Barriers to Lean Adoption for Construction Projects

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ABSTRACT

Lean has been judged to have improved construction project performance the world over. due to its theoretical advantages and benefits. The effective implementation of this concept in construction projects is rare in developing countries. This rare adoption may be a result of some existing barriers and problems ensuing there from. The purpose of this study was to explore the barriers to adoption of lean in construction projects. Critical barriers to lean implementation were reviewed via a questionnaire-based survey. The population for the study was populated from five (5) construction firms located in Port Harcourt, Nigeria. The population consists of project managers, construction managers, architects, quantity surveyors, engineers and project supervisors working on construction projects within the firms.

The population for the study consists of 362 practitioners. The construction firms were contacted via a purposeful/convenience sampling technique where a sample size of 291 was arrived at via the Krejcie and Morgan method for sample size determination. Statistical Package for Social Science (SPSS version 21.0) was used in generating the descriptive and inferential statistics, while Relative Importance Index (RII) was used to analyze the main theme bordering on the barriers to lean adoption. On the basis of RII rankings, the results revealed that lack of adequate lean awareness and understanding with a RII value of 0.56 and ranked first was the most important barrier to lean implementation. While resistance to change and culture RII 0.55; lack of technical capabilities RII 0.53; lack of financial resources RII 0.52 were the next on the list of the highest ranked barriers to lean adoption. The study recommends amongst others, that government and other professional associations within the built industry should as a matter of urgency and necessity should pay more attention to knowledge creation, as well as building capacity and innovation through the application of lean principles as this would help create the needed change in paradigm that would propel the Nigerian construction industry to greatness.

(Keywords: barriers, construction projects, lean, RII construction management, relative importance index)

INTRODUCTION

According to Chen and Taylor (2009), lean management and innovation are two key vital drivers of modern-day businesses. Most of the lean management practices reinforce some mechanisms that precipitate tendencies for increased productivity and cost control at a price that is akin to an organization's level of creativity. Chen and Taylor (2009), further opined that the philosophy of lean originated from the Massachusetts Institute of Technology's (MIT) vehicle industry (Engineers Australia, 2012; Poppendieck, 2002). They further stated that lean practices were usually implemented on the basis of some ideologies that came up prior to the introduction of the lean concept.

These ideologies include; total quality management (TQM), as well as the just-in-time (JIT) production. The idea behind these ideologies according to Chen and Taylor (2009) gave rise to the emergence of some of the key

elements of lean which includes; the focus on producing high quality products that are readily in need and relatively cost effective to users.

According to Desale and Deodhar (2014), an engineer working for Toyota, by name Taiici Ohno, developed the lean production theory as a veritable means for eliminating waste with minimum cost and maximum value (Torp, Knudsen and Ronneberg, 2018; Womarck and Jones, 2003; Zhang and Chen, 2016). Ohno further observed some inefficiencies in the works of Henry Ford's assembly line production in order to continue the development of a flow-based production management system that is basically meant to reduce the share of non-value adding activities, increase output value through a systematic consideration of users requirement, benchmarking, inventory reduction, cycle time reduction as well as the increase in output flexibility (Desale and Deodhar, 2014).

In as much as the lean principles emanated from the manufacturing sector/ industry, the similarities existing between craft and manufacturing and the construction processes makes the lean production principle ideal for its application into the construction industry and other disciplines (Desale and Deodhar, 2014; Poppendieck, 2002).

According to Intergraph, (2012), the term "lean" is used consistently and is usually associated with lean manufacturing, lean thinking, lean production and lean construction. There are ensuing arguments and debates over each of the aforementioned acronyms. Intergraph, (2012), further stated that the word lean has different meanings and uses as well. One of such meanings is that, lean means, to minimize and eliminate waste. The other meaning is to sway towards an opinion. This second meaning portrays a situation where adopters of lean sway to a new direction and change their mindset and philosophy. According to Pekuri, Pekuri and Haapasalo (2014a), the concept of lean is adjudged to be an endless trip towards perfection, but in reality, most lean trips normally end even before the trip starts. They further opined that an organization-wide lean transformation is a process by which primitive and archaic habits must be replaced with new ideas that are basically hinged on a totally different belief and theory.

In a nutshell, it is a paradigm shift within an organization. (Pekuri et al., 2014a). Lean according to Warcup (2015) is a "philosophy that provides a way to do more and more with less and less-less human effort, less equipment, less time and less space". Turner Construction (2012), defined lean as delivering the most vale from a customer's perspective while also consuming the fewest resources just in time and perfectly.

