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LEAN CONSTRUCTION AS A PANACEA FOR POOR CONSTRUCTION PROJECTS PERFORMANCE

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ABSTRACT

Recurring problems in the delivery of construction projects have been time and cost overruns, poor quality, poor health and safety, waste and loss of value. This situation is worsened by the reluctance of construction organisations to fully implement lean construction technique which has proved to be an innovative solution to these problems. This study assessed construction professionals' perception of the awareness, adoption and benefits of lean construction in remedying poor construction project performance in the south-south region of Nigeria. A well-structure questionnaire distributed by hand and electronically using the snowball sampling technique were used to gather data from the participants from both the private and public organisations. Frequency, percentage and factor analysis were used to analyse the collected data. It was found that the level of awareness of lean construction is high but it s adoption is low. Lean construction is a panacea for poor construction project performance because of it s cost related benefits, value and relationship benefits, environmental benefits, quality improvement benefits, motivation and productivity benefits, profitability and market benefits, time and work flow benefits, waste reduction benefits, and HS and rework reduction benefits. The creation of dedicated department/team for driving the lean initiative is recommended.

I. INTRODUCTION

Globally, the construction industry has proven to be of great benefits to national economic growth and development. Its impacts are evident in various forms of building and infrastructural provisions, employment generation, wealth creation, and contributions to national income. According to the submission of [1] and [2], the construction sector is one of the critical industries in both developed and developing economies that contribute significantly to economic growth. The industry has however, been faced with numerous challenges which according to [3], have tried to limit its contribution to sustainability and effectiveness in providing clients' value for their monies and end-users satisfaction. Furthermore, the industry is heterogeneous in character with different project types that are constantly being confronted with a lot of ambiguity in design and planning, multitude of stakeholders with varying interest, resources availability, environmental variables, economic condition and legislations and regulatory requirements [4]. The slow and sluggish nature of the key stakeholders of the industry in the uptake and adoption of innovative techniques, technologies and concepts like lean construction, has been blamed for its inefficiencies that have led to poor project performance and delivery issues [5-9]. Also, the implementation barriers to lean construction at the initial stages of project is due to the absence of suitable evaluation tools that would enable companies determined the true value of lean construction [10].

The lean construction have proven to be an innovative practice to improving project delivery and performance in the area of time, cost, quality, waste generation, clients and end-user satisfaction. According to [11], lean construction is an innovation tool for efficiently managing construction projects as well as

minimising wastes and enhancing performance. Similarly, in South Africa, [4] also found that the key impacts of lean construction on construction projects are waste minimisation, efficient materials administration and improved whole-life cost. The lean construction practice offers a value added technique for designing, managing, construction projects to improve time and workflow performance, efficient resource utilisation, waste elimination, with the overall maximisation of value for clients' monies [12-13].

In Nigeria, construction projects delivery are known to be suffering from a lot of setbacks as evident in the submissions of [14-16]. It was submitted that building construction projects are characterised by poor quality, cost and time overruns. These problems have contributed greatly to the decline in profit margin being experienced in the Nigerian construction industry; this is in spite of the ever increasing demand for housing and other infrastructure of general nature [17]. More worrisome are the issues of poor productivity and performances in terms of time, cost and quality [12]. A suitable measure for ameliorating the problem is the adoption of lean construction practice. Although, maximization of the full benefits of lean construction is jeopardized by the level of adoption of the lean conept which is still at the infancy. The concept is however, gradually gaining wider awareness among professionals, alt hough, the adoption is still low in the construction industry [3].

A review of studies on lean construction practice in Nigeria shows that researchers and academics have adopted a single state as there study area. For instance, [13] assessed lean construction practice among construction professionals in Ondo State, and recommended for an extended study that would cover a wider area and locations. [12] assessed the prospects and challenges of lean construction practices among architects in Lagos State, and recommended for a similar study to evaluate the perception of other construction professionals in other areas. Port-Harcourt is among the five states considered in the study of [3]; Port-Harcourt is just one of the 6 states that made up the south-south region of Nigeria. There is no known study on lean construction that has covered the entire south-south geo-political zone of Nigeria. These region houses the six key oil producing states of Nigeria and particularly the Niger-delta region of the country. [18] submitted that majority of the construction firms operating in the Niger delta regions of Nigeria are SMEs and the size of these firms exerts a significant influence on the level of adoption of sustainability practices in the Niger Delta. The lean construction techniques have a link with sustainability practices as indicated in the report of [19]. It was reported that lean and sustainable constructions have considerable commonality which include cost savings, waste minimization, Jobsite safety improvement, reduced energy consumption, and customers' satisfaction improvement. It is based on these that this study titled 'lean construction as a panacea for poor construction projects performance', is carried out. To achieve this purpose, the study assessed construction professionals' perception on the awareness, adoption and benefits of lean construction in remedying poor construction project performance in the south-south region of Nigeria. The study also offered recommendations for improving the practices of lean thinking, for better project performance and delivery.

This study adds to existing body of knowledge on lean construction globally and particularly to the few available studies on lean concept in Nigeria. Construction organisations and other stakeholders will be encouraged to adopt this innovative technique that has proven to increase profit generation, waste reduction and client satisfaction. In addition, it's a step towards meeting the economic, social and environmental dimensions of sustainable construction needs of Nigeria, and by extension other developing countries.

