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# An Assessment of Awareness and Barriers to the Application of Lean Construction Techniques in Kano State, Nigeria

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**Abstract**
Generally, the construction industry in most developing countries perform below acceptable quality standard and it is associated with cost and schedule overruns. To improve the efficiency and effectiveness of the construction process, many countries adopt lean construction. However, previous studies indicated that the application of lean construction techniques is low in developing countries. This study aims to assess the level of awareness and barriers to the application of lean construction techniques in Kano State, Nigeria. The study adopted a quantitative approach, whereby 200 questionnaires were administered to construction practitioners in the study area. A total of 159 were returned completed, representing a 79.5 percent response rate. The data collected were analyzed using the mean score. The results reveal that the level of awareness/knowledge of lean techniques among construction practitioners in the study area is low. In addition, the study found that the major barriers to the application of lean techniques in construction projects are the absence of awareness workshops to enhance understanding of LC and the lack of education and training required to implement lean construction. This study can contribute to improving the understanding of construction practitioners and other stakeholders in the industry on barriers to the application of lean construction techniques and how to tackle them.

**Keywords:** Awareness; Barriers; Construction projects; Lean techniques; Questionnaire survey.

## 1. INTRODUCTION

The construction industry helps in improving the quality of life of people by providing the necessary socio-economic infrastructure such as roads, hospitals, and schools (Towey, 2012; Aje et al., 2009). However, the industry is known for low performance (concerning project quality, budget, and schedule), poor project management, and an increase in rework and defects (Ameh et al. 2010; Aje et al., 2009; Ramani and Lingan, 2021; Albalkhy and Sweis, 2022 Aslam et al. 2022). In developing countries where a significant percentage of materials and equipment are imported, these problems can be especially costly.

To improve construction project delivery, many countries adopt lean construction (Ballard and Howell, 2003; Albalkhy and Sweis, 2022). Lean construction (LC) is a method that improves effectiveness and efficiency in construction delivery processes. It focuses on waste reduction, value maximization, and meeting end users' satisfaction, through continuous improvement (Forbes and Ahmed, 2011; Koskela 2002, 1999; Pinch, 2005; Sarhan et al., 2017; Mohammadi et al. 2022). Generally, lean construction facilitates effective management of the three goals of production that is transformation, flow and value (Koskela, 1992; Mano et al., 2021).

The term "lean" was coined by a research team working on the international automobile industry (Ballard and Howell, 2003). The original thinking was to develop a delivery process that met customers' needs with very little inventory, and failure to meet customers' needs was considered as waste (Forbes and Ahmed, 2011). The drivers of lean include waste elimination, process control, flexibility, optimization, people utilization, continuous and efficient improvement, and value to customers (Ogunbiyi et al., 2013).

The basic principles of lean thinking are: specifying a value for specific products from the perspective of a customer; identifying the value stream for each product (all steps in the process that add value based on customer perspective); creating process flow without interruptions; allowing customers pull production (produce only what the customer wants just in time) and manage continuous improvement and perfection (Womack and Jones, 2003; Ghosh and Burghart, 2021).

The application of lean principles in construction projects results in better utilization of resources. It also results in better construction quality in completed facilities,

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eliminates waste, increases value/client satisfaction, and ensures higher levels of safety (Ayarkwa et al., 2011; Aziz and Hafez, 2013; More et al., 2016; Shurrab and Hussain, 2018; Albalkhy and Sweis, 2022, Ghosh and Burghart, 2021; Mano et al., 2021). Thus, lean construction is an effective management tool to enhance productivity in construction. However, despite the benefits of lean principles in improving construction project performance, it has been reported that there are poor or non-application of most of them in Nigeria (Oladiran, 2017; Babalola, et al., 2018). Thus, there is a need to address this problem.

This study aims to assess the level of awareness and barriers to the application of lean construction techniques in Kano State, North-west Nigeria, intending to improve construction projects' performance there. Most of the studies (Igwe et. al., 2022; Ghosh and Burghart, 2021; Shurrab and Hussain, 2018) on lean construction were conducted overseas. Limited studies had been conducted in Nigeria, and those studies concentrated on assessing the extent of implementing lean construction in Nigeria while failing to assess the awareness and barriers to the application of lean construction techniques. Thus, the present work is set to address this gap.

