduction

It is noteworthy that aside being a pivotal contributor to economic growth, the construction industry has been experiencing global rapid growth over the years due to increase in demands for its products. Consequently, space has been a major constraint of construction projects (Dawood *et al.*, 2005). Ellen and Janet (2002) also corroborate that unavailability

or inadequate storage space for materials is a major problem of space-constraint sites, especially in congested areas. JIT technique is a lean construction tool that was used to solve lack of space for materials in the Japanese manufacturing industry (Swapnil *et al.*, 2014). The JIT strategy connotes having the right materials at the right place, right time and right quantity, just in time for production.

The application of JIT in construction differs substantially from its application in manufacturing because construction and manufacturing are different types of production although they both require supply of materials (Ballard and Howell, 1995). Ready-mix concrete is the most common example of JIT, though its use is limited in Nigeria. It entails the delivery of concrete in the right quality and quantity just in time for placement; thereby proffering solution to space constraint on construction sites and minimization of material waste arising from site storage and production. Developed countries like Singapore (Dulaimi and Tanamas, 2001); UK (Callen *et al.*, 2000); Brazil (Silva and Cardoso, 1999); and so on, have been benefiting from JIT, unlike their developing counterparts like Nigeria. It is on this background that this study focuses on investigating JIT concrete delivery on construction process in Nigeria. The key objectives are: to assess the awareness of the JIT concrete delivery within building contracting firms, and to investigate the significant barriers to the adoption of JIT concrete delivery by the present adopters of the approach in Nigeria. According to Oladiran (2008), construction wastes are excess resources used than required for construction production. This study argue that its incidence has not been adequately curbed due to sparse implementation of JIT, and thus the problem this study seeks to solve.

Literature Review

JIT is both a philosophy and as well a technique for elimination of waste. The philosophy is to have “the right product at the right place, right time and right quantity” to streamline production with little or no site inventory (Pheng and Choong, 2001). Singh and Garg (2011)

opine that JIT is founded on a philosophy of waste elimination and usage of workers maximally to reduce cost and get optimal profits. It tends to resolve all the problems associated with traditional purchasing, such as high inventory, inflated cost, adverse suppliers’ relationship, poor quality and low productivity.

JIT has several nomenclatures due to its wide usage especially in the West, such as zero inventory production, stockless production, world class manufacturing, small batch production and continuous flow manufacturing. Pheng and Choong (2001) and Low and Mok (1999) opine that the basic concepts of JIT are Kanban or pull system, which is material flow being initiated by demand; total quality control (TQC), which is ensuring delivery of quality jobs or materials at all stages; top management commitment and employee involvement, ensuring availability of management high commitment and motivated employee to aid the success of JIT; uninterrupted workflow, ensuring that the production process is uninterrupted via simplified work processes and reduced process set-up time; suppliers relations, having long-term relationship with minimal suppliers to procure materials; and elimination of waste, removal of non-value adding materials or processes via good design and standardization. Oladiran (2008) noted that the awareness of JIT techniques is low in Nigeria, stating that organizations implement it with some modifications and in combination with traditional approach. Some of the modifications include selective usage for specific materials, site central store, multiple suppliers and direct purchase.

JIT could be difficult to implement in spite of the benefits (Kumar *et al.*, 2013). Some of its elements are difficult to

implement, such as zero defect, zero deviation, JIT supply, setup reduction, small lot size, equip layout; although there are others that are relatively easy to implement, such as employee involvement, quality, training of workers and suppliers and quality circle. Some of the problems that make JIT difficult to implement are inconsistent timing and quantities of delivery, inconsistent quality of incoming materials, workers resistance, lack of top management support, unwillingness of workers to perform multi tasks and lack of communication between management and workers. Kumar *et al.*, (2013) shows that the panacea to these problems are proper training of workers, initiation of quality circles, simplification of layout, reduction in active number of vendors and automation. However, all these require management initiatives, such as provision of work force security, training, commitments, teamwork and promotion of employee responsibility. Several issues have mitigated against the successful implementation of the JIT especially in developing countries like Nigeria. Specific characteristics of developing countries that have negatively impacted the JIT implementation include: implementation costs, costs of technology and maintenance, labour productivity and labour costs, inflation and the supply conditions, the demand conditions and culture. Sarhan and Fox (2013) opine that significant barriers to the implementation lean construction are lack of adequate lean awareness and understanding; cultural and human attitudinal issues; and lack of top management support. In the same vein, Oladiran (2008) identified and grouped the likely barriers of JIT in Nigeria as skill and knowledge, technical, management, government, attitude, resources, logistic and others. Low and Mok (1999)