II. LITERATURE REVIEW

II.1 THE CONCEPT OF LEAN CONSTRUCTION

Bajjou et al.[20] and Sarhan et al. [1] states that the origin of lean construction philosophy that is practiced in the construction industries of countries can be traced to the lean concept of the manufacturing sectors, and particularly from the Toyota production system. Egan [21] reported that the adoption of lean philosophy in construction was based on the successes recorded by the manufacturing sector for implementing the lean principles and the resultants benefits therein. One of the early authors who made efforts to introduce the lean thinking in the construction industry was [22]. In the Stanford report by [22], contains the discussion of the applicability of what was called 'the new production philosophy'. Ever since it was introduced to the construction industry, after it was first introduced to manufacturing by Toyota motors, the concept of lean construction have successfully been adopted globally in the construction industry [23]. The Lean concept is a philosophical tool of management that focuses on finding and eradicating wastes from the whole process of production value chain [24]. It is not only applied on production organisations but also along the chain of supply and implementation. Lean construction according to [25] is a technique of designing the production systems to focus on material waste and time reduction and to maximize value. This definition by [25] is not different from the main philosophy of lean objective in manufacturing. The main objective of lean manufacturing is waste minimisation and value maximisation. In the same vein, lean construction was defined by [26] as a systematic approach adopted to improve value for customers through identifying and excluding waste through a repeated process of enhancement in the quest for excellence. Hall [27] defined lean construction as a philosophy adopted by the construction team that involves the practices and technologies that decrease costs, materials, time and effort, that are specific to the project at hand. Therefore, the principles and concepts of lean construction is aimed at making construction project delivery and management focus on waste elimination for value maximisation and project success.

II.2 LEVEL OF AWARENESS AND ADOPTION OF LEAN CONSTRUCTION TECHNIQUES

The adhesion of other improvement processes of an organisation have made it impracticable to implement lean construction in the construction industry of Brazil [10]. The investment evaluation and benefits assessment are key requirements prior to adoption of the lean construction principles [28]. The requirements and efforts involved in the benefits assessment and investment evaluation have grossly been misinterpreted as a weakness [10].

In the UK, [29] and [30] reported that more than two decades after Egan report was published, the implementation of the lean construction practices was still limited, and according to [6], the situation was attributed to structural and cultural barriers. In an earlier study by [7] in Germany, low level of awareness of

the lean techniques was reported. In the USA and India, successes have been recorded in reducing waste and making profit from the actual implementation of the lean methods in construction projects [31]. The study found that although the implementation is high, the participants were not awareness that they were using a lean techniques in minimising waste and maximising profit.

In the Ghanaian construction industry, there is a good level of awareness, but with a low familiarity and application level of the lean construction concept among construction practitioners [32]. Later studies by [33] in Turkey, and [34] in Ethiopia, indicated low level of awareness of lean construction techniques among practitioners in the construction industries of the countries. [11] in Morocco found that, although, the level of adoption of lean construction practice is low, its awareness among professionals is high. Wandahl [35] reported that 3 out of 4 practitioners do not know about lean construction practices, and this situation was blamed on lack of knowledge, education and communication on the importance of the lean concept.

In a study carried out by [3] in five cities from the five geo-political zones of Nigeria, it was found that the level of awareness of lean thinking is improving but there is a comparatively low level of adoption among construction firms. In a study carried out a decade earlier by [36], it was reported that the level of awareness of lean construction technique is low among construction stakeholders. However, [13] reported that a larger number of the construction professionals are aware of the term lean construction and its techniques. Similarly, according to the study of [12], 89% of the Architects sampled are well informed of the lean construction techniques.

II.3 LEAN CONSTRUCTION PRINCIPLES

Banna [37] submitted that the number of construction firms that have embraced the lean methodology is growing because of its emphasis on value maximization for customers and waste minimization. In addition, the lean methodology is mostly suitable for industry where cost, time and safety are critical. Although, lean construction practices are simple and attractive, its methodology of project delivery is different from the conventional methods. This has made the proper implementation of the lean philosophy and techniques challenging.

The model in which the lean construction are executed is different, the lean model operate in such a way that projects are managed to align with deliverying true value to clients [38]. It involves a continuous monitoring which provides the project team and field operatives with an opportunity for improvement and reduce waste, as well as keeping the line of communication clear and ensuring seamless flow of works, timely completion, and making sure that customers' requirements are met with zero delays and discrepancies [38].

There are building blocks and/or guiding principles that help organisations reduce construction cost, time, material waste, labour cost, and improve productivity and efficiency. [37-40] identified six principles and they are; identifying value from the client's viewpoint, implementing processes that deliver true value, eliminating waste at every point possible, achieving a collaborative and continuous workflow from start to finish, using pull planning and scheduling for a streamlined approach, and continuous monitoring and optimisation. The successful implementation of these lean principles is a key to cost cutting, construction time reduction, productivity improvement and efficiently managed projects [40]. Furthermore, these principles drives and guide key industry players in developing tools and methods to aid the achievement of the lean construction goals and holistic approach to the delivery of projects.

II.4 BENEFITS OF LEAN CONSTRUCTION TECHNIQUES

A lot of countries have realised the importance of lean construction and now adopt it for better performance and delivery of construction projects. The interest in lean construction approach may not be unconnected to the various problems associated with the conventional system of building construction delivery. Shang and SuiPheng [41] states that time and cost overruns have remained recurring problems inherent in construction and engineering fields. Furthermore, construction projects according to [20] are characterised by poor quality, poor health and safety performance, and negative environmental effects.

Construction organisations that adopt lean construction are preparing themselves against the future. According to [27], contractors who adopt lean construction as part of their strategic plan, are preparing themselves for both the present and the future. [27] further identified five elements that guide the lean thinking philosophy, and they are shorten construction time, reduced cost, accelerate activities, improved planning and improve process control.

Kane [42] posits that the benefits of construction techniques include; improve the health and safety on site, streamlining of construction processes to ensure quicker and efficient working. This will help to reduced product waste, time waste, energy waste and money waste. Tasks are finished faster, thus, leading to cost savings. The efficient working which the lean construction technique leads to, helps in time savings and labour cost reduction. [43] states five reasons why building lean is beneficial, and these are meeting the industry demands, maximizing efficiency, reducing safety hazards, decreasing waste, and valuing relationships.