This study is intended to answer the following research questions:

1. What is the level of awareness/ knowledge of various lean construction techniques among construction practitioners in Kano State, Nigeria?
2. What are the barriers to the application of lean techniques in construction projects in Kano State, Nigeria?

The present study contributes to the body of knowledge by identifying barriers to the implementation of lean construction techniques in Nigeria. As suggested by Mano et al. (2021), understanding the barriers will help construction firms to concentrate their efforts towards determining the best way to tackle them for a better chance of success.

## 2. LITERATURE REVIEW

### 2.1 Lean Construction Techniques

Several studies were conducted in various countries to assess the level of applications of lean construction techniques. Enshassi et. al. (2019) investigated the application of eight lean construction techniques in reducing accidents in construction projects in Gaza Strip. The techniques studied includes last planner system, increased visualization, 5S, poka-yoke, daily huddle meetings, first run studies, kaizen, and 5 why's. The results of the study revealed that, lean construction techniques were poorly applied in construction projects in Gaza Strip.

Aslam et al. (2022) developed a framework for the selection of appropriate lean tools based on their objectives and functionalities. The lean tools/ techniques presented in the study includes last planner system, just in time, concurrent engineering, daily huddle meeting, visual management, first run studies, six sigma, fail-safe for quality and safety, value stream mapping, 5S, and kaizen, among others.

Babalola et al. (2018) assessed the awareness and adoption of 32 lean tools/ techniques in the Nigerian construction industry. The tools studied comprised of total quality management, last planner system, visualization tools, just-in-time, six sigma, concurrent management, kaizen, fail safe for quality and safety, and first run study among others. The study concluded that, the level of adoption of lean techniques in Nigerian construction industry was low.

Ogunbiyi et al. (2013) conducted an empirical study of the impact of lean construction techniques on sustainable construction in the UK. The identified lean techniques include just-in-time, visualisation tool, daily huddle meetings, value analysis, value stream mapping, total quality management, fail safe for quality, 5S, total preventive maintenance, first run studies, last planner system, concurrent engineering, pull approach, kanban, kaizen, and six sigma. Earlier, Salem et al. (2005) conducted a similar study to test the effectiveness of some lean construction techniques including last planner, increased visualization, daily huddle meetings, first run studies, 5S process, and fail safe for quality.

Aziz and Hafez (2013) assessed the application of lean thinking in construction industry in Egypt. The study concluded that, lean construction can be achieved using the following techniques: concurrent engineering, last planner, daily huddle meetings, kanban system, quality management, and visual inspection. Sarhan et al. (2017) investigated state of lean construction implementation in Saudi Arabia. The identified techniques that support lean implementation includes last planner, value stream mapping, standardized work, the 5S process, kaizen, total quality management, increased visualisation, fail-safe for quality and safety, daily huddle meetings, first run studies, the five why's, just in time, plan of conditions and work environment in the construction industry, concurrent engineering, kanban system, poka-yoke, target value design, and partnering. The study concluded that, lean construction techniques were not adequately implemented in Saudi Arabia.

From the above literatures it can be noted that lean construction can be achieved through applications of several techniques. Table 1 presents 12 lean construction tools/ technique which have been mentioned in several studies.

### 2.2 Barriers to the Application of Lean Construction Techniques

Several barriers to the application of lean construction were identified by previous researchers. For instance, Alarcon et al. (2006) explore barriers to implementation of lean construction to include lack of time for implementing LC techniques in projects, lack of training, lack of self-criticism to learn from errors, low understanding of LC concepts, Weak communication, and transparency among participants. Shang and Pheng (2014) identified 22 barriers to implementation of lean construction, these were categorized into six groups namely people and partner barriers, managerial and organizational barriers, lack of support and commitment barriers, cultural and philosophical barriers, government related barriers and procurement related barriers.

More et al. (2016) concluded that the major barriers to implementing lean in Indian construction industry were lack of lean awareness and understanding, cultural and human attitude issues, commercial pressure, lack of proper training, long implementation time required, lack of top management commitment, and educational issues.

