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AWARENESS, USE AND BENEFITS OF LEAN TECHNOLOGIES ON CONSTRUCTION PROJECTS IN NIGERIA

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Abstract

The Nigerian construction industry is confronted with numerous challenges, including poor performance and waste generation during construction. Lean, to a greater extent, has been able to improve quality, minimize waste generation, and ensure value for money on delivered projects. Hence, this paper aims at identifying the extent and level of awareness of lean technology;

assessing the benefits of adopting lean technologies on construction projects in Imo state, Nigeria. A total of about 200 self-administered questionnaires were purposely distributed to practitioners within Imo state. Of the 200 questionnaires, 132 were completed and returned, while 6 were found unfit, and the rest (126) were analyzed using IBM SPSS Statistics 25.0. The result indicates that the level of awareness of lean construction technology use is still at a moderate level, while the benefits of lean technologies adoption include allowing for the maximum use of equipment and materials on construction sites. This paper recommends that workshops and seminars by professional bodies be organized from time to time to help in enlightening practitioners on the needs and benefits derivable from the adoption of lean construction technologies.

Keywords: Awareness, Benefits, Construction projects, Lean technologies

Introduction

Since the lean approach has a well-defined set of priorities in the implementation process, the management of a construction project using a lean approach is somewhat different from the usual conventional approach (Ramani & Lingan KSD, 2019). With lean, the process is intended to optimize efficiency for the benefit of the client; simultaneously design the product and processes; as well as exercise control over the project's life cycle (Alaskari, Ahmad & PinedoCuenca, 2015). In order to put it plainly, these conglomerates want to be able to offer high-quality, personalized goods and services in the right quantities and at the right time and locations. Chen and Taylor (2009) affirmed that on the basis of certain philosophies that existed before the implementation of the lean principles, lean practices were typically introduced. The concept behind these philosophies led to the introduction of some of the main lean elements that include the emphasis on the development of high quality, easily needed and relatively cheap goods for the consumer. Because most industries indirectly profit from the products of the construction industry, the tendency to remove all kinds of waste and non-value-added processes is sacrosanct if cost savings are made and a strong consumer base and competitive advantage is obtained in the long run.

It is on this premise that Koskela (Koskela et al., 2000), a renowned scholar in Lean Construction, challenged the construction sector practitioners to start applying extant lean production thinking and practices. He reiterated that lean holds tremendous promise in terms of improving chronic problems and providing solutions to the industry. It is evident from the available literature that there are no readily available studies explicitly performed in Imo State, Nigeria on lean principles and their implementation in the Nigerian construction industry (Amade, Ononuju, Obodoh & Okorie 2019).

Despite the fact that lean development ideas have recently been considered as an advanced method, the industry has been slow in adopting lean ideas to improve construction performance and work profitability. The construction industry, as Amade et al, (2019) and Turner (2012) said, is plagued by a multitude of problems arising from the failure to produce quality services and goods that would be less costly for the consumer. As opined by Abarinda, Kibwami and Tutesigensi (2019), the subsequent propensity on the part of the industry to embrace the new continuous improvement strategies, such as lean, six sigma and overall quality control, as a strong indicator of the industry's vulnerability to failure as opposed to what occurs in the manufacturing sector. Ayangade et al. (2009) argued that the manner of procurement of most construction projects in Nigeria has been degraded by non-compliance with the rules on tendering and selection of qualified hands in the delivery of projects according to timetable, cost and quality objectives. Amade et al, (2019) and Saka and Chan (2020) further reiterated that one of the problems bedeviling the Nigerian construction industry is the fragmented nature of the industry, coupled with the rise in the number of stakeholders, lack of information management and the consistent reliance on traditional approaches. In spite of the fact that the Nigerian construction industry has comparable qualities to business in different climes, cycles of conveyance contrast on account of social and natural contrasts. Thusly, effective usage of lean construction in Nigeria is expected not only to understand the methods and processes used to carry out the projects, but also to consider the climate factors that affect the practice of the project in order to promote harmonious ties. Given the dynamic nature of most construction projects and the resultant difficulties, it is crucial that the Nigerian construction industry contributes to the economy by deploying value-

added activities and waste reduction strategies with a view to achieving competitive advantage (Amade et al., 2019). Integrating lean tools and techniques in construction project management within Imo state, Nigeria specifically, is still lacking in the literature. Therefore, this paper aims to fill the gap, by analyzing the level of awareness and use of lean technologies, analyzing the benefits of deploying these technologies in promoting construction projects and their processes, and to help optimize construction project performance.