[44] in South Africa found that the top five benefits of lean construction practices are reduction of waste, effective administration of materials on site, improved life-cycle cost, greater client satisfaction, and good project coordination. [45] had earlier reported that the most importance benefits of lean construction are waste reduction and value achievement throughout the entire construction process. [46] highlighted seven points that enhances the view of lean construction, these points are; continuous improvement in construction industry, focus on smart work through companies management rather than hard work by adopting strategic plans for future, reduces waste production in the field which is useful in increasing the profit, reduces the cost of the project, increase in customer satisfaction, better and smooth communication among parties and increases in productivity.

From the study of [13], the major benefits of lean constriction practices are; improvement of project delivery methods, more satisfied clients, delivery of products or services that enable clients to better accomplish their goals, promotion of continuous improvement in project delivery methods through lessons learned, and minimization of risk and maximization of opportunities. In Sweden, [47] found that lean principle has the potential for improving planning process for maintenance contracts, even though, the effective application is limited by contractors' lack of knowledge. According to [48], lean-based tools have successfully been applied to both simple and complex construction projects in Egypt, and the result have shown that

lean-based construction projects are managed better and easier, have better safety performance records, completed earlier than planned, cost less and have better quality performances. In a separate study in Egypt, it was reported by [49] that lean technique implementation play a critical role in reducing the entire duration of an industrial project by 15.57%.

In the Moroccan construction industry, [11] found that the major benefits of adopting lean construction approach in order of mean weighting are; better project quality, improving safety, Improving the environmental performance, reducing overall project duration, and reducing construction cost. It was further submitted that construction practitioners recognised that lean construction helps to achieve the non-financial performance of construction projects. In Iran, it was concluded that the performance of construction projects in which lean approach was applied is better than that in which the traditional process was used [50]. In the South African Construction Industry, construction professionals opined that the major benefits of lean construction are; reduced waste, efficient administration of materials, improved whole-life cost, improved customer satisfaction, improved safety, and increased productivity [4]. In the Swedish construction industry, a case study of large construction organisation revealed a reduction of the project cost by 1.25% by increasing the added value from 40% to 45% [51]. After incorporating lean construction principles, the total duration reduced by 6.15% -9.56%; this was the finding of [52] in Turkey, who compared a residential building project with lean and non-lean scenarios using a Monte Carlo simulation.

It was reported in the USA that, a parking-garage project was completed 3 weeks ahead of schedule, within proposed budget and with negligible quality defects; as a result of the application of lean construction tools [53]. A study by[54] in the USA, showed that the application of kaizen activities in housing lead to a 50% saving in costs. In the USA, [55] combined the lean concept with safety analysis approach in a case study of modular housing plant, and found that safety risks such as trip hazards from excess cords and fatigue from less walking were reduced. This study revealed a decline in accidents and injury, thus, implying an improvement in employees safety. Similarly, in an earlier study by [56] in the US, an analysis of responses from 62 homebuilders who used continuous improvement programs of the lean concept, revealed a significant decline in fatalities and accidents rates when compared to builders who does not apply any of the continuous improvement programs. Thus, this shows that there is a relationship between the adoption of lean construction techniques and improvement in workforce safety.

[31] broke down the benefits of implementing Lean concept into three groups, and they operational improvements, administrative improvements, and strategic improvements. Under the operational improvement, the key benefits are; reduced lead time (cycle time), increased productivity, reduced work-in-process inventory, improved quality, and reduced space utilisation. Example of benefits under the administrative improvements are; reduction in processing errors, reduction of paper work, reduction of staff demands, reduction of turnover and the resulting attrition costs, engagement of highly performing professionals, and streamlining of customer service functions so that the customers are no longer placed on hold. The strategic improvements benefits are; help successful companies to improve their market share, time delivery of goods and services to customers are reduced, more sales, repeat patronage, increased in company's revenue, profit and cash flows [57]. A study that adopted three case studies from Brazil, Ecuador and Nigeria, established that the benefits of lean construction to affordable housing projects are; increase the production efficiency, reducing losses, improved product quality and improving productivity, which produced a direct impact on time reduction, materials and labour savings and profitability [17].

Lean construction has shown successful results with complex, uncertain and quick projects [53]. It is claimed that in emerging economies, the implementation of lean construction techniques on construction projects have led to benefits such as; more satisfied clients, productivity gains, greater predictability, shorter construction periods, design improvement, less waste and reduced cost [58, 30]. According to [11], more developing countries have started adopting the lean construction philosophy in recent years. This is because of its objective of minimising waste, maximising value to the clients, keeping to deadlines and budgets, improving staff safety and reduction of the harmful effects of construction activities on the environment. The importance of adopting lean construction techniques on construction projects according to [59], are maximise the use of multi-skilled workforce, improve communication effectives among stakeholders, encourage collaboration, productivity improvement, waste reduction, better quality of work, time savings, and employees are encouraged to think lean.