**Table 1:** Summary of Lean Construction Tools/Techniques

| Lean Tools/Techniques | Description | Sources |
|---|---|---|
| Last Planner System (LPS) | This is a lean tool/technique for planning and control. It smooths workflow and addresses project variability to increase productivity in construction. The components of last planner system are look ahead planning, commitment planning, and learning. | Enshassi *et.* al. (2019), Aslam *et* al. (2022), Babalola et al. (2018), Ogunbiyi et al. (2013), Salem et al. (2005), Aziz and Hafez (2013), Sarhan et al. (2017), Ballard and Howell (2003) |
| Daily Huddle Meetings | These are short daily start-up meetings held as a means for continuous improvement. The project team members discuss issues related to the progress of the work plan, as well as challenges. The tool enables members to plan ahead and address problems before affecting project's progress. | Enshassi *et.* al. (2019), Aslam *et* al. (2022), Ogunbiyi et al. (2013), Salem et al. (2005), Aziz and Hafez (2013), Sarhan et al. (2017), |
| Value Stream Mapping | This tool facilitates evaluation of present state and planning a future state for a sequence of activities that make a product or services, from the start to finish. Any non-value adding activity in the present state will be removed or make it more efficient when planning future state. | Aslam *et* al. (2022), Ogunbiyi et al. (2013), Sarhan et al. (2017), Forbes and Ahmed (2011), Ramani and Lingan (2021). |
| Just-In-Time | This is a method of production that ensures delivery of actual material, manpower and equipment etc needed, at the exact time needed and of the actual quantities needed. This tool reduces flow times: production times and response times. | Aslam *et* al. (2022), Babalola et al. (2018), Ogunbiyi et al. (2013), Sarhan et al. (2017), Howell and Ballard (1998), Forbes and Ahmed (2011). |
| Increased Visualization | This technique is about using visual tools such as sign, diagrams and labels to display important information to workers at construction site. This comprises progress charts and schedules, as well as safety signs. The technique can lead to high level of participation among the workforces. | Enshassi *et.* al. (2019), Babalola et al. (2018), Ogunbiyi et al. (2013), Salem et al. (2005), Aziz and Hafez (2013), Sarhan et al. (2017), Forbes and Ahmed (2011). |
| Total Quality Management | This technique enables organizations and their workers to concentrate on findings new methods to continuously improve the quality of their products and services. | Babalola et al. (2018), Ogunbiyi et al. (2013), Aziz and Hafez (2013), Sarhan et al. (2017), McGeorge and Palmer (2002), Forbes and Ahmed (2011). |
| Five (5) S Process | The tool facilitate workflow and reduces various forms of wastes and thus improve the construction project performance. It also supports standardization of work processes which should be sustained for continuous improvement. The 5S words stands for (Sort, Straighten, Shine, Standardise and Sustain). | Enshassi *et.* al. (2019), Aslam *et* al. (2022), Ogunbiyi et al. (2013), Salem et al. (2005), Sarhan et al. (2017), Abdelhamid and Salem (2005), Forbes and Ahmed (2011). |
| First Run Studies | First Run Studies (Plan-Do-Check-Adjust) involves planning critical or repetitive activities, implement the plan and study the activities, analyses and determine the most effective method of doing the work. The work method is then redesign and become new standard, and this process are repeated. | Enshassi *et.* al. (2019), Aslam *et* al. (2022), Babalola et al. (2018), Ogunbiyi et al. (2013), Salem et al. (2005), Sarhan et al. (2017), |
| Kaizen | Kaizen is a continuous improvement tool that maximize value and reduce waste. It seeks to standardize processes and eliminate or reduce waste. It starts with recognizing a problem, and subsequently a need for improvement. | Enshassi *et.* al. (2019), Aslam *et* al. (2022), Babalola et al. (2018), Ogunbiyi et al. (2013), Sarhan et al. (2017), Forbes and Ahmed (2011), |
| Fail Safe for Quality and Safety | This is a technique that prevents defective parts from flowing through the process. Fail safe for quality depends on the generation of ideas that signify for potential defects. The project manager selected the activity that had potential quality defect problems to further study for prevention purposes. | Aslam *et* al. (2022), Babalola et al. (2018), Ogunbiyi et al. (2013), Salem et al. (2005), Sarhan et al. (2017), |
| Concurrent Engineering | Concurrent engineering (CE) is a systematic approach in which activities in design and manufacturing phases of products and their related processes are integrated and manage concurrently. The aim of CE is to reduce time, and cost and uncertainties in project development. | Aslam *et* al. (2022), Babalola et al. (2018), Ogunbiyi et al. (2013), Aziz and Hafez (2013), Sarhan et al. (2017), Gunasekaran and Love (1998), Ngowi (2000). |
| Six- Sigma | Six- Sigma is an improvement strategy that reduces variation in any process to eliminate defects or faults. One of the fundamental components of this strategy is the DMAIC methodology (define, measure, analyse, improve and control). | Aslam *et* al. (2022), Babalola et al. (2018), Ogunbiyi et al. (2013), Maciel-Monteon et al. (2020), Shankar, (2009). |