Literature review

Lean, according to Singh et al. (2017), is a philosophy that eliminates waste of various kinds in the production functions of a typical organization. While Tserng et al. (2013) are of the view that lean entails a system that uses fewer inputs to produce the same output as those produced by the conventional mass production system, while at the same time delivering the required value and improved customer satisfaction. According to Capo et al. (2004), the word lean, Ayarkwa et al. (2012) and Chen and Taylor (2009) originated from the work of a research team working on an international piece in an effort to reflect the essence of the Toyota Production System while also differentiating their works from the lines of handicraft and related production. As Capo et al. (2004) claimed, the key focus of the research team was to concentrate on the manufacturing process as a whole, unlike the handicraft production system, which relies entirely on worker efficiency. The word lean is used to describe how the Toyota Production System sought to continuously identify and eliminate waste, according to Engineers Australia (2012). We further describe it as a fundamental way of how individuals work together while adding value.

As a result of the dynamics of development and the need and zeal to carry out the changes brought about by social and demographic trends over time, the construction industry around the world is constantly growing. According to Oyedele (2013), the industry is the key driver of growth in the manufacturing, education and health sectors as a result of its dependence on the construction industry for results. Lean construction is a production management philosophy focused on the execution of projects, the new means of design and construction, with a view to improving the previous construction methods (Fapohunda, 2014). Cleves and Michael (2006) are of the opinion that the

main driver of the lean project delivery strategy is the perception that incentives and rewards are related to the value of the projects delivered. All the different professionals in the project are required to work together to help to improve any perceived problems faced in the project. In applying lean construction concepts in construction projects, the design process is carried out with the primary purpose of achieving enhanced customer satisfaction across the entire process.

According to Amade et al, (2019); Fapohunda (2014), the lean construction process is based on the following concepts i.e., minimizing waste; specifying value from the client's point of view; clearly streamlined process that will be of value to the client; minimizing all non-value-added processes and activities; ensuring that there is a flow between all value-added processes without interruptions in the management of interfaces between steps and activities ensure that the client decides to pause and accelerate activities as needed; ensure that perfection is achieved by quality improvement; elimination of waste on site (Fitchett & Hartmann, 2017), as well as reduce and manage unavoidable waste, reducing labour while maintaining throughput, reducing inventory while increasing customer service levels, increase capacity in current facilities, improve quality and increase profits, increase system flexibility, improving cash flow, in the construction process (Abo-Zaid & Othman, 2018). While El-Sawalhi, Jaber and Shukri (2018) in their study identified the reduction of environmental impact on construction process, reduction of non-value adding work and cost saving measure to construction projects as benefits of lean. The idea behind the implementation of lean in construction consists of a dynamic and rigorous articulation of ideas vis-à-vis waste disposal, value added, continuous improvement, teamwork and increase in project's stakeholders' satisfaction during the planning phase of the project to name but a few (Herrera, Mourgues, Alarcon, & Pellicer, 2020). As can be seen from some of the literature, the adoption and implementation of this theory and definition has not been fully utilized in the Nigerian construction industry. As Adamu and Howell (2012) have pointed out, the Nigerian construction industry has yet to follow lean construction principles for reducing waste and improving value, as can be seen in a multitude of problems such as a decline in contracting, increased conflicts and claims as a result of variations and the

consequent decline in housing and other infrastructure. Olatunji's (2008) research argued that the level of knowledge and understanding of the lean theory and its implementation in the Nigerian construction industry was abysmally poor, even though a handful of study respondents considered the lean definition to be a promising venture, given its waste minimizing nature and other value-enhancing capabilities.

In addition, Olatunji (2008) recommends enlightenment and training as a means of inculcating the lean philosophy to practitioners with a view to encouraging them to embrace the concept. On the other hand, Ahiakwo (2014) reiterated that the Nigerian construction industry, as well as other West African countries, is still struggling to embrace the lean model despite the associated gains.