demonstrate that the seven concepts of JIT can be operated on construction sites. However, the study shows that the principal problem of JIT in construction is people, which are clients/consultants, suppliers, subcontractors and workers. All these people must work in cooperation for JIT to work. The consultant requires putting up design that incorporates standard components, which will require his knowledge of them. Clients also need to accept standard designs, but most clients want unique designs different from other people's houses. Suppliers may not readily and quickly adapt to contractors request, because long term relationship with a single supplier takes time and any default could be damaging. It also takes time to educate, train and guide subcontractors on JIT during construction, and they are very significant because they do most of the jobs. JIT advocates training of workers to be multi task, but the problems of training borders majorly on communication and cultural barriers.

Research Method

The research design adopted for this study is survey research design. The survey was carried out by means of self-administered questionnaires to elicit information on the awareness and barriers of the JIT technique in Nigerian construction projects. The population of the study is professionals who have participated in projects where JIT concrete delivery was used. Purposive sampling technique was used to select the respondents from the population. The questionnaire comprises demographic information of the respondents, awareness and barriers of JIT. The awareness of JIT concepts was measured on 5-point Likert scale, where 1 represents Very Low awareness, 2 represents Low awareness, 3

represents Average awareness, 4 represents High Awareness, while 5 represents Very High Awareness. The barriers to the adoption of JIT concrete was measured on another 5-point Likert scale, where 1 represents very low significance, 2 represents low significance, 3 represents average significance. The data were analyzed with mean, mode, percentage, standard deviation and ANOVA.

Result and Discussion
Organizations’ and Respondents’ Profiles

The organizations’ profile shown in Table 1 reveals that 3.6% of the respondents work in consulting firms,

58.9% of the respondents work in contracting firms, while 37.5% work in construction/contracting firms; 87.3% of the respondents works in fully indigenous-owned firms, 1.8% works in fully expatriate-owned firms and 11% works in both expatriate and indigenous-owned (Mixed) firms; 21.4% of the respondents work in firms that have between 1-5 years of experience in the construction industry, 8.9% work in firms with 6-10 years of experience in the industry, 14.3% work in firms with 11-15 years of experience in the industry, 10.7% work in firms that with 16-20 years of experience in the industry, while 44.6% of the respondents work in firms that have above 20 years of experience in the construction industry.

Table 1: Organizations’ Profile

Nature	Ownership & Management	Age (in years)
Consulting (3.5%)	Fully indigenous (87.3%)	1-5 (21.4%)
Contracting (59%)	Fully expatriate (1.8%)	6-10 (8.9%)
Consulting/Contracting (37.5%)	Mixed (11%)	11-15 (14.3%)
		16-20 (10.7%)
		Above 20 (44.6%)

The Respondents’ profile is shown in Table 2, 18% of the respondents are designated as Project Managers, 34% are Site Engineers, 12% are Builders, 14% are Site Managers, 8% are Quantity surveyors, while 14% are Architects; 1.8% of the respondents have Ordinary National Diploma (OND) qualification, 16% have Higher National Diploma (HND) qualification, 44.6% holds either a B.Sc. or a B.Tech degree, 34% have M.Sc. qualification, while only 3.6% have Post Graduate Diploma (PGD) qualification; 22.0% of the respondents are members of the Nigerian Institute of Building (NIOB), 20.0% are members of the Nigerian