According to Poppendieck (2002), the most common denominator rattling industry success stories is lean thinking. As lean looks at the value chain as well as how things can be structured so that value –adding becomes the other of the day in an organization. Lean as opined by Ayarkwa et al. (2013) is essentially about getting the right things to the right place at the right time, in the right quantity, whilst minimizing waste and being open and responsive to change.

Today, lean is being applied the world over in virtually every industry one can imagine, ranging from service, mining, manufacturing, hospitals, hotels, government and currently construction (Engineers Australia, 2012). In the last decade, there has been a consistent and deliberate interest on the theme, lean construction (Abdul-Rahman et al.,2012). scholars were keen to investigate the extent of application of the Japanese model of lean production into construction. Lean construction as opined by Abdul-Rahman et al. (2012) emanated from the adoption and implementation of Japanese manufacturing principles the construction industry as a result of the successes recorded from the manufacturing sector (Womack & Jones, 1996).

The construction industry according to Diekmann et al. (2004), has a far reaching, diverse effort in applying lean principles and practices. Diekmann et al. (2004), further opined that America and Europe have devoted exclusively certain organizations into the study of lean ideas and its applications which has led the industry towards the adoption of innovative ideas of lean thinking. Bertelsen and Koskela (2004), opined that construction is obviously a production activity, the basic idea about construction is that it should not be seen as transformational alone, but as a flow of work and creation of value. They further opined that in understanding the nature of construction, it should also be seen as one whose product is one-of-a-kind and is achieved by on the site cooperation with the aid of multi-skilled *adhoc* teams.

One of the major problems confronting the Nigerian construction industry is the inability of the industry to adopt modern means and techniques of eliminating or minimizing waste and also the value of its product (Adamu et al.,2012). They further stated that one of the factors limiting the use and application of lean tools in the Nigerian construction industry is the dearth of knowledge and research development in the areas of improving construction productivity. From the available literature, it is evident that there are no readily available studies carried out specifically in Nigeria on lean principles and its application in the Nigerian construction industry. With this study, there is the need to ascertain and bridge in the knowledge gap in this area.

The construction industry as opined by Taner (2013) is plagued by a myriad of problems stemming from the inability to deliver quality services and products that would be less expensive to the client. The identification of and elimination of these attendant problems from the onset could help in ameliorating the problems ensuing there from. The attendant foot-dragging tendency of the industry in adopting latest continuous improvement techniques such as lean, six sigma, and total quality management is a clear indication of the susceptibility of the industry to failure in contrast to what exist in a manufacturing setting. While Rahman et al. (2012) argued that the construction industry has been affected by incidence of low productivity and poor performance compared to other industries.

The attendant result of this impasse is as a result of the magnitude of waste generation that is attributed to the construction processes. As opined by Olapade and Anthony (2012), the Nigeria's landscape is awash with traces of abandoned buildings, roads, rails, ports as well as other construction projects. Olapade and Anthony (2012) further reiterated that it is unthinkable to state that the projects were out rightly abandoned prior to their implementation.

The case of the East West road in Rivers State, Ajaokuta Steel Rolling Mills in Kogi State are clear evidence of the number of abandoned projects that litter the landscape of the nation to mention but a few. Most delays associated with the completion of construction projects in Nigeria are also having an adverse effect on the credibility of contractors to deliver optimum value to their customers. Ayangade et al. (2009) argued that the manner of procuring most construction projects in Nigeria has been bedeviled by the non-adherence to laid down rules bordering on the process of tendering and selection of competent hands in delivering projects to schedule, cost and quality objectives. Akpan et al. (2014), further stated that the performance of construction projects in Nigeria is far below international best practice given the rampant state of collapse of most projects on a regular basis.

A critical evaluation of the application of lean principles and techniques will help a creating room for value-adding and waste reduction in the Nigerian construction industry for the good and benefit of all and sundry. The central objective of this study is to identify barriers to the adoption of lean in construction projects. Given the complex nature of most construction projects and the ensuing difficulty arising there from, it is imperative for the Nigerian construction industry to contribute to the economy by deploying value-adding activities and waste reduction strategies with a view to achieving competitive advantage in the industry.