Lean technologies for construction projects

Lean has a host of technologies and tools which make her versatile for all industry applications, such as failure mode and impact analysis, Kanban, complete management of the quality, quality feature deployment, Kaizen, value stream mapping and five sigma (Alvarez et al., 2009; Salem et al., 2006; Zhang, Niu, & Liu, 2020). Castiblanco et al. (2019) were of the opinion that lean tools are known for their ability to add value and minimize waste, which is typical of a business process. Many organizations have attested to the benefits of adopting lean construction tools such as setup reduction, Visual Management, Just-in-Time, Pull system, Value Stream Mapping, One Piece flow, Standardized Procedures/work, Mistake Proofing, Kaizen and 5S. It is important to note that numerous studies have concluded that most practitioners and academics believe lean tools aim to reduce inventories, lead times, and fast product production processes, among other things.While Enshassi and Zaiter (2014) reiterated that using lean tools such as last planner, increased visualization and 5s processes, reduces waste and increases efficiency, as well as results in the reduction of process steps and materials. This reduction in turn helps in minimizing the probability of being involved in an accident or coming in contact with hazardous materials. The following lean technologies are briefly explained below.

1. Increased Visualization

Increased visualization is a veritable method used to convey crucial information among the different workers employed on the construction project by using signs and marks to help points (Salem et al., 2005).

2. Occupational Health and Safety Assessment Series (OHSAS)

As Marhani et al. (2012) believes, its deployment in a construction environment would help improve the safety, awareness and morale of construction workers, ultimately leading to the reduction of accidents, claims and loss of man hours. They further stated that the OHSAS 18001 series has been specifically proven to be real instruments to help construction companies manage their occupational health and safety risks as part of their organizational system of improving health and safety performance through the planning and review of existing programs (Allu & Emuze, 2017).

3. Continuous Improvement (Kaizen)

Continuous improvement (CI) is a comprehensive and systematic approach to incremental and continuous improvement that depends on inventory reduction and the reduction of faulty parts (Sanyal & Bhattacharya, 2014). According to Engineers Australia (2012), CI in all its implications is done with a view to improving safety, efficiency and productivity on construction sites. They assumed that CI is an operation that must be carried out by crew managers, team leaders and other diverse professionals who will eventually own the process and inevitably begin to clearly see the resulting advantages. According to Ahiakwo (2014), CI is a method that helps workers to promote efficiency and minimize costs for work related to construction by using their intellectual skills. Ahiakwo (2014) further argued that the strategy encourages change for the better by focusing solely on constant incremental development, generating more value, while also reducing waste. In line with Engineers Australia (2012), CI, while embedded in the Deming's Cycle of Plan, Do Check Act (PDCA), is often extended from organizational to tactical to strategic levels of the organization.

4. Daily Huddle Meetings

The daily huddle meeting, according to Salem et al. (2005), is referred to as' tool box meetings, 'is a two-way contact mechanism aimed at achieving successful employee engagement. The daily huddle meeting is a lean construction technique where meetings are conducted on a daily basis (Ogunbiyi, 2014). The process gives the members of the project team the opportunity to conclude the previous work with respect to work activities on issues that could impede the progress of the project.

5. Fail Safe for Quality and Safety

According to Salem et al. (2005), this instrument is rightly opposed to the ab initio principle of quality control where only a sample of a whole lot is tested and decisions on the few lots are made. The inability to be quality-safe depends on producing some concepts that suggest the potential for a resulting defect. According to Ogunbiyi (2014), this method is close to visual inspection of lean manufacturing (Poka-Yoke device). Furthermore, Ogunbiyi (2014) claimed that the failure to be safe for quality can be applied to safety, as there are potential hazards inherent instead of potential defects that are then connected to the conventional production safety risk assessment method of traditional manufacturing.

6. Value Stream Mapping

It is a procedure for recording and streamlining the flow of a construction process by evaluating its current state and paying more attention to the value-adding and non-value-adding times with their corresponding lead times (Ahiakwo, 2014). Alaskari et al, (2015) and Ramani and Lingan KSD (2019) allude to VSM as a lean technique that is commonly used to produce a process flow diagram of activities and other project-related data. It is used as a structured tool to document the process steps and flow of work items that are further adopted in a systematic procedure for the purpose of process review and creation of an improvement plan.