Fadeke et al. (2016) presented 22 barriers to the implementation of lean construction, with absence of awareness program, and lack of adequate training as major barriers.

Enshassi et al. (2021) identified 39 barriers to application of lean construction techniques and categorized them into six groups namely management barriers, financial barriers, educational barriers, government barriers, technical barriers, and human attitudinal barriers. Mano et al. (2021) identified the following as barriers to lean construction: lack of commitment to the team, difficulty in focusing the business on the customer, resistance to change arising from the fear of unknown practices, difficulty getting support and commitment from top management, resistance to change by the leadership, centralization of decisions, insufficient knowledge of managers to manage the change process, and inability to measure project progress. These barriers were synthesized and presented in Table 2.

## 3. RESEARCH METHODOLOGY

### 3.1 Method of Data Collection

The study was conducted in Kano State, North-west Nigeria. This state was chosen because it has high concentration of construction activities in the region, as well as for accessibility of data. A questionnaire survey was employed as a method of data collection. According to Sekaran and Bougie (2009), questionnaire is widely used by researchers as an efficient means of data collection, because it can collect data fairly and easily. Initially literature review was carried out in which 12 lean techniques that were severally mentioned in previous studies and 22 barriers to the application of lean techniques in construction were identified and used in the development of the research instrument. The lists of the identified lean techniques and barriers are presented in Table 1 and Table 2 respectively.

A draft questionnaire was then designed and presented to eight experts who have experience or knowledge on lean construction (four professionals and four academicians) for validation. All the observations made by the experts were affected before the development of preliminary questionnaire. Subsequently, a pilot survey was performed to pre-test the preliminary questionnaire. The purpose of the pilot test was to refine the questionnaire to ensure clarity of the questions in the research instrument. This process was suggested by Sekaran and Bougie (2009).

A final questionnaire was then developed and divided into three main sections. Section I is related to the general information of the respondents. Section II includes the list of identified lean techniques. Respondents were required to specify their opinions on the level of awareness/ understanding of the lean techniques using a Five Point Likert Scale ranging from 1 to 5, where 1 represents not aware; 2= less aware; 3= moderately aware; 4= aware; and 5= very aware, this scale was used in a similar study by Babalola, et al. (2018).

Section III contains the list of barriers to the application of lean techniques in construction projects. Respondents were asked to rate the effects of the barriers to the application of lean techniques in their projects using a Five Point Likert Scale ranging from 1 to 5, where 1 represents no effect, 2= low effect, 3= moderate effect, 4= strong effect and 5= very strong effect, this scale was used in a similar study by Enshassi et al. (2021).

The target population of this study was construction professionals with experience in building construction projects who are domiciled in the study area. These comprise architects, builders, civil engineers, and quantity surveyors. The total population was found to be 320 construction professionals as obtained from the directory of members of the respective professional institutions, (Nigerian Institute of Architects, Nigeria Institute of Builders, Nigerian Society of Engineers, and Nigerian Institute of Quantity Surveyors) Kano state chapter.

The study used a sample size 175 construction professionals determined using Krejcie and Morgan's (1970) table. However, 200 questionnaires were administered to take care of non-return ones. The study used the simple random sampling technique to identify and select samples from the population as recommended by Saunders et al. (2012). Internal consistency for the responses of the data collected was calculated using Cronbach's alpha test as suggested by Pallant (2011).