LITERATURE REVIEW

The construction industry, the world over is consistently growing as a result of the dynamisms of development as well as the need and zeal to carry along the changes brought about by the social and demographic tendencies overtime (NBS, 2015). The industry according to Oyedele (2013) is the main driver of growth in the manufacturing, education, health sectors as a result their reliance on the construction industry for performance. On the other hand, the contribution of the industry to the Nigeria's economy drastically reduced to about 1 percent of the gross domestic product (GDP) in 2002.

However, by April 2014, the findings of the Nigerian Statistical Fact Sheet on Economic and Social Development of 1999-2003 as opined by Equere and Tang (2010) revealed that the building and construction activities took a different dimension in 2003 culminating into a growth rate of about 9 percent. While the (NBS, 2015) revealed that the industry grew to about 21.3 percent in its GDP by the year 2011. Reasons for this momentous growth according to (NBS, 2015) were as a result of the increase in the contribution of the industry to GDP by taking into consideration all other economic activities

within the sector. The Nigerian construction industry according to Abdulsalam et al. (2012) is labor intensive and the largest employer of the nation's labor force. It also accounts for about a 50 percent of the country's gross fixed capital formation (GFCF). But it is unfortunate to state that most findings have revealed that the outputs from the industry are on the low side when compared with other developing (third world) countries.

Mbamali and Okotie (2012) stated that in present day Nigeria, the focus on infrastructural development by the government as well as concerted efforts made at privatizing and commercializing construction activities have resulted to an unprecedented boom in the construction sector. Coupled with the increasing demand for construction related activities and subsequent attraction for global construction players ensuing from this arrangement, there is an attendant shortage of skilled manpower, shortage of construction materials, high cost of labor and security challenges bedeviling the industry (Mbamara and Okotie, 2012).

While Oyedele (2013) further stated that the construction industry in Nigeria is neither organized nor controlled as there are no clear-cut differences between the various contractors as some are merely in business to make huge profit irrespective of the nature of the job involved. The industry is under-funded, and this also contributed to its low contribution to the nation's GDP.

The Nigerian construction industry according to Oyewobi et al. (2011) is extremely susceptible to corruptible tendencies as a result of the heterogeneous nature of the industry. They further opined that the menace of corruption is one of the factors militating against the development of the industry. While in the area of budgeting and funding, budgets are not properly planned for purposes of construction, as the implementation of such budgets are mostly characterized by fiscal indiscipline, bureaucracy which often leads to abandonment of such projects (Opawole et al., 2012). Other factors affecting the construction industry includes; insensitive and disjointed government policies, poor procurement procedures, dominance of the industry by foreign nationals to the detriment of the indigenous ones, etc.

Lean Concept

The word "lean" has been used most often and it is associated with lean thinking, lean manufacturing, lean construction and lean production (Ballard and Howell, 1998; Womack and Jones, 1996). According to Intergraph (2012), a lot of arguments have arisen as to what each of the aforementioned lean terminologies exhibit in relation to one another. The underlying fact is that the word lean keeps appearing. Lean according to Tserng et al. (2013) entails a system that uses less in terms of inputs in creating the same output akin to the once created by a traditional mass production system (Gao and Low, 2014) while also providing the needed value and increased satisfaction to end users.

The word lean according to Capo et al. (2004), Ayarkwa et al. (2012b), Chen and Taylor, (2009) originated from the works of a research team working on an international piece in a bid to reflect the nature of the Toyota Production System while also differentiating their works from handcraft and associated production lines. The main focus of the research team as opined by Capo et al. (2004) was to focus on the production process as a whole unlike the handcraft production system which relies solely on worker productivity.

Lean in Construction Projects

Lean construction according to Ayarkwa et al. (2012a) has of recent received audience as a way of improving construction performance and productivity. It has been adduced to be the latest management concept that advocates for the minimization of waste in construction processes as well as changing the construction industry needs. Lean construction is a way of designing a production system that minimizes the waste of materials, time and effort with a view to generating ample value within the construction process (Ayarkwa et al., 2012b).

Lean construction is a production management based idea of delivering projects, the latest means of designing and building with a view to changing the previous ways of constructing (Fapohunda, 2014). Cleves and Michael, (2006), are of the view that the key driver of the lean project delivery approach is in the understanding that rewards and compensations are attached to the value of the delivered project. All the various

professionals in a project are expected to collaborate and help in ameliorating any perceived difficulty experienced in a project. In applying the lean construction principles in construction projects, the process of design is carried out with the sole aim of achieving enhanced client satisfaction throughout the entire process. Fapohunda (2014) further opined that the lean construction process is hinged on the following principles, viz;

(i) reducing waste

(ii) specifying value from the perspective of the client.