7. Visual Management (VM)

Visual management (VM) is a type of orientation that focuses on visual control of output quality and organizational management (Koskela, 1992). The concept behind visual management is to streamline the criteria envisaged by the establishment of deviation steps to be noticed by everyone. According to Engineers Australia (2012), VM enables one to visualize one's work area by showing if the planned regular goals have been reached, displaying structured methods in use, easily identifying any irregular circumstances, communicating performance metrics, setting work objectives, displaying vital and secure activity features. For example, visual management solves problems with regards to being on-site and equipment, which gradually transcends into a standardized occupational gesture and better professional enhancement (Zhang et al., 2020).

8. The Five (5) S Process (Visual Workplace)

Salem et al. (2005) opined that the five (5) S method looks at the place of everything and everything in its place. The 5S method, often referred to as the visual work place, has five main levels that can help to minimize waste inside the system. Although Ahiakwo (2014) argued that it is a work place design tool that is used to clean and set up a work site in an organized and structured manner, while at the same time increasing the efficiency and protection of employees. Five main levels include: "seiri" (sort), "seiton" (straighten), "seiso" (shine), "seiketsu" (standardize), and "shitsuke" (sustain).

9. Just in Time (JIT)

This is a philosophy that tends to eliminate all the waste in all activities and operations. The JIT system is a production cost system that specifies the time for productivity to be achieved within a project activity, thus leading to development and cost reduction. Aka, Isah, Eze and Timileyin (2019) and Tourki (2010) further stated that the JIT system is an approach by which an organization can deliver the right items at the right time and at the right quality. JIT is a timely inventory cost management system in which works are received for further use on a later day by adjusting the time of material receipt and the time of its application in production, as well as the time of completion

with when it would be delivered to the customer.This procedure is a step in controlling stocks, leading to a successful JIT process. The objectives of the JIT are to dispose of all types of stocks, to minimize waste of time and resources in productive processes, to make purchases at the appropriate time and to meet the needs of consumers in a timely and quality manner. It also leads to the development of trust and relationships between companies and suppliers through the development of long-term trust-building goals.

10 Last Planner System (LPS)

LPS, is a production planning and control system that produces a predictable workflow process as well as a rapid learning system that leads to the programming, designing, construction and commissioning of construction projects (Murguia, 2019). The LPS sequences run through the Master Pull Schedule, the Reverse Phase Schedule, the Look Forward Schedule, the Weekly Work Plan and the Percent Plan are completed (Alsehaimi et al., 2013; Howell, 2014; Rajprasad et al.,2014; Salem et al.,2005). The main objective of the LPS is to draw up activities by means of reverse phase planning through team planning and to optimize the use of resources over the long term. The tool is similar to the Kanban system and the production leveling tools which are similar to lean manufacturing. The Master Schedule is the output of the front-end plan that describes the type of work to be carried out over the entire duration of the project. The Weekly Work Plan shall be drawn up on the basis of the schedule, the actual schedule, and the field conditions prior to the weekly meeting. Percent plan complete is an LPS performance measurement metric. Sarhan and Fox (2013) argued that some practitioners allude to the full percentage plan as a measure of commitment and reliability. At the end of the analysis, uncompleted plans are reviewed and analyzed with a view to identifying the problems and causes that have hindered the implementation process from the outset.

11. First Run Studies

First-run studies are used to rebuild significant jobs. Activities are investigated altogether, and thoughts and recommendations are raised to investigate elective methods of carrying out the responsibility. The PDCA (plan, do, check,

and act) cycle is utilized to develop the first run study (Sarhan, Xia, Fawzia & Karim, 2017).

12. Total Quality Management

TQM (Total Quality Management) and PDCA (Plan-Do-Check-Act) both are lean development quality administration strategies. TQM is a methodology that helps to improve quality and execution by coordinating all quality-related capacities and cycles all throughout the undertaking. The PDCA cycle is an iterative four-venture model for nonstop improvement (Zhang & Chen, 2016). As stated by Roriz, Nunes and Sousa (2017), TQM standards with lean production standards have ended up being satisfactory for some organizations. Different philosophies, for example, reengineering or mechanization can likewise bring about improved execution. The use of the value tool is minimal, especially in small to medium-sized enterprises (SMEs).