III. MATERIALS AND METHODS

This study was carried out to establish that lean construction is a panacea for poor construction projects performance. The approach of investigation was a questionnaire survey of construction professionals' perception on the awareness, adoption and benefits of lean construction in remedying poor construction project performance in the south-south region of Nigeria. The questionnaire is useful where the study requires covering of wider areas within a shorter time and at an economical cost. It brings objectivity to research by allowing for quantifiable outcome [60]. The questionnaire was design into three parts. The first part gathered data on respondents' basic personal and organisational information. Data from this first section served as a quality check to data from other sections of the questionnaire. The second part collected data on the level of awareness and adoption of the lean construction principle. The third part gathered information on the benefits of lean construction. Target respondents were asked to rate the 41 benefits of lean construction selected from literature review; in accordance to the level of importance in remedying poor construction performance from their experiences, using a Likert scale of 1to5 (where 1 is the lowest and 5, the highest scale). In order to obtain quality and unbiased data, construction professionals who are knowledgeable about the lean concept, currently engaged in an active construction site, and have at least 5 years of working experience within the study region were sampled. These professionals are Architects, Builders, Engineers and Quantity Surveyors. They were chosen because they form bulk of the professionals engaged by construction organisations whether in the public and/or private sector. The population of these professionals within the study area is 1252 (Akwa Ibom =214, Bayelsa state =128, Cross River =223, Delta =200, Edo =237, Rivers =250) [18]. Using [61] sample size determination table, the samples size of 197 was obtained.

The survey of the professionals was conducted using the snowball technique. A preliminary survey led to the identification of some target respondents who met the study sample selection criteria. This is because it was impracticable to get the exact

number of the target professionals with the set years of experiences and that were actively involved with a construction site during the period of this study. The snowball sampling is dependent on referral [62], and can significantly increase the study sample size [63]. Furthermore, due to the wider study area, this study adopted personal delivery of the questionnaire and by electronic means. This is to further reach a larger audience, at a shorter time and economical cost. The electronic means reduces the volume of papers involved; thus, saving the forest (i.e. is it an environmentally friendly means of survey). At the end of the survey, 161 useable responses were collected from professionals that met the study selection criteria. The retrieved responses represent a response rate of 81.73%, and this was deemed adequate for the analysis. This higher return rate could be attributed to the survey period of 14 weeks and follow up calls to some select participants.

The gathered data was first subjected to a reliability evaluation using Cronbach alpha test. An alpha value of 0.933 was obtained for the variables on the benefits of lean construction. This shows that the questionnaire used is reliable, and the data are of good quality. A normality evaluation was carried out to ascertain data nature and distribution using Shapiro-Wilk test. The Shapiro-Wilk test is suitable for samples that are below 2000 according to [64]. The result obtained shows that data gathered were non-parametric in nature. Frequency and percentages where used to analyse the data gathered on the respondents' basic personal and organisational information, the level of awareness and adoption of lean construction. Kruskal-Wallis H-Test was further used to determine the difference in the perception of the professionals regarding the rating style of the variables gathered on the benefits of lean construction, and in establishing the proportion of the variables where the views differs significantly. This test was conducted based on the understanding that since these professionals are from different states, different organisational background and experiences; there is tendency to have differing opinion regarding the variables of the questionnaire. The Kruskal-Wallis H-Test is suitable for determining the difference in the opinion of three groups and above. In addition, the non-parametric nature of the data justifies the use of Kruskal-Wallis H-Test. Factor analysis (FA) using principal component analysis (PCA) with varimax rotation was used to analyse the data on the benefits of lean construction. The aim is to group the variables into manageable, cohesive proportion of different constructs. Prior to the actual FA, its suitability was justified by an examination of the communalities, Kaiser– Meyer–Olkin (KMO) and Bartlett test of sphericity. The use of FA is one of the gap identified from extant studies. Existing studies on lean construction utilised mean analysis, relative importance index (RII) and percentages in their analyses. The entire analysis is summarized in the flow chart below (Fig.1).

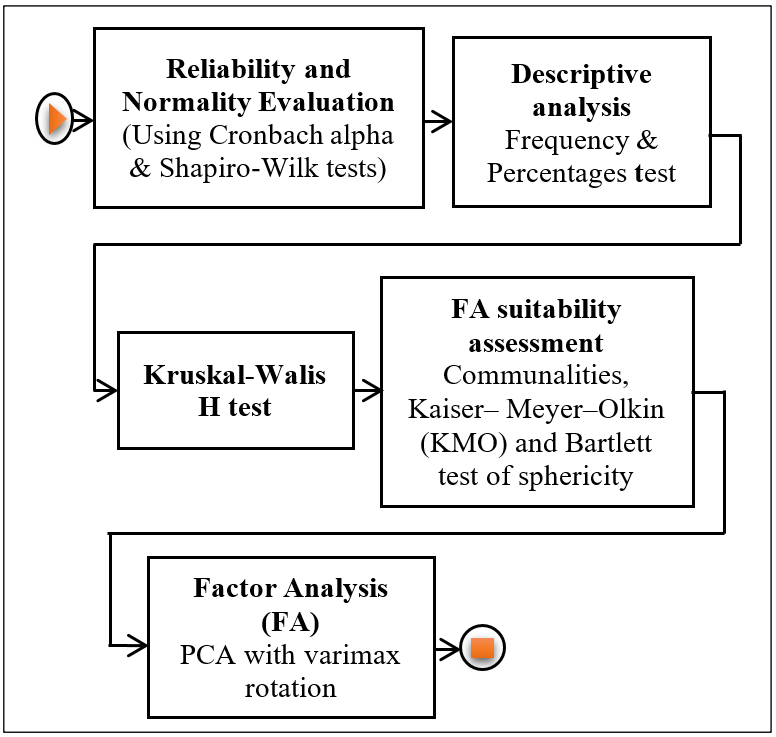

Figure 1: Data analysis flow chart.
Source: Authors, (2020).