(iii) clearly streamline the process that would deliver value to the client

(iv) minimize all non-value adding processes and activities

(v) ensuring that there is a flow between all value-adding processes devoid of interruptions in managing the interfaces between the steps and activities.

(vi) ensure that the client agrees to halt and accelerate activities when the need arises.

(vii) to ensure perfection is achieved via continuous improvement.

Most construction related activities have been adduced to a complex process of delivering one-of-a-kind product via the incorporation of a temporary and multiskilled team (Wolbers et al., 2005). Wolbers et al. (2005) further stated that the two main contributors to lean construction are Koskela's Transformation Flow Value (TFV) and Ballard's Last Planner System (LPS) which were later followed by Ballard and Howell's Lean Project Delivery System (LPDS).

Transformation Flow Value

The introduction of the ideas of lean thinking into construction was formulated through the transformation-flow-value (TFV) theory of production. As opined by Rajprasad et al. (2014), the TFV theory of production when properly deployed, could lead to improved performance in construction projects. They see construction production as a continuation of conversion flow processes of eliminating waste while the traditional method of construction dwells more on conversion only and ignoring flow and value.

According to Bertelsen and Koskela (2004) and Ahiakwo (2014) the continuous improvement concept of lean originated from the fact that lean construction hinges more on the three objectives of production viz; transformation, flow and value (TFV) in conjunction with waste minimization. According to Ogunbiyi (2014), waste elimination is essentially linked to the elimination of needless movements, eliminating unnecessary costs, optimizing workflows as well as the sharing of benefits ensuing from improved performance.

Transformation and its management is a procedure of managing contracts and establishing quality and safety procedures which would ultimately lead to the increase in productivity and optimization of construction processes (Bertelsen and Koskela, 2004). According to Pekuri et al. (2014b), the pertinent issue in lean is the conceptualization of projects as entities geared towards achieving the mutual goals of transformation, flow and value (TFV) generation within the production system of any project. They further opined that to function based on the tenets of TFV theory, the entire project delivery system needs to support production maximally. This implies that the project organization, operating system of the project as well as the commercial entities binding the project stakeholders per se must be work in unison.

Last Planner System

Last Planner System (LPS) according to Ahiakwo (2014), is a system of production control that was introduced by Glen Ballard in 1992. While Adamu and Howell (2012) opined that LPS, a developed tool of lean construction lays more emphasis on the relationship between scheduling, planning and production control with a view to producing predictable workflow system. Salem et al. (2005) asserts that LPS is "a technique that shapes workflow and addresses project variability in construction". They further opined that the LPS is responsible for operational planning via the deployment of structures for product design with a view to streamlining improved workflow thereby achieving the completion of various work components.

The LPS according to Howell (2014), decentralizes decisions and strengthens the workmen that are in direct contact with the work in planning and scheduling detailed work packages. Howell (2014) further opined that the LPS draws from the concept of collaboration, team work, communication, empowerment and ownership in creating a standard for planning and scheduling certain key techniques in a project-based environment. The key techniques include; the master pull schedule, reverse phase schedule, the look ahead schedule, the weekly work plan and percent plan complete (Alsehaimi et al., 2013; Howell, 2014; Rajprasad et al., 2014; Salem et al., 2005; Sundararajan and Madhavi, 2018).

Lean Project Delivery System

The Lean Project Delivery System (LPDS) according to Ogunbiyi (2014) was one of the outcomes of the lean construction institute (LCI) that was developed from the manufacturing industry and later metamorphosed into the construction industry. the LPDS is a conceptual framework developed by Glen Ballard for purposes of guiding the implementation of lean construction on project related production system. Howell (2014) opined that the LPDS primarily hinges on the minimization of deficiencies prevalent with the traditional construction methods such as poor design, schedule and cost overruns, reworks and poor-quality production amongst others.

The fundamental criteria necessitating the application of the LPDS are majorly centered on the “five big ideas” (Howell, 2014; Ogunbiyi, 2014). The five big ideas include; project definition, lean design, lean supply, lean assembly and lean use. According to Wolbers et al. (2005), project definition has to do with defining the customer as well as the stakeholders purpose and value, design concept and criteria. Lean design has to do with deferring certain decisions to a later date with a view to making for adequate time in developing and exploring possible alternatives.