13. Building Information Modeling (BIM)

According to Amade et al. (2018), BIM is a digital representation of the physical and functional aspects of a facility that is accessible to all parties and forms a reliable platform for making informed decisions throughout the life of the facility. The idea behind BIM emerged initially at the Georgia Institute of Technology in the late 1970s and it grew rapidly thereafter. As stated by Azhar (2011), some of the benefits of BIM include; visualization, cost estimation, code reviews, fabrication/shop drawings, forensic analysis, sequencing and collusion detection amongst others. With the advent of BIM, the construction industries in developed climes have begun to change their mode of operation (Saka & Chan, 2020). They further reiterated that it is imperative for the Nigerian construction industry to start exploiting the gains associated with BIM implementation. To further buttress more on this, Moaveni, Banihashemi and Mojtahed (2019) assert that researchers have acknowledged that the traditional construction method needs to be upgraded via lean construction with a view to improving the performance of construction projects.

Research method

A purposive sampling technique (non-probability sampling design) was adopted by the study to select its respondents. This was preferred because the purposive sampling enables the researcher to select respondents with the necessary knowledge of the topic in question (Amade et al., 2019; Umar, Rizeiqi & Badr, 2020). In addition, the study seeks to obtain information from professionals within the study area who by virtue of their class and experience, and the capacity and knowledge necessary to participate in the study, taking into account the nature of the industry. Questionnaires were used to collect the respondent's information. A Likert scale was modeled on a questionnaire to measure the respondents' attitudes as suggested by Kothari (2004). The questionnaires had closed-ended questions and the researchers were self-administering them. The questionnaire was divided into two sections: the first section consists of the demographic features of the target population, i.e. their business background, careers, professional qualifications and level of education obtained, etc., while the second section consists of the key questions presented in the study objectives. An object was evaluated on a scale of five points ranging from 1 (low) to 5 (low) (high). Researchers seeking the views of experts in the field of research, in particular some of the university's senior academics and professors, created the contents of the questionnaire. Cronbach's alpha was used in terms of reliability to verify the reliability of the instrument on the basis of the internal accuracy of the test instruments.

Cronbach's alpha was developed for the main themes in the questionnaire, which formed the scale for the test of the reliability of the instrument. IBM SPSS Statistics (version 25.0) was used to produce descriptive and inferential statistics. Descriptive statistics included tables and frequency distribution, mean and standard deviation, while for inferential statistics, the relative importance index (RII) with the support of Microsoft Excel Spreadsheet was used to examine key discourse issues bordering on lean construction technologies and their benefits for construction projects in the study area. The RII was used to rate the scores of each response based on the percentage response to the 5-point Likert Type-Scale.

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Results and discussions

126 respondents comprising of experts from the built environment industry within the study area took part in the research. The responses were analyzed with the aid of frequency and percentage of responses regarding the demographic attributes of practitioners. A response rate of 63% was gotten, hence depicting an exceptionally high reaction rate as represented in table 1.

Table 1. Demographic Characteristics

Characteristics	Frequency	Percentage
Industrial experience		
1-5 years	24	19.0
6-10 years	33	26.19
11-15 years	52	41.27
15 and above	17	13.49
Professionals		
Architects	8	6.3
Project Managers	24	19.0
Quantity Surveyors	28	22.2
Builders	56	44.4
Engineers	10	7.9
Professional qualifications		
ARCON	8	6.35
PMI/CIPMN/PMP	18	14.29
CORBON	48	38.10
QSRBN	26	20.63
COREN	15	11.9
Others	11	8.73
Academic qualifications		
HND/B.Sc/B.Tech/B.Eng	81	64.29
MBA/M.Sc/M.Eng	42	33.33
PhD	3	2.38
Total	**126**	**100**

Note: ARCON=Architects Registration Council of Nigeria; PMI=Project Management Institute; CIPMN=Chartered Institute of Project Managers of Nigeria; PMP=Project Management Professional; CORBON=Council of

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Registered Builders of Nigeria; QSRBN= Quantity Surveyors Registration Board of Nigeria; COREN=Council of Regulation of Engineering in Nigeria.