### 3.2 Method of Data Analysis

The data obtained from the questionnaire survey were evaluated for normality using statistical means (skewness and kurtosis). All the skewness and kurtosis range from -1 to +1 indicating that they are normally distributed as suggested by Pallant (2011). Subsequently, the data were analyzed using descriptive statistics (frequency, percentages, standard deviation and mean score)

Descriptive analyses (frequency and percentage) were used to analyze the demographic information of the respondents. And in determining the level of awareness of lean techniques in the study area mean score ranking was employed. The same analysis was used in determining the effects of barriers to the application of lean techniques in the study area. This approach was adopted in a similar study by Fadeke et al. (2016). The effect of each barrier was calculated through the following formula used by Fadeke et al. (2016).

$$MS = \frac{\sum_{i=1}^{5} aixi}{\sum xi} \qquad \text{.....eq. (1)}$$

Where

- ai = constant expressing the weighting assigned to response i; (ranging from 1 for no effect to 5 for very strong effect),
- xi = frequency of the responses

i = 1, 2, 3, 4, 5.

## 4.0 DATA ANALYSIS AND RESULTS

This section analyses the data collected from the field survey and presents the results obtained. Out of the 200 questionnaires administered, 159 were returned completed, representing a 79.5% response rate. The response rate is considered good as it is above that of previous studies of Igwe et al. (2022) who reported a response rate of 55%, Rosli et al. (2023) reported 74.3%, while Albalkhy and Sweis, (2022) reported 52.9%.

**Table 2:** Barriers to the Application of Lean Construction

| S/N | Barriers | Sources |
|---|---|---|
| 1 | Lack of management support and involvement in the implementation of lean in construction | Enshassi et al. (2021), Alarcon et al. (2006), Mano et al. (2021), Shang and Pheng (2014), More et al. (2016), Fadeke et al. (2016) |
| 2 | Centralization of decision making | Enshassi et al. (2021), Mano et al. (2021) |
| 3 | Resistance to change by the management | Enshassi et al. (2021), Mano et al. (2021), Shang and Pheng (2014) |
| 4 | Long implementation time required for LC techniques application | Enshassi et al. (2021), Alarcon et al. (2006), Fadeke et al. (2016), More et al. (2016) |
| 5 | Poor communication among project parties | Enshassi et al. (2021), Alarcon et al. (2006), Fadeke et al. (2016) |
| 6 | Poor coordination among project parties | Enshassi et al. (2021), Alarcon et al. (2006), Fadeke et al. (2016) |
| 7 | Inadequate planning to apply LC techniques | Enshassi et al. (2021), |
| 8 | Absence of long-term philosophy for construction improvement | Enshassi et al. (2021), Shang and Pheng (2014), Fadeke et al. (2016) |
| 9 | High implementation cost of lean construction. | Enshassi et al. (2021), |
| 10 | Lack of incentives and motivation to encourage employees to apply innovative strategies | Enshassi et al. (2021), Shang and Pheng (2014) |
| 11 | Difficulty in understanding LC concept | Enshassi et al. (2021), Alarcon et al. (2006), Shang and Pheng (2014), More et al. (2016), Fadeke et al. (2016) |
| 12 | Lack of knowledge and expertise needed to apply lean construction techniques. | Enshassi et al. (2021), More et al. (2016) |
| 13 | Lack of education and training required to implement lean construction. | Enshassi et al. (2021), Alarcon et al. (2006), Shang and Pheng (2014), More et al. (2016), Fadeke et al. (2016), |
| 14 | Absence of awareness program to enhance understanding about LC | Enshassi et al. (2021), Fadeke et al. (2016) |
| 15 | Lack of government support to construction firms towards implementation of lean construction | Enshassi et al. (2021), Shang and Pheng (2014) |
| 16 | Difficulty in the implementation of LC | Enshassi et al. (2021), Fadeke et al. (2016) |
| 17 | Resistance to change by employee | Enshassi et al. (2021), Mano et al. (2021), Shang and Pheng (2014) |
| 18 | Lack of self-criticism to evaluate oneself shortcomings | Enshassi et al. (2021), Alarcon et al. (2006) |
| 19 | poor performance-measurement strategies | Enshassi et al. (2022), Mano et al. (2021) |
| 20 | Lack of interest from the client | Enshassi et al. (2021), Fadeke et al. (2016) |
| 21 | Lack of agreed methodology for implementing LC | Enshassi et al. (2021), Fadeke et al. (2016) |
| 22 | Lack of knowledge sharing among construction organizations. | Enshassi et al. (2021), Fadeke et al. (2016) |

### 4.1 Reliability Test

The reliability of the data collected from the field survey (Internal consistency) was calculated through Cronbach's alpha reliability test as suggested by Pallant (2011). Overall, Cronbach's alpha for the questionnaire was 0.949, meaning that the participants' responses were consistent and the reliability of the scale was very good as suggested by Pallant (2011).