While lean supply according to Howell (2014) utilizes three (3) key approaches in solving problems like improving workflow reliability using web-based project management software to increase openness across value streams and linking production workflow with the material supply. Lean assembly implies incorporating key frameworks within logistics and fabrication, physical installations and commissioning. Howell (2014) further stated that the lean assembly phase is the most volatile due to its exposure to risk. It is therefore imperative to develop a robust workflow schedule and production control be monitored with a view to creating the most credible assembly system. The last stage of the LPDS involves evaluating how the complete facility would satisfy the user. It is the stage of confirming the services to be derived from the project by using the post occupancy evaluation (POE) method.

Barriers to the Adoption of Lean in the Nigerian Construction Industry

Lean construction has proved to be a highly rewarding venture to the construction industry in the UK (Sarhan and Fox, 2013). Sarhan and Fox (2013) further opined that this assertion was emphasized by the Egan’s Committee who equally stated that the concept of lean thinking could lead the UK construction industry’s quest of improving quality and efficiency. A good number of barriers militating against the successful implementation of lean abound in the literature, they include Sri Lanka (Senaratne and Wijesiri, 2008), Uganda (Alinaitwe, 2009), China (Gao and Low, 2014), Indonesia (Abduh and Roza, 2006) and Nigeria (Olatunji, 2008).

Research has been carried out with a view to investigating the factors that could impede the successful implementation of lean construction, notable amongst them are highlighted below even though from the available literatures, there are no studies relating to the aforementioned issue that has been carried out in Nigeria specifically.

The application of lean principles to construction is bound to encounter some obstacles. A study by Ayarkwa et al. (2012a) identified and prioritized possible barriers to the successful implementation of lean construction in the Ghanaian building industry and measures to overcome potential barriers. The study identified the barriers to include lack of proper planning and control, lack of teamwork, poor project management, lack of technical capabilities, lack of financial resources and poor communication between parties.

Bashir et al. (2010) in a study on barriers towards the sustainable implementation of lean

construction in the UK construction organizations found six barriers categorized based on a thorough and critical review of literature relating to lean practices. The barriers identified include; financial, educational, governmental, attitudinal, managerial and technical issues.

Sarhan and Fox (2013) in its study, sought to identify and assess the possible barriers to the successful implementation of Lean in the UK. Based on an extensive literature review, followed by a statistical analysis of data gained from a questionnaire survey which targeted practitioners in the UK construction industry, a number of barriers were identified as key. The barriers include; lack of adequate lean awareness and understanding; lack of top management commitment and cultural and human attitudinal issues.

Barriers to lean implementation according to Tourki (2010) vary from one firm to another based on the aims and objectives, and firm types. Tourki (2010) further grouped these barriers into four categories namely; technological barriers, financial barriers, external barriers and internal barriers.

Ogunbiyi (2014) in a study on the implementation of lean approach in sustainable construction in the U.K., identified the following as key barriers to lean implementation. They include; resistance to change and culture; employees'attitudinal issue; lack of management support; lack of customer-focused and process-based performance measurement systems; lack of adequate lean awareness and understanding; and lack of implementation understanding and concepts are some of the most severe barriers to the implementation of lean.

RESEARCH METHODOLOGY

This aspect discusses the methodological approach for the study which consists of the research design, target population sampling design, research instruments, data collection procedure and data analysis methods. A research design delineates the methods and procedures of acquiring the necessary information needed in a research (Saunders, Lewis and Thornhill, 2007). The study deployed both the descriptive survey and case study research designs. The descriptive survey design was used since the study gathered quantitative and qualitative data that described the nature and application of lean in the Nigerian construction industry.

Case study research is described as a strategy for empirically investigating a contemporary phenomenon within a real-life context using multiple sources of evidence (Saunders, Lewis and Thornhill, 2009; Yin, 1994). The two study designs facilitated the gathering of reliable data describing the application of lean principles in the Nigerian construction industry.

The target population for the study were from five (5) construction firms located in Port Harcourt, Nigeria. The population included project managers, construction managers, architects, quantity surveyors, engineers and project supervisors working on construction projects within the firms. The study adopted purposive sampling technique to select the respondents. This was preferred because purposive sampling allows the researcher to select respondents who possess the requisite knowledge about the subject in question. Besides, looking at the nature of the industry, the study seeks to solicit information from the professionals within the study area who by virtue of their class and experience have the capacity and requisite knowledge to participate in the study.