Table 1 depicts the demographic qualities/profiles of the respondents. A larger proportion of the (41.27 percent) respondents had spent around 11 to 15 years in the construction business. This means that the respondents have gained a lot of experience and can serenely contribute to the outcome of this investigation. The majority of respondents (44.4 per cent) are builders, while 100.0 per cent of practitioners have gained the appropriate professional expertise and skills of their respective vocations.

In addition, about 64.29 per cent of respondents had first degrees and their equivalents as scholarly skills, while 33.33 per cent had Master's degree (postgraduate) equivalent, and 2.38 per cent had PhD qualifications. It is therefore imperative to state that the respondents possess the necessary academic credentials as an indicator of their ability to provide the right information that would further lend credence to the outcome of this work.

Table 2. Level of awareness and extent of lean technology use

S/N	Lean Construction Technologies	Descriptive Statistics			
		N	Standard Deviation	Mean	Rank
1	Occupational Health and Safety Assessment Series (OHSAS	126	1.20570	3.952	2nd
2	Value Stream Mapping	126	1.38811	2.238	12th
3	Continuous Improvement (Kaizen)	126	1.29038	2.849	7th
4	Daily Huddle Meetings	126	1.31899	3.627	3rd
5	First Run Studies	126	1.24936	2.555	9th
6	Total Quality Management	126	1.31444	4.015	1st
7	Visual Management (VM)	126	1.31008	2.587	8th
8	Increased Visualization	126	1.39562	2.373	10th
9	The Five (5) S Process (Visual Workplace)	126	1.32493	3.523	6th
10	Building Information Modeling (BIM)	126	1.27732	3.611	5th
11	Last Planner System	126	1.30834	2.015	13th
12	Fail Safe for Quality and Safety	126	1.10169	3.619	4th
13	Just in Time (JIT)	126	1.39407	2.357	11th
	Valid N (listwise)	126			

Table 2 summarizes the findings with respect to the level of awareness among respondents and the use of various lean construction technologies. Respondents were asked to indicate on their questionnaire whether they had used any of the lean technologies mentioned above in their construction projects. The responses were as follows; the majority of practitioners with a mean score of 4.0159 had used Total Quality Management (TQM) on their projects, while the respondents attested that the OHSAS (Occupational Health and Safety Evaluation Series) with a mean score of 3.9524 had been deployed on their projects. This is followed by the remaining lean technologies vz; daily huddle meetings with a mean score of 3.6270; fail safe for quality with a mean score of 3.6190 and Building Information Modeling (BIM) with a mean score of 3.6111. The result of Table 3 shows the mean score and the standard deviation of lean technologies. As Akinradewo et al. (2019) and Ahadzie et al. (2008) have indicated, a variable with a mean score greater than 3.5 is considered important. Lean construction technology with a mean score of 3.5 is therefore considered to be significant and, as such, industry practitioners would be interested in adopting such technology. The results show that only the first six (6) lean technologies for total quality management (TQM), occupational health and safety assessment series (OHSAS), daily huddle meetings, safety and quality failure, building information modeling and the five (5) S process (visual work place) had mean scores of 4.0159 ≤ 3.5238. Remaining lean technologies vz; continuous improvement (Kaizen); visual management (VM); first-run studies; enhanced visualization; just in time (JIT); stream mapping and last-planner system are almost unavailable as their mean score drops below the 3.5 threshold. It is imperative to note that the first six (6) lean technologies were within the threshold of 3.5 in ranking terms. Out of this, TQM, OHSAS, daily huddle meetings are often categorized under the major lean philosophy/concept classes. While the other sets that fall below the threshold value of 3.5 are the key lean construction technologies. In the opinion of Sospeter and Kikwasi (2017) and Marhani et al. (2013), TQM and other value-based management strategies are known as lean concepts.