### 4.2 Demographic Distributions of Respondents

Table 3 presents demographic distributions of the respondents. The results show that, 44% of the respondents work in construction firms, 32.7% in public sector, while 23.3% work in consultancy firm.

In terms of Academic qualification, 48.4% of the respondents hold bachelor's degree and about 20% hold postgraduate degrees in relevant field. The results also reveal that, about 30% of the respondents have 5-10 years of experience in construction industry, 50% have 10-15 years of experience, and 14% have more than 15 years of experience. Thus, based on these results, the respondents have adequate knowledge and experience to provide reliable information.

### 4.3 Awareness/ knowledge of Lean Construction Techniques among Construction Practitioners in Kano State Nigeria

Table 4 presents the level of awareness of lean construction techniques among construction practitioners in Kano State, Nigeria.

**Table 3**: Demographic characteristics of respondents

| S/N | Variables | Attributes | Frequency | Percentage |
|---|---|---|---|---|
| 1 | Organization | Construction firm | 70 | 44.0 |
| | | Consultants firm | 37 | 23.3 |
| | | Public sector | 52 | 32.7 |
| | | **Total** | **159** | **100** |
| 2 | Qualification | National Diploma | 17 | 10.7 |
| | | Higher National Diploma | 33 | 20.8 |
| | | Degree (B.Sc.) | 77 | 48.4 |
| | | Master's Degree | 31 | 19.5 |
| | | Ph.D. Degree | 1 | 0.6 |
| | | Total | **159** | **100** |
| 3 | Experience | < 5 years | 9 | 5.7 |
| | | 5-10 years | 49 | 30.8 |
| | | 10-15 years | 79 | 49.7 |
| | | Above 15 years | 22 | 13.8 |
| | | **Total** | **159** | **100** |
| 4 | Profession | Architect | 35 | 22.0 |
| | | Quantity surveyor | 46 | 28.9 |
| | | Builder | 30 | 18.9 |
| | | Civil engineer | 48 | 30.2 |
| | | **Total** | **159** | **100** |

**Table 4:** Level of Awareness of Lean Construction Techniques

| SN | Techniques | Mean | Std. Deviation | Rank |
|---|---|---|---|---|
| 1 | Last planner system | 3.37 | 1.265 | 1 |
| 2 | Daily huddle meetings | 3.17 | 1.384 | 2 |
| 3 | Increased visualization | 2.83 | 1.223 | 3 |
| 4 | Total Quality Management | 2.80 | .964 | 4 |
| 5 | First run studies | 2.53 | 1.168 | 5 |
| 6 | Just-In Time | 2.33 | 1.139 | 6 |
| 7 | 5S (Visual Work Place) | 2.29 | 1.172 | 7 |
| 8 | Fail Safe for quality and safety | 2.24 | 1.198 | 8 |
| 9 | Concurrent engineering | 2.23 | 1.148 | 9 |
| 10 | Value stream mapping | 2.22 | 1.215 | 10 |
| 11 | Six sigma | 2.14 | 1.084 | 11 |
| 12 | Kaizen | 2.03 | 1.124 | 12 |
| | **Average** | **2.52** | | |

The results reveal that the overall mean score of awareness level of lean construction techniques among construction professionals in the study area was 2.52, which is less than the average mean score of 3 (for a 5- point Likert Scale ranging from 1-5) (Enshassi et al., 2019). The results in Table 4 also indicated that the two top-rated lean techniques with awareness levels above average (mean score of 3) were the last planner system (mean score = 3.37) and daily huddle meeting (mean score = 3.18). Whereas the awareness levels of the respondents in the remaining ten lean techniques were below average (mean scores range from 2.03- 2.83). The last three ranked lean techniques in terms of awareness were value stream mapping, six-sigma, and Kaizen.

### 4.4 Ranking Barriers to the Application of Lean Construction

Table 5 presents the respondents' views on the effects of barriers to the application of lean construction techniques in the study area. The Table indicates that the mean effect values of the 22 barriers identified from the literature range from 2.26 to 4.18. Analysis of the results show that two barriers have mean scores greater than 4.00, ten barriers have mean scores between 3.00 and 4.00, and the remaining ten barriers have mean scores below average (less than 3.00).