Questionnaires were used to collect data from the respondent. A Likert scale was used in the questionnaire to measure attitudes presented by the respondents as recommended by (Kothari, 2004). The questionnaires were self-administered by the researcher. The questionnaire was divided into two sections: The first section collected the demographic characteristics of the target population i.e. the age, gender, level of education etc., while the second section consists of the key questions raised in the research question. Each of items will be measured on a five-point scale varying from 1 (low) to 5 (high).

The content validity of the questionnaire was established by the researchers by seeking the opinions of experts in the field of study especially some of the University's senior academics and Professors. Validity relates to the extent to which the research data and the methods for obtaining the data are accurate, honest and on target (Somekh and Lewin, 2004). In terms of the reliability, Cronbach's alpha was used to check the reliability of the instrument which is based on internal consistency of the research instruments.

The research made use of both primary and secondary data. Primary data consisted of structured questionnaire with both open-ended and closed-ended questions. Open-ended questions gave respondents the freedom to express and explain themselves. Secondary data was obtained from journals and research papers done by other scholars.

According to Spector (2011) job satisfaction can be measured by interviewing or administering a survey instrument to the sample population. However, interviews are rarely used. In most cases, the studies on the phenomenon of job satisfaction are conducted using a questionnaire.

The statistical package for social science (SPSS) (version 17.0) was used for generating the descriptive and inferential statistics, while relative importance index (RII) with the aid of Microsoft Excel Spreadsheet was used to analyze the key theme bordering on barriers to lean adoption in the Nigerian construction industry. The RII was used to rank the scores of each response which was based on the percentage responses to the 5-point Likert type-scale. The survey required respondents to indicate their opinions on how strongly they agree or disagree with the statements and / or questions, ranging from strongly agree to strongly disagree with an option to tick the right options.

RESULTS AND FINDINGS

The population for the study consists of 362 practitioners from five (5) construction firms located in Port Harcourt, Rivers State. The construction firms were consulted via a purposeful/convenience sampling technique where a sample size of 291 was arrived at after being subjected to the Krejcie and Morgan method of sample size determination (Krejcie and Morgan, 1970). Table 1 below shows details of questionnaires retrieved and those found usable for further statistical analysis.

Reliability and Validity of Instruments

The Cronbach's alpha test was used to determine the reliability of questionnaires with a view to confirming their ability to produce consistent and stable measurements over time.

Table 2 below shows the outcome of the internal consistency of the individual categories of constructs via SPSS version 17.0. According to Sekeran (2010), a "high" alpha value is often used as a confirmation that the items being measured is a latent construct. Cronbach's alpha values range between 0–1, where 0 is the weakest and 1 the strongest. Hence, according to (George & Mallery, 2003; Gaur & Gaur, 2009; Pallant, 2005). alpha values within this range; $\alpha \geq 0.9$ excellent; $0.9 > \alpha \geq 0.8$ good; $0.8 > \alpha \geq 0.7$ acceptable; $0.7 > \alpha \geq 0.6$ questionable; $0.6 > \alpha \geq 0.5$ poor; $0.5 < \alpha$ unacceptable.

The data for this study were found to be reliable judging from the outcomes of the Cronbach's alpha coefficient values in Table 2.

Table 1: Questionnaire Response.

Construction Firms	Population	Sample size	Sample retrieved	Number found usable
1	92	73	65	63
2	54	44	32	29
3	112	86	72	69
4	67	56	51	49
5	37	32	25	23
Total	**362**	**291**	**245**	**233 (80.07%)**

Table 2: Cronbach's Alpha Value.

Reliability Statistics	
Cronbach's Alpha	N of Items
.879	11

Demographic Information

The initial aspect of the questionnaire captured the respondent's characteristics with respect to their discipline, years of experience in the industry, qualifications, nature of project executed as well as knowledge of lean principles as applicable in the industry.

Respondent's Discipline

Table 3 shows that a greater percentage, 52 (22.41%) of the respondents are architects, while 48 (20.69%) are builders, 44 (18.97%) project managers, 38 (16.38%) are engineers, 27 (11.64%), while others are 23 (9.91%).

Respondent's Years of Experience in the Industry

Figure 1 shows the experience of the respondents in the industry. 38 (16.31%) of the respondents have spent between 1-5years, 56 (24.03%) spent between 6-10 years, 62 (26.61%) 11-15 years, 44 (18.88%) 16-20 years, while 33 (14.16%) spent above 21 years in the industry.