Institute of Quantity Surveyors (NIQS), 14.0% are members of the Nigerian Institute of Architects (NIA), 42.0% are members of the Nigerian Society of Engineers (NSE), while 2.0% of the respondents are members of the Project Management Institute (PMI); 37.5% of the respondents have work experience of between 1-5years, 23.2% have 6-10 years, 35.7% have 11-15 years, while 3.6% of the respondents have above 20 years; 15% are of Architecture Profession, 22% of Building, 18.5% are Quantity Surveying, 40.5% of Civil Engineering, 2% each are of Project Management and Mechanical Engineering.

Table 2: Respondents' profile

Position	Highest academic qualification	Professional body	Professional Background	Years of Experience
Project Manager (18%)	OND (1.8%)	NIOB (22%)	Architecture (15%)	1-5 (37.5%)
Site Engineer (34%)	HND(16 %)	NIQS (20%)	Building (22%)	6-10 (23.2%)
Builder (12%)	BSc./B.Tech(44.6%)	NIA (14%)	Quantity Surveying	11-
Site Manager (12%)	MSc.(34%)	NSE (42%)	(18.5%)	15(35.7%)
Quantity surveyor (10%)	PGD(2)	PMI (2%)	Civil Engineer(40.5)	16-20(3.6%)
Structural Engineers (14%)			Mechanical Engineering(2) Project Management(2)	

Note that NIOB means Nigerian Institute of Building; NIQS means Nigerian Institute of Quantity Surveying; NIA means Nigerian Institute of Architect; NSE means Nigerian Society of Engineers; PMP means Project Management Professional

Awareness of JIT Concepts

Table 3 shows the level of awareness of JIT concepts by management staff of construction firms. Total quality control has the highest awareness with a mean score of 4.16, indicating high awareness on the Likert scale of measurement. It is followed in descending order by uninterrupted work flow (3.65), multi-functional skills training (3.64), single-sourcing supplier relations (3.27), value stream (3.25), zero-deviation schedule (3.16), right the first time production approach (3.16) and stockless production (2.73). Total quality control is a concept that is quite popular even beyond the bounds of the construction industry as other industries adopt a form of total quality control one way or the other in their operations. Stockless production on

the other hand which simply means 'production without storage' is uncommon because it is viewed difficult not to have any form of storage on most construction sites. Comparing this result with the work of Oladiran (2008) shows that there has been tremendous improvement on the awareness of JIT in Nigeria in the last 10 years. Oladiran (2008) revealed that the awareness of lean techniques was low and that JIT usage barely existed in construction projects, although the study did not investigate specific concepts of JIT. Its usage then was mixed with traditional approach and not absolutely JIT concepts. For instance, there were still site storage for some materials and components, and JIT was not practiced for all materials.

Table 3: Awareness JIT concepts

Concepts	N	1	2	3	4	5	Mode	Mean	Rank
Total quality control	55	-	1	10	23	21	4	4.16	1
Uninterrupted workflow	55	-	5	20	19	11	3	3.65	2
Multi-functional skills training	55	-	8	14	23	10	4	3.64	3
Single-sourcing supplier relations	56	6	5	18	22	5	4	3.27	4
Value Stream	53	1	7	27	14	4	3	3.25	5
Zero deviation schedule	55	2	11	21	18	3	3	3.16	6
'Right the first time' production approach	55	2	11	23	14	5	3	3.16	6
Stockless production	55	8	13	23	8	3	3	2.73	7

Where N represents Total number of respondents, 1 represents Very Low awareness, 2 represents Low awareness, 3 represents Average awareness, 4 represents High Awareness, while 5 represents Very High Awareness