**Table 5:** Barriers to the Application of Lean Construction

| Barriers | Mean | SD | Ranking |
|---|---|---|---|
| Absence of awareness program to enhance understanding about LC | 4.18 | 0.73 | 1 |
| Lack of education and training required to implement lean construction. | 4.09 | 0.61 | 2 |
| Lack of management support and involvement in the implementation of lean in construction | 3.97 | 0.53 | 3 |
| Resistance to change by employee | 3.86 | 1.01 | 4 |
| Lack of knowledge and expertise needed to apply lean construction techniques. | 3.78 | 0.84 | 5 |
| Resistance to change by the management | 3.72 | 0.91 | 6 |
| Absence of long-term philosophy for construction improvement | 3.59 | 0.70 | 7 |
| Lack of incentives and motivation to encourage employees to apply innovative strategies | 3.46 | 0.86 | 8 |
| Lack of government support to construction firms towards implementation of lean construction | 3.39 | 0.59 | 9 |
| Lack of knowledge sharing among construction organizations. | 3.22 | 1.20 | 10 |
| Centralization of decision making | 3.20 | 0.63 | 11 |
| Poor performance-measurement strategies | 3.17 | 0.68 | 12 |
| High implementation cost of lean construction | 2.87 | 0.78 | 13 |
| Difficulty in understanding LC concept | 2.79 | 0.54 | 14 |
| Inadequate planning to apply of LC techniques | 2.72 | 0.68 | 15 |
| Difficulty in the implementation of LC | 2.66 | 0.92 | 16 |
| Poor coordination among project parties | 2.56 | 0.73 | 17 |
| Lack of interest from the client | 2.54 | 1.19 | 18 |
| Lack of self-criticism to evaluate oneself shortcomings | 2.51 | 0.83 | 19 |
| Poor communication among project parties | 2.31 | 1.07 | 20 |
| Long implementation time required for LC techniques application | 2.29 | 0.79 | 21 |
| Lack of agreed methodology for implementing LC | 2.26 | 0.69 | 22 |

## 5. DISCUSSION OF FINDINGS

The results from this study indicated that there was a low level of awareness of lean techniques among construction practitioners in the study area (overall mean score was 2.52). Awareness and knowledge of lean techniques among construction practitioners can increase the level of applications of the techniques in construction projects which will result in waste minimization and improve performance (Babalola, et al., 2018). The finding agrees with Oladiran (2017) that lean construction techniques were poorly implemented in Lagos State, Nigeria. However, the finding is contrary to that of Babalola, et al. (2018) and Fadeke et al. (2016) who found that there was an appreciable level of awareness and knowledge of lean construction and its techniques among construction practitioners in their study area. The contradiction of these findings with the current study may be as a result of different study areas. The practitioners in their study areas may be ahead in terms of the level of awareness of lean tools and techniques. Value stream mapping, six-sigma, and Kaizen were the least ranked techniques in terms of awareness level by the respondents. These are important lean construction techniques that reduce process variability, eliminate defects, and ensure continuous improvement (Maciel-Monteon et al., 2020; Forbes and Ahmed, 2011).

On the other hand, one of the objectives of this study is to explore barriers to the application of lean construction techniques in the study area. The results in Table 5 revealed that the absence of awareness workshops to enhance understanding of lean construction among construction practitioners has been ranked the first (most important) barrier. This result is in line with the finding reported in Table 4 that there was a low level of awareness of lean construction techniques in the study area. Lack of awareness of the benefit of lean in value addition and waste reduction in construction projects can have a significant influence on the level of implementation of lean techniques in construction projects. This barrier can be overcome by organizing regular conferences and seminars for construction practitioners to enlighten them on the benefits of the application of lean techniques in their projects. The finding is consistent with previous studies (Fadeke et al., 2016; Enshassi et al., 2021 .

The second most important implementation barrier is the lack of education and training needed by construction practitioners to implement lean construction. Without adequate education and training on lean construction techniques, construction practitioners will not be able to have the required knowledge and understanding to apply the concept in their projects. To overcome this barrier, the lean construction concept should be incorporated into the curriculum of higher institutions of learning in Nigeria. This can assist in producing potential construction professionals with adequate knowledge of lean thinking. This finding agrees with previous studies (Alarcon et al., 2006; Fadeke et al., 2016; Enshassi et al., 2021 ).