Respondent's Academic Qualification

From the Table 4, a greater percentage, 162 (69.53%) of the respondents had HND/B.Sc/B.Tech/B.Eng as their academic qualifications. While 47 (20.17%) had OND as qualification, 24 (10.30%) had MBA/M.Tech/M.Sc. as qualification. None of the respondents had a Ph.D. as academic qualification.

Nature of Construction Projects Executed

On the nature of construction projects executed by the respondents, Figure 2 below depicts that 64 (27.47%) being the majority were building projects, 61 (26.18%) were road projects, 45 (19.31%) were bridges, 35 (15.02%) were jetties, while others were 28 (12.02%).

Table 3: Respondent's Discipline.

Discipline	Number of respondents	Percentage
Project Managers	44	18.88
Engineers	38	16.31
Architects	52	22.32
Quantity Surveyors	27	11.59
Builders	48	20.60
Others	24	10.30
Total	**233**	**100**

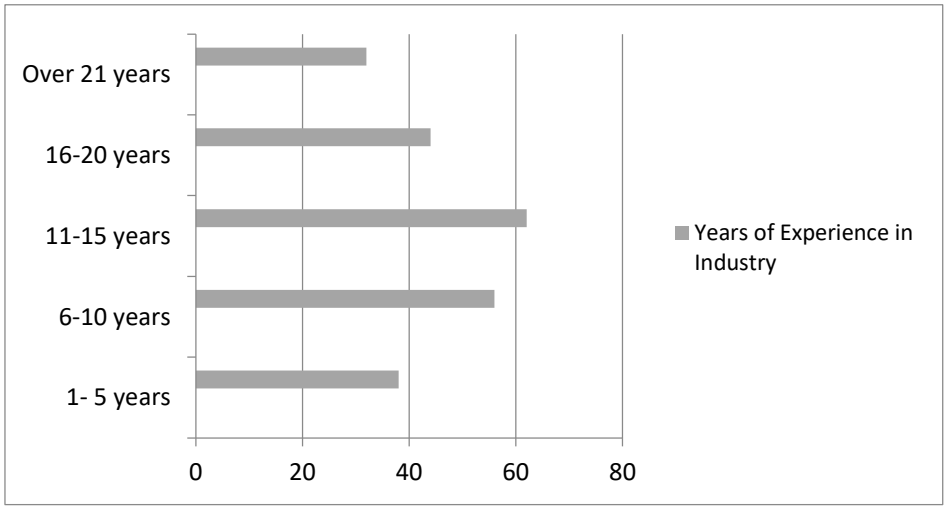

Figure 1: Respondent's Years of Experience in the Industry.

Table 4: Respondent's Academic Qualification.

Qualification	Number of respondents	Percentage
OND	47	20.17
HND/B.Sc/B.Tech/B.Eng.	162	69.53
MBA/ M.Tech/ M.Sc.	24	10.30
Ph.D.	-	-
Total	**233**	**100**

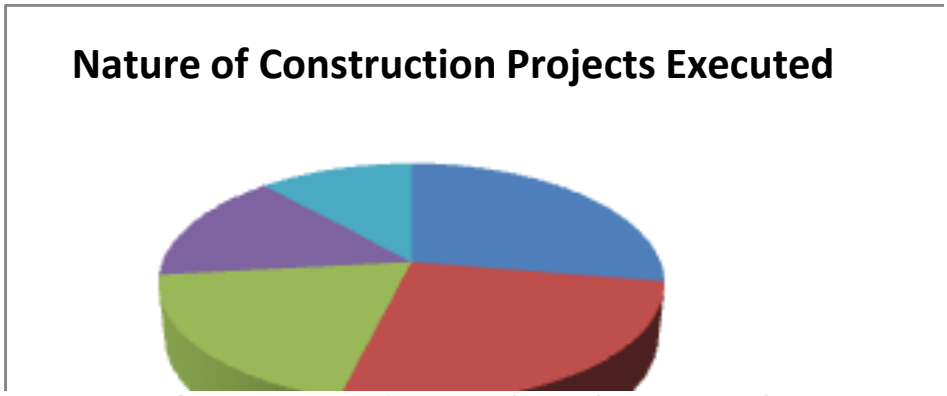

Figure 2: Nature of Construction Projects Executed.

Table 5: Relative Importance Index for Barriers to the Implementation of Lean Principles.