IV. RESULTS AND DISCUSSIONS

IV.1 RESPONDENTS BASIC PERSONAL AND ORGANISATIONAL INFORMATION

Table 1 displayed the respondents' basic personal and organisational information. In terms of organisational ownership, 42.86% of those sampled are from the publicly owned organisations, and 57.14% are from the private sector organisation. This shows that the participant cut across the private and public sector organisations that have something to do with construction works. The states of operation of the organisations of the participants shows that 9.94% are in Akwa Ibom state, Bayelsa state (8.70%), Cross River state (16.77%), Delta state (24.22%), Edo state (18.01%, and Rivers state (22.36%). The participants profession are Architects (30.43%), Builders (13.66%), Engineers (Civil & services) (31.66%), and Quantity

Surveyors (24.22%). This shows that the key professions that form the bulk of the professional employees of construction organisations participated in the study. From their years of experiences in the industry, average years of experience are 13.48 years and this fell within the range 11-15years. This range is still the modal and median class. This period in the construction industry is enough to have gained enough experiences regarding the subject matter of this study. With regards to the educational qualification of the respondents, those with HND are 17.39%, PGD (13.04%), BSc./B.Tech (36.02%), MSc./M.Tech. (29.81%) and those with PhD are (3.73%). This shows that they are academically qualified to contribute meaningfully to the subject of this study. Finally, 91.30% of the respondents are corporate members of their various professional bodies. Only a few of them are still probationer members (8.70%) of their professional bodies. This further shows the quality and expertise possessed by the participants.

Table 1: Respondents Basic personal and Organisational information.

Variables	**Classification**	**Freq.**	**%**
Organizational ownership	Public organisation	69	42.86
	Private organisation	92	57.14
	TOTAL	**161**	**100.00**
States within the zone	Akwa Ibom	16	9.94
	Bayelsa	14	8.70
	Cross River	27	16.77
	Delta	39	24.22
	Edo	29	18.01
	Rivers	36	22.36
	TOTAL	**161**	**100.00**
Profession of construction professionals	Architect	49	30.43
	Builders	22	13.66
	Engineers (Civil & Services)	51	31.68
	Quantity Surveyors	39	24.22
	TOTAL	**161**	**100.00**
Years of experience	5-10years	49	30.43
	11-15 years	57	35.40
	16-20 years	31	19.25
	21-above	24	14.91
	TOTAL	**161**	**100.00**
Educational Qualification	Higher national Diploma (HND)	28	17.39
	Postgraduate Diploma (PGD)	21	13.04
	Bachelor of Science/technology (BSc./B.Tech)	58	36.02
	Master's Degree (MSc./M.Tech.)	48	29.81
	Doctorate degree (PhD)	6	3.73
	TOTAL	**161**	**100.00**
professional affiliation	Member Nigerian Institute of Architect (MNIA)	46	28.57
	Member Nigerian Institute of Builders (MNIOB)	19	11.80
	Member Nigerian Society of Engineers (MNSE)	47	29.19
	Member Nigerian Institute of Quantity Surveyors (MNIQS)	35	21.74
	Probationer	14	8.70
	TOTAL	**161**	**100.00**

Source: Authors, (2020).

IV.2 LEVEL OF AWARENESS OF THE LEAN CONSTRUCTION TECHNIQUES

Figure 2 shows the result of the analysis of the data collected on the level of awareness of the lean construction concept. With 40.99% of them indicating that the level is high, and 28.57% indicating very high, it can be said that the level of awareness of the lean concept within the south-south region of Nigeria, ranges from high to very high. Based on this, the awareness level for lean construction technique is better described as being high. The finding in this section is in line with studies of [13, 3, 12, 11]. The result is, however, not in line with the studies of [7, 33-35]. Notwithstanding that the level of awareness of the lean concept is high; it can further be deduced from Fig. 2 that the Nigerian construction organisations, regulatory agencies and construction professionals are not there yet, as more awareness creation needs to be carried out. The high awareness reported here could be attributed to years of experience of the participants. It is clear that, as one spend more time or age in a system, the more experiences and aware of trends they become.

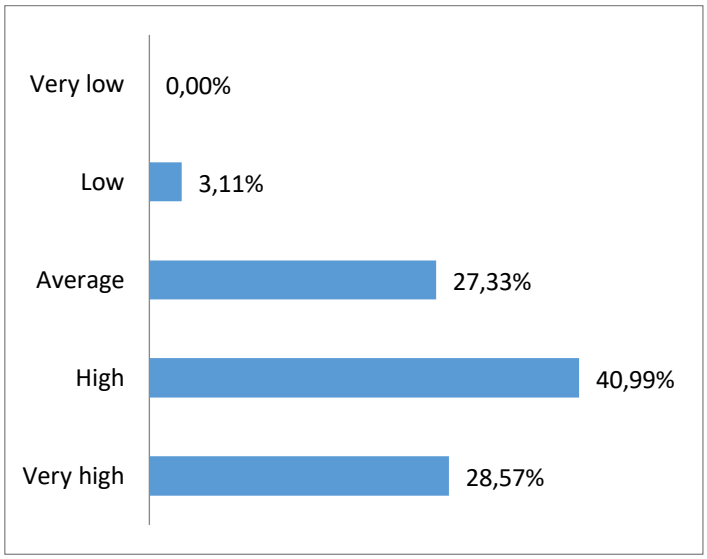

Figure 2: Level of awareness of the lean construction techniques.
Source: Authors, (2020).

IV.3 LEVEL OF ADOPTION OF LEAN CONCEPT ON CONSTRUCTION PROJECTS

On the level of adoption of lean concept on construction projects, the analysis of the participants responses shows that The level range from low (32.92%) to average (35.40%) (see fig 3). Appreciable adoption of the lean concept was however reported (high=23.60% and very high=4.95%). With a total of 71.43% (those who indicated very low to average), it can be said that the adoption level of lean construction on construction projects in Nigeria is low. This is similar to the reports from other climes. [29] and [30] in the UK, reported that there is a low implementation of lean constructions. [32] also reported that the lean concept familiarity and implementation in the Ghanaian construction industry is low. Even in the Moroccan construction industry, the level of implementation of lean construction is low as reported by [11]. [3] also reported a comparatively low level of adoption of lean construction among construction firms in Nigeria. However, in the USA and India, the situation is different as observed from the study of [31]. It was found that the USA and India have recorded successes in reducing waste and making profit from the actual implementation of the lean methods in construction projects. It is vital to stress that reaping of the full benefits of the lean construction principles comes with actual implementation by organisations and other stakeholders.