Lack of management support and involvement in the implementation of lean in construction has been ranked as the 3rd barrier to lean techniques application. The successful application of lean construction techniques depends on management support and commitments (Enshassi et al., 2021 ). To overcome this barrier, top management should support their employees with the necessary training and resources required for the effective application of lean techniques in their projects. This finding is in line with the previous studies (Shang and Pheng, 2014; Enshassi et al., 2021; Mano et al., 2021 ).

Resistance to change by employees has been ranked as the 4th barrier to the application of lean construction techniques. Several construction practitioners in the study area are unfamiliar with most of the lean techniques. Thus, fear of new practices may generate resistance to the application of the techniques by the employees. This barrier can be overcome by organizing training workshops for construction practitioners on lean construction to be equipped with adequate knowledge and skills for the effective application of the techniques in their projects. This barrier was ranked 19 of 22 barriers by Shang and Pheng, 2014; and 22 of 39 barriers by Enshassi et al. (2021 ).

The lack of knowledge and expertise needed to apply lean construction techniques has been ranked as the fifth barrier in order of importance. Some construction practitioners in the study area do not have adequate technical skills to apply most of the lean techniques in their projects. Without adequate knowledge and experience in lean, construction practitioners cannot apply lean techniques in their projects. The finding is consistent with previous studies (Enshassi et al., 2021 ; More et al., 2016; Shang and Pheng, 2014).

Resistance to change by the management has been ranked as the sixth barrier in order of importance. Fear of unfamiliar practices may generate resistance to the implementation of lean construction by top management due to a misunderstanding of the concept. To overcome this barrier, top management of construction companies should be prepared to accept changes in terms of the adoption of innovation and management techniques. This result is in agreement with previous studies (Mano et al., 2021; Shang and Pheng, 2014).

The seventh-ranked barrier was the absence of long-term philosophy for construction improvement. The absence of a long-term vision for construction improvement is a major hindrance to the implementation of lean construction. This barrier was ranked 1 of 22 barriers by Shang and Pheng (2014), and 12 of 22 barriers by Fadeke et al. (2016).

Long implementation time and lack of agreed methodology for implementing lean construction were the lowest-ranked barriers to the application of lean techniques. These were ranked 36 and 13 of 39 barriers by Enshassi et al., (2021 ), and ranked 14 and 9 of 22 barriers by Fadeke et al. (2016). The results implied that the respondents do not consider these barriers as important in the application of lean construction techniques in the study area.

## 6. CONCLUSION

This study was conducted to determine the level of awareness and barriers to the application of lean construction techniques in Kano State, Nigeria. The finding from the study indicated that the level of awareness/ knowledge of lean techniques among construction practitioners in the study area was low with an average score of 2.52 on a scale of five. It can be concluded that construction firms in the study area are still using traditional approaches in project management instead of adopting innovative approaches that improve project performance. The study also found that the major barriers to the application of lean techniques were the absence of awareness workshops to enhance understanding about lean construction, lack of education and training required to implement lean construction, and lack of management support and involvement in the implementation of lean in construction. To address these challenges, regular workshops and seminars should be organized for all stakeholders of the construction industry to be enlightened on the benefits of the application of lean techniques in their projects. In addition, there is a need for the establishment of a Lean Construction Institute in Nigeria to promote and monitor lean construction practices in the country.

This study helps improve the understanding of construction practitioners and other stakeholders in the construction industry on barriers to the application of lean construction techniques, as well as the best way to tackle them. The study also provides a basis for evaluating barriers to the adoption of innovation or new management techniques in construction projects and adds to the existing barriers to the application of lean construction techniques. Despite the objective of the study was achieved, the followings are some limitations of the study. Firstly, the sample size used for the conduct of this study was not large enough, however, it is sufficient for statistical analysis. Secondly, descriptive

statistics (Mean scores) were used in data analysis. Thus, the findings of this study cannot be generalized. And thirdly, the geographical boundaries of the study cover only the northwest of Nigeria. Thus, a future study could be conducted with a larger sample size that covers the entire country.

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