Significant Barriers to the Adoption of JIT Concrete Delivery

Table 4 presents the opinion of the respondents on the significance of the barriers against the adoption of JIT concrete delivery. Twenty five barriers coined from literature were investigated, which were grouped to four categories, namely: management, technical, logistics and attitudinal. It can be seen from Table 4 that the respondents consider all the barriers of above average significance because all the mean scores are above 3, which represents average significance on the Likert scale of measurement, but none is up to 4 (i.e. high significance). The ranking of the variables based on their mean scores was done both in group and overall. In the management group, risk aversion was considered the most significant (3.64) out of the seven barriers, which is followed in descending order by heavy reliance on labour-intensive techniques (3.59), centralization of decisions (3.51), and so on. In the technical group, site access requirements was considered the most significant (3.69) out of the six barriers, which is followed in descending order by little or no allowance for poor workmanship (3.56), workability retention in hot weather (3.42) and so on. In the logistics group, delay due to traffic congestion was considered the most significant (3.75) out of the six barriers, which is followed in descending order by long distance between batching plant and sites (3.56), poor access to site (3.27) and so on. In the human group, preference of cost over quality was considered the most significant (3.75) out of the six barriers, which is followed in descending order by selfishness among professionals (3.42), fear of unfamiliar practices (3.27) and so on. Moreover, the overall ranking sheds light on the

significance of each barrier among the 25. Preference of cost over quality and delay due to traffic congestion were ranked as the most significant barriers as they both have the highest mean score of 3.75. They were closely followed by site access requirements, risk aversion, heavy reliance on labour-intensive techniques and long distance between batching plant and site having mean scores of 3.69, 3.64, 3.59 and 3.56 respectively. The least significant barriers on the overall scale include non-availability of mineral admixtures, inadequate on-site quality control, poor delivery planning, dread of cultural change and lack of trust in ready-mix concrete suppliers with mean scores of 2.80, 3.11, 3.15, 3.18 and 3.22 respectively. This finding agrees in some sort with the opinion of Kumar *et al.* (2013), which opined that some of the elements of JIT, such as zero defect, zero deviation, JIT supply, setup reduction, small lot size and equip layout are difficult to implement. Kumar *et al.* (2013) posit that the difficulties are caused partly by management and human related problems as also revealed in this present study, such as worker resistance, lack of top management support, unwillingness of worker to perform multi tasks and lack of communication between management and workers. Thus, Kumar *et al.* (2013) noted that solving these problems or barriers require management initiatives, such as provision of work force security, training, commitments, teamwork and promotion of employee responsibility. This finding is also in consonance with Sarhan and Fox (2013), which show that lean significant barriers include human attitudinal issues and management problems. Human related problems are one of the barriers reveal in this study. Additionally, it is noteworthy that this study absolutely

agrees with the findings of Oladiran (2008) because all the barriers identified

in the study are similar with the ones discovered in this current study.

Table 4: Barriers to the adoption of JIT concrete delivery

Barriers	N	1	2	3	4	5	SD	Mean	GR	OR
<u>Management Related Barriers</u>										
Risk aversion	55	1	4	17	25	8	0.890	3.64	1	3
Heavy reliance on labour-intensive techniques	54	3	4	16	20	11	1.073	3.59	2	4
Centralization of decisions	55	1	9	15	21	9	1.016	3.51	3	6
Misconception about cost of ready-mix concrete	55	-	11	16	18	10	1.016	3.49	4	7
Absence of long term planning	55	3	7	19	16	10	1.100	3.42	5	8
Lack of supply chain integration	55	-	6	25	19	5	0.809	3.42	5	8
Lack of client and supplier involvement	52	1	5	26	14	6	0.886	3.37	6	10
<u>Technical Related Barriers</u>										
Site access requirements	55	1	7	13	21	13	1.034	3.69	1	2
Little or no allowance for poor workmanship	55	1	7	17	20	10	0.996	3.56	2	5
Workability retention in hot weather	55	4	7	16	18	10	1.150	3.42	3	8
Extra caution required in readiness for placement	55	1	13	11	19	11	1.120	3.41	4	9
Inadequate on-site quality control	55	4	14	15	16	6	1.133	3.11	5	17
Non availability of mineral admixtures	54	8	14	17	11	4	1.155	2.80	6	18
<u>Logistics Related Barriers</u>										
Delay due to traffic congestion	55	1	11	11	10	22	1.236	3.75	1	1
Long distance between batching plant and site	54	2	6	19	14	13	1.093	3.56	2	5
Poor access road to site	55	5	19	12	14	3.45	1.230	3.27	3	11
Poor communication between site management and suppliers	55	3	15	11	17	9	1.190	3.25	4	12
Uncertainty in supply chain	55	2	12	19	15	7	1.053	3.24	5	13
Poor delivery planning	54	3	15	14	15	7	1.139	3.15	6	16
<u>Human attitudinal issues</u>										
Preference of cost over quality	55	3	3	11	26	12	1.040	3.75	1	1
Selfishness among professionals	55	1	10	15	23	6	0.975	3.42	2	8
Fear of unfamiliar practices	55	3	10	19	15	8	1.096	3.27	3	11
Lack of transparency	55	2	10	24	12	7	1.013	3.22	4	14
Lack of trust in ready-mix concrete suppliers	55	4	11	16	17	7	1.134	3.22	4	14
Dread of cultural change	55	3	8	23	18	3	0.945	3.18	5	15