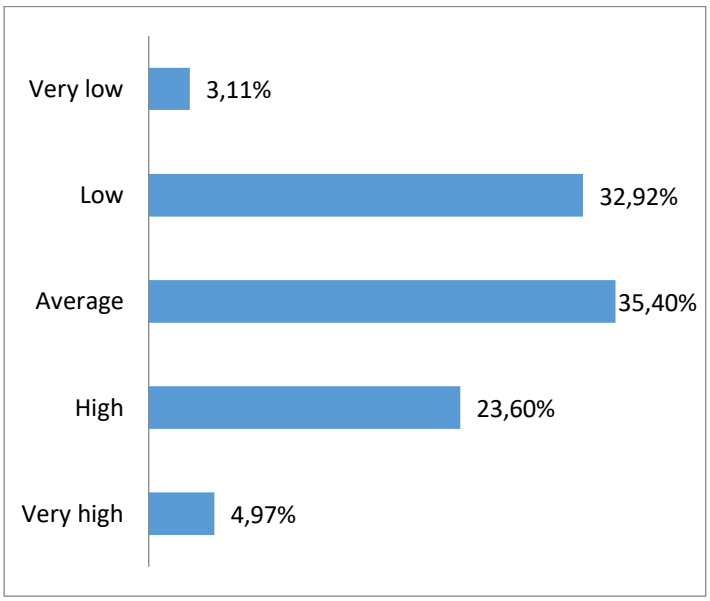

Figure 3: Level of adoption of lean concept on construction projects.
Source: Authors, (2020).

IV.4 AVAILABILITY OF DEDICATED LEAN TEAM/DEPARTMENT

Regarding whether the participants organisation have a dedicated lean team/department, result in Figure 4 shows that the majority of the organisations does not have a dedicated team/department responsible for lean related matters. However, 36% of them indicated that they do engage the services of consultants or advisers for lean related issues. This could be a pointer to why the implementation level is still low despite the high awareness level among organisations and the professionals. The high consultancy fees could also hamper the full-scale implementation of the lean concept in the study area and Nigeria at large. This is because the bulk of construction firms in the area are small and medium-sized.

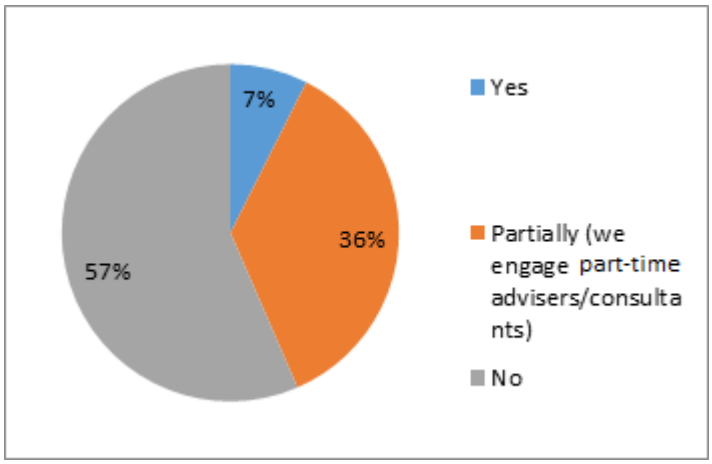

Figure 4: Availability of dedicated lean team/department
Source: Authors, (2020).

IV.5 BENEFITS OF LEAN CONSTRUCTION

There is the possibility of having some sort of difference in the rating style and perception of the assessed variables by the construction professionals from the different states within the study area. Kruskal-Wallis H-Test was conducted to identify the variables in which the views of the participants differ significantly and the proportion of the variables where the rating style is the same and /or differs. As can be seen in column 12 and 13 of Table 2, the pattern of rating on 27 of the variables is the same, and the p-value of these variables is greater than 0.05. These 27 variables represent 84.38% of the assessed variables. Based on the p-value of these variables, it can be said that there is a convergent perception by the professionals regarding them. This further means that there is agreement among the participants that lean construction is a panacea for poor performance of construction projects. The views of the participants was however divergent in 5 of the variables, as their p-value is lower than 0.05 significant level. These variables are; encourage collaboration, design improvement, better and smooth communication among parties, accelerate/improves project activities and delivery method, and greater predictability. These variables represent 15.63% of the assessed variables. These differences in perception maybe attributed to the varying level of understanding and awareness and implementation of the lean concept in the various organisations and projects.

The factor analysis (FA) is preceded by the determination of the factorability and suitability evaluation of the data for FA. From recommendations in extant literature, the sample size of 161 and number of variables of 41 are adequate for factor analysis [65-66]. With an average communalities value of 0.712 for the 41 variables, the sample size becomes meaningless in determining the factorability of variables [67]. Although, there is yet to be an agreement among academics and researchers regarding what should be the ideal number of variable for FA. Also, with the results obtained for the Kaiser– Meyer–Olkin (KMO) and Bartlett test of sphericity, it can be concluded that the gathered data are suitable and factorable. The KMO of 0.759 was obtained and it is higher than the threshold of 0.60 based on [66-69] submissions. Similarly, Bartlett test of sphericity of 0.000, df=820 was obtained, and this shows that it is significant at below 0.05 [66, 70].