As a result, it can be deduced that the Nigerian construction industry is using lean technology to deliver its construction projects. This statement further supports the Adamu and Howell (2012) inquiry into the 80-unit housing

project in Yobe State, Nigeria. Some lean construction technologies concentrate on the removal of on-site waste as well as on the reduction and management of unavoidable waste during the construction process (Fitchett & Hartmann, 2017). Many lean technologies are typically used to improve or solve management issues. Visual management, for example, addresses issues bordering on-site and on-site facilities, resulting in the development of structured work behaviors and strong professional qualifications (Zhang et al., 2020).On the other hand, just-in-time goods are produced to the degree that the products are required, the quantity needed and the particular products that the consumers require. The findings of this study are in tandem with that of (Aisha & Kasimu, 2019; Marhani et al., 2012; Salem et al., 2005; Ogunbiyi, 2014) who conducted similar studies in other climes.

Table 3. Benefits of deploying lean technologies

S/N	Benefit of Lean Deploying Technolog	SA 5	A 4	N 3	D 2	SD 1	SUM	RII	RANK
1	Minimize non-value adding tasks	8	15	16	65	22	300	0.900	7th
2	Curtail unnecessary movements on site	49	27	20	16	14	459	1.377	2nd
3	Worker skill level is enhanced	40	33	28	14	11	455	1.365	3rd
4	Maximum use of equipment and materials site	66	24	12	16	8	502	1.506	1st
5	Eliminate excess inventory	14	12	19	26	55	282	0.846	8th
6	Consistent holding of meetings information dissemination	8	11	13	41	53	258	0.774	9th
7	Reduce redundancies on tasks	14	14	28	32	38	312	0.936	6th
8	Minimize materials handling not part construction	39	43	15	13	16	454	1.362	4th
9	Assist in continuous minimize of defects	11	26	67	10	12	392	1.176	5th
Strongly Agree (SA); Agree (A); Neutral (N); Disagree (D); Strongly Disagree (SD)									

In determining the benefits of lean technology being applied by professionals on construction projects. Nine (9) lean construction technologies have been identified from the related literature and respondents were asked to rate them using the Likert scale. The scale was divided into 5 scales, with 1 indicating strongly disagree and 5 indicating strongly agreed. The outcome of the response of the respondent is shown in Table 4. The table showed that the overall on-site usage of equipment and materials was ranked high with a

relative importance index (RII) of 1,506, indicating that practitioners see the advantages of using lean construction technology to optimize on-site use of equipment and materials. Maximum utilization of on-site equipment and supplies will lead to a large reduction in the costs associated with the construction process. As Ogunbiyi (2014) argued, the integration of lean construction technology could be defined as a paradigm shift in the workings, processes, and behaviors of all and sundry. This inevitably culminates in a community of efficient and effective cooperation between individuals and organizations. Other benefits of lean technologies in terms of hierarchy, which the practitioners agreed to eliminate excessive on-site movements with a RII score of 1,377, develop workers' skills with a RII score of 1,365, decrease materials handling not part of building with a RII score of 1,362, aid in the continuous minimization of defects with a RII score of 1,176, reduce layoffs on tasks with a RII score of 0.936, minimize non-value adding tasks with a RII score of 0.900, eliminate excess inventory with a RII score of 0.846, and ensure consistent holding of information dissemination meetings with a RII score of 0.774.

Conclusion and recommendation

The aim of this study is to investigate the practitioner's awareness and proficiency in implementing lean construction technologies in response to a dearth of readily available studies on the effective deployment of lean construction technologies in Imo State, Nigeria. Numerous organisations have reaped significant benefits from lean's definition and inventions. This has been confirmed by a number of authors and researchers in the field of lean construction. The study's primary finding is that construction industry practitioners in the Nigerian state of Imo have a modest level of awareness about lean construction technology.

There is a moderate gap in practitioners' awareness and implementation of lean technologies, and the primary advantage of applying lean construction technologies is to optimise on-site equipment and materials use, among other benefits. As shown by the study's findings, the majority of practitioners lack sufficient expertise and have no exposure to lean construction technologies. However, lean building methods would be extremely beneficial if they are

implemented in Imo, Nigeria's construction processes. This study recommends that lean technologies should be promoted by seminars and symposia. Additionally, practitioners must establish relationships with their professional associations and other allied professions in the built environment in order to educate them about the importance of implementing these technologies, given their inherent benefits. As one of the research's limitations, further studies in other parts of Nigeria are essential to more broadly generalise the findings.

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