Barriers to lean implementation	SA 5	D 4	N 3	D 2	SD 1	SUM	RII	Rank
Resistance to change and culture	82	48	41	36	25	822	0.55	2nd
Poor project management	54	33	62	50	33	721	0.48	7th
Lack of financial resources	52	74	28	57	21	775	0.52	4th
Lack of adequate lean awareness and understanding	88	55	29	35	25	842	0.56	1st
Government attitude to innovation	81	37	24	47	43	762	0.51	5th
Lack of proper planning and control	63	42	30	28	69	698	0.47	8th
Poor communication between parties	17	32	40	82	61	558	0.37	11th
Lack of teamwork	50	44	28	39	71	659	0.44	9th
Lack of top management commitment and support	54	69	33	44	32	765	0.51	5th
Lack of technical capabilities	73	62	28	30	39	796	0.53	3rd
Lack of customer-focused and process-based performance measurement systems	22	51	62	64	33	661	0.44	9th

The respondents were requested to indicate their level of agreement with the eleven (11) barriers to lean implementation that were identified from the literature. Table 5 shows that the most important barrier to lean implementation as stated by the respondents is lack of adequate lean awareness and understanding with a RII value of 0.56 and ranked first. While on the other hand the results show that poor communication between parties has the least RII value of 0.37 and was ranked eleventh. Resistance to change as well as culture and lack of technical capabilities were the next in the list of the highest ranked factors.

DISCUSSION OF RESULTS

In discussing the findings emanating from the results, it is imperative to x-ray on some of the key issues of discourse arising specifically from the reliability tests and the research questions earlier articulated *ab initio*. The outcome of the Cronbach's alpha coefficient test was to determine the reliability of questionnaires/instruments with a view to ascertaining their ability to produce consistent and stable measurements over time. Table 2 depicts the outcome of the internal consistency of the various categories of the variables under study.

The findings of the Cronbach's alpha coefficient score confirm with that of (Gaur and Gaur, 2009; George and Mallery, 2003; Pallant, 2005; Sekeran, 2010), which states that a "high" alpha value $\alpha \geq 0.8$ as good and acceptable. The outcomes of this exercise were commendable having exceeded the 0.7 mark of acceptability.

These findings gave credence and integrity to the instruments and as such rendered them fit for this study. On the barriers to implementation of lean principles, the study also found that although the eleven (11) barriers were identified from the literature (Table 5), the findings shows that the most important barrier to lean implementation as opined by the practitioners is lack of adequate lean awareness and understanding with a RII (0.56) and ranked first. While on the other hand the findings indicate that poor communication between parties has the least RII (0.37) and was ranked eleventh.

Resistance to change and culture, lack of technical capabilities, lack of financial resources were the next in the order of the highest ranked barriers. A similar result was ascertained by Sarhan and Fox (2013), Ogunbiyi (2014), Tourki (2010), Bashir et al. (2010), Ayarkwa et al.(2012a).

It is also interesting to note that none of these barriers to lean implementation occurred in any related study in Nigeria per se. This could also be attributed to the dearth of studies of this nature situated in Nigeria. Nonetheless, a good number of the barriers could help in changing the tide and help to create the needed change in the Nigerian construction industry if properly given the needed attention.

CONCLUSION AND RECOMMENDATIONS

The study specifically identified barriers to the adoption of lean in the Nigerian construction industry. A sample of 291 respondents from five (5) construction firms in Port Harcourt, Rivers state were selected to participate in the study from a larger population of 362. There was a 80.07% response rate, a total of 245 questionnaires were filled and duly returned, while 233 were finally used for analyses. The outcome of the responses was sufficient for arriving at a conclusive study.

The key findings ensuing from the study shows that eleven (11) barriers to lean implementation in the Nigerian construction industry were identified and evaluated. The study findings revealed that lack of adequate lean awareness and understanding with a RII value of 0.56 and ranked first was the most important barrier to lean implementation. While resistance to change and culture RII 0.55; lack of technical capabilities RII 0.53; lack of financial resources RII 0.52 were the next in the list of the highest ranked barriers to lean implementation.

From the outcomes of the results, the study now concludes that; The most important barriers to lean implementation are; lack of adequate lean awareness and understanding; resistance to change and culture; lack of technical capabilities; lack of financial resources; government attitude to innovation and lack of top management commitment and support. To help ameliorate the none/lack of application of lean concept and its principles, government as a matter of urgency and necessity should pay more attention to knowledge creation and innovation via the application of lean principles as this would create the needed change that would propel the Nigerian construction industry to greatness.

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