Following the suitability and factorability evaluations, the FA executed using principal component analysis (PCA) with varimax rotation, nine factors were suitably retained since their eigenvalues are greater than 1, and they accounted for about 60.41% of the total cumulative variance (TCV). The TCV is higher than the threshold set by [66, 71-72], for adequate construct validity. Furthermore, A strong component structure is present when the factor loading on each component is greater or equal to 0.50 [73]. With this knowing, the rotated component matrix of the benefits of lean construction (Table 2), shows only that variables retained are those with factor loading ranging from 0.50 and above.

Considerations were given to the variable with the higher factor loading (FL) within a component structure, when name a component. In this study, the latent characteristics of other variables within the components where considered in naming components, and this is in addition to the factor with the higher loading other variables are considered. This is because [74] confirmed that the name of components in FA is influenced by the variables under the components.

Table 2: Rotated component matrix of the benefits of lean construction.

	Component									**K -W**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**X^2**	**Sig.**
Cost reduction /savings	0.804									2.532	0.623
Improved planning	0.728									6.783	0.079
Improve process control	0.594									6.763	0.08
Minimization of direct costs through effective project delivery management	0.538									7.088	0.136
Labour cost reduction	0.511									2.25	0.745
Value achievement/maximisation		0.8								6.718	0.079
Valuing relationships		0.698								1.833	0.766
Improved life-cycle cost		0.646								6.198	0.182
Encourage collaboration		0.59								12.09	0.007*
Improving the environmental performance			0.83							0.789	0.765
Reduction of the rate of work disruption (reduction of variations)			0.794							7.294	0.063
Risks minimisation and opportunities maximisation			0.679							1.058	0.787
Better quality performances				0.79						5.385	0.146
Design improvement				0.739						12.22	0.011*
Repeat patronage				0.609						4.249	0.236
Increase production efficiency				0.541						5.097	0.165
Improvement in employees motivation					0.773					2.971	0.572
Increased productivity					0.696					7.088	0.135
Better and smooth communication among parties					0.564					24.31	0.000*
Increased in company's revenue and profitability						0.773				3.278	0.351
Better market share						0.715				3.205	0.361
More sales						0.662				0.765	0.858
Maximise the use of multi-skilled workforce						0.501				2.982	0.394
Shorten construction time							0.793			2.248	0.523
Accelerate/ improves project activities and delivery method							0.556			27.51	0.000*
Increases client satisfaction							0.512			0.65	0.885
Waste reduction/elimination								0.728		4.033	0.412
Effective administration of materials on site								0.536		0.73	0.866
Reduction in idle time								0.528		3.723	0.293
Improve the health and safety on site									0.777	5.864	0.118
Reduced rework									0.765	6.503	0.09
Greater predictability									0.504	30.14	0.000*
Eigenvalues	6.09	3.84	3.36	2.64	2.15	1.92	1.73	1.65	1.39		
% of Variance	14.85	9.37	8.2	6.45	5.25	4.68	4.21	4.02	3.39		
Cumulative % of variance	14.85	24.21	32.41	38.86	44.11	48.79	53	57.02	60.41		
number of extracted variables	5	4	3	4	3	4	3	3	3		

Source: Authors, (2020).

*Sig=Pvalue<0.05; K-W= Kruskal-Walis H test.

IV.6 DISCUSSION OF EXTRACTED FACTORS

As can be seen in Table 2 above, the first component has 5 variables loading under it, and accounts for about 14.85% of the total variance explained. Based on the latent characteristics of these variables, this component was named '*cost related benefits'*. The variables are cost reduction/savings, improved planning, improve process control, minimization of direct costs through effective project delivery management, and labour cost reduction.

The second component has 4 variables which are; value achievement/maximisation, valuing relationships, improved life-cycle cost, and encourage collaboration; as the variables that loaded under it, and they accounted for 9.37% of the total variance explain. The component was named '*value and relationship benefits'* based on the features of the variables.

The third component is named '*environmental benefits'* and its account for 8.20% of the total variance explained and with 3 variables loading under it. These variable are; improving the environmental performance, reduction of the rate of work disruption (reduction of variations), and risks minimisation and opportunities maximisation.

The fourth component account for 6.45% of the total variance explained, and has 4 variables loaded under it. These variables are; better quality performances, design improvement,

repeat patronage, and increase production efficiency. A cursory look at these variables shows they are closely link to quality improvement. Based on this, the component was named '*quality improvement benefits*'.

The fifth component is named '*motivation and productivity benefits'.* This component has 3 variables loading under it, in addition to accounting for about 5.25% of the total variance. The variable loading under this component are; improvement in employees motivation, increased productivity, and better and smooth communication among parties.

The sixth component has 4 variables that accounts for 4.68% of the total variance explained. These variables are; increased in company's revenue and profitability, better market share, more sales, and maximise the use of multi-skilled workforce. These variables are closely related to company's profitability and market improvement, thus, this led to the naming of the components as '*profitability and market benefits'*.

The variables that are loaded under the seventh component are; shorten construction time, accelerate/ improves project activities and delivery method, and increases client satisfaction. This component accounts for 4.21% of the total variance explained and based on the characteristics of the variables, it was named '*time and work flow benefits'*.

The eighth component has 3 variables loading under it and accounted for about 4.02% of the total variance explained. The variables that are loaded under these components are; waste reduction/elimination, effective administration of materials on site, and reduction in idle time. A cursory look at these variables shows they are closely related to reduction in waste, and based on this, this component was named '*waste Reduction benefits'.*

The ninth component has 3 variables that loaded under it, and these variables are; improve the health and safety on site, reduced rework, and greater predictability. The component accounts for about 60.41% of the total cumulative per cent of variance. This component was subsequently named '*HS and Rework reduction benefits'*, following the examination of the characteristics of the variables.