Where N: Total number of respondents. 1 represents very low significance, 2 represents low significance, 3 represents average significance, 4 represents high significance, 5 represents very high significance.

Test of Hypotheses

H₀: There is no significant difference between organizations on the barriers to the adoption of JIT concrete delivery.

ANOVA test was carried out to test the difference between organizations on the barriers to the adoption of JIT concrete delivery. The organization criteria used

for the test was 'ownership and management' which includes fully indigenous, fully expatriate, partly indigenous and partly expatriate. The decision rule adopted was that significant difference exists at p-value equals to or less than 0.05. Where the p-value is greater than 0.05, H_0 is accepted while H_0 is rejected where the p-value is less than 0.05. The result indicates that there is no significant difference between organizations on their perception of all the barriers to JIT concrete delivery save for one, which is 'fear of unfamiliar practice'. Therefore H_0 is accepted for all the barriers to JIT concrete delivery because they all have p values higher than 0.05 except for 'fear of unfamiliar practice'. The inference that can be drawn from this result is that all the organizations do not differ on their perception of the barriers to JIT concrete delivery except in the case of fear of unfamiliar practice. This goes to show that there is indeed an awareness and adoption (albeit low) of ready-mix concrete in the construction industry. Thus, it cannot be said that the use of ready-mix concrete is an unfamiliar practice but that the other barriers listed are the ones that actually pose impediments to the adoption of JIT concrete delivery.

Conclusion

This study set out to investigate JIT in concrete delivery on construction projects. The objectives are to assess the awareness of the JIT concrete delivery in building contracting firms, and to investigate the significant barriers to the adoption of JIT concrete delivery in Nigeria. The study was carried out and the following conclusions are made based on the findings:

- The level of awareness of JIT concepts is above average although total quality control is the most known JIT concept in Nigeria. The low awareness also translates to low adoption and this implies that there could be high incidence of concrete waste in Nigeria construction projects
- There are 25 barriers of JIT concrete delivery, of which the most significant are delay due to traffic congestion and preference of cost over quality. This implies that the erratic traffic situation in the country and the attitudinal preference of cost over quality among professionals are the major impediments to the adoption of JIT concrete delivery.

Recommendations

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

1. JIT should be extended to other construction materials to enhance workflow improvements and waste minimization. This can be achieved by adopting an overall JIT policy for construction process in organizations.
2. Strategies should be developed to mitigate the barriers impeding the adoption of JIT concrete delivery especially in the area of traffic congestion, as it poses the most threat. The development of proper road networks would help ease traffic flow.
3. Professional bodies, researchers and institutions of higher learning should give attention to enlightening Nigerians and companies on the JIT technique, so as to improve the awareness and adoption. This can be done through organized seminars, workshops and other sensitization programmes.

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