The study revealed that the major benefits which made lean construction a panacea for poor construction project performance are; cost related benefits, value and relationship benefits, environmental benefits, quality improvement benefits, motivation and productivity benefits, profitability and market benefits, time and work flow benefits, waste reduction benefits, and HS and rework reduction benefits. The result of this study support findings from previous studies [19, 11, 44, 46, 17, 59]. [11] found that the major benefits of adopting lean construction approach in order of mean weighting are; better project quality, improving safety, improving the environmental performance, reducing overall project duration, and reducing construction cost. [19] found that lean constructions have considerable impact on cost savings, waste minimization, Jobsite safety improvement, reduced energy consumption, and customers' satisfaction improvement. According to [12] and [13], lean construction practice offers a value added technique for designing, managing, construction projects to improve time and workflow performance, efficient resource utilisation, waste elimination, with the overall maximisation of value for money for the clients.

The successful implementation of lean construction on construction projects on building and civil engineering projects, simple and complex projects, have shown impact on cost, time, quality, safety, waste, value addition, client satisfaction, disputes and claim reduction among others. [48] submitted that lean-based construction projects are managed better and easier, have better safety performance records, completed earlier than planned, cost less and have better quality performances. Seven points have been advanced to proof why lean concept must be adopted in construction. These points according to [46], are; continuous improvement in construction industry, focus on smart work through companies management rather than hard work by adopting strategic plans for future, reduces waste production in the field which is useful in increasing the profit, reduces the cost of the project, increase in customer satisfaction, better and smooth communication among parties and increases in productivity.

One of the three groups of benefits of implementing the lean concept identified by [31], is the strategic improvements benefits. Under this group lean techniques showed successes in helping organisations to improve their market share, time delivery of goods and services to customers are reduced, more sales, repeat patronage, increased in company's revenue, profit and cash flows [57]. [17] established that the benefits of lean construction to affordable housing projects are; increase the production efficiency, reducing losses, improved product quality and improving productivity, which produced a direct impact on time reduction, materials and labour savings and profitability.

Construction projects delivery are known to suffer from; time and cost overruns, poor quality, poor health and safety performance, and they have negative effects on the environment due to the volume of waste generated from demolition and rework [41, 20]. These problems lead to loss of profit of the contractors, loss of revenue by the client, abandonment, disputes and claims, amongst other issues. All these problems are overcome when lean construction techniques are implemented. Lean construction is thus, a panacea for the poor construction project performance.

V. CONCLUSION AND RECOMMENDATIONS

This study utilised a well-structured questionnaire distributed by hand and electronically, and the snowball sampling technique to assess the awareness level, adoption level and benefits of lean construction in the south-south region of Nigeria. With the purpose of determining the role of lean concept as a panacea for the poor construction project performance in Nigeria and by extension other developing countries, the data gathered from construction professionals in both the private and public organisations, led to some vital findings.

The study found that construction organisations do not have dedicated team or department for championing the use of lean techniques but engage consultants on part-time basis. Also, the level of awareness of lean construction is high but it s adoption is low. The major benefits which made lean construction a panacea for poor construction project performance are; cost related benefits, value and relationship benefits, environmental benefits, quality improvement benefits, motivation and productivity benefits, profitability and market benefits, time and work flow benefits, waste reduction benefits, and HS and rework reduction benefits. These benefits cover the key areas and issues of project performance determinants in the construction industry of developed and developing countries. Construction project cost, time, and quality are majorly the key indicators for a successful and well performed project. Contractors are responsible for the delivery of the finished project and the capability to meet client needs and expectations will add value to the project. Where this is achieved, there will be little or no disputes and claims. Without disputes and claim, every of the parties are satisfied. Judging from the benefits of lean construction found in this study, lean construction is the solution to: time overrun, cost overrun, lack of

value addition, disputes, landfill, poor quality, higher waste, lack of efficiency, lack of motivation, poor productivity, poor HS performance, rework, lesser market share, and loss of profit and revenue. Thus, lean construction is a panacea for the poor construction project performance.

To further encourage the implementation of lean construction for curing all construction project ills, the following recommendations were made for better project performance;

1. Government legislation on the implementation of lean concept on public projects is required, and this must be backed with adequate monitoring and enforcement.
2. Construction clients should engage lean construction contractors, and project managers should also engage professionals that are knowledgeable about the lean method. This is in a bit to take full advantage of the benefits therein, which cut across all the parties to the contract, the project and the environment.
3. Creation by organisations of special/dedicated department for the implementation of the lean concepts. This will further increase awareness level, improve familiarity and understanding of the concept.
4. In addition to other pre-qualification documents, tenderers should be made to produce evidence of 'lean performance' on previous projects. This will further improve awareness and adoption by contractors. Is it also another smart moves toward ensuring sustainability.

Knowing the benefits of lean construction to the adoption of the lean concept by construction organisations as part of the policies and culture in project delivery. The management of construction organisations will find this study useful in making decision towards uptake of lean method. Key players in the construction industry will adopt the findings of this study in making decisions regarding sustainability. This is because waste minimisation is targeted to environment, health and safety covers the social dimension of sustainability and cost, profit and the market covers the economic dimension. This study also add to the existing body of knowledge on lean construction in Nigeria and globally.

Although, the study showed how beneficial the lean construction techniques can be in areas of achieving sustainable construction and remedying ills of construction project delivery that affect project parties, its geographical boundary and sample size could limit the generalisation of the findings. Based on this, a similar study that will adopt interview in addition to questionnaire could be carried out in other geo-political zones or other developing countries in Africa with similar level of technology/construction methods. This will make data available for comparison. A study that will compare the role of sustainable construction and lean construction in the achievement of sustainability could be embarked upon.

VI. AUTHOR'S CONTRIBUTION

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