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Factors Affecting the Adoption of Lean Principles in Construction Waste Management in Bauchi Metropolis

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Abstract: *This study was conducted to assess the factors that affect the adoption of lean principles in construction waste management and possible solutions to avoid the obstacles of applying lean principles. Considering the high cost of materials and devaluation of naira in Nigeria couple with economic resin worldwide, it is obvious that waste management techniques most be adopted to maximize profit for continuous growth and development of the construction industry to compete favourably at the international scene. This study employed a survey research design with a population of 150 with a sample size of 108 obtained using Krejcie & Morgan table, (1970). The instrument of data collection was a questionnaire with a likert scale tag Lean Construction Management Questionnaire (LCMQ). Three research questions were raised and answered data were analyzed using mean and standard deviation. The Findings of this study revealed that Construction industries are not practicing lean construction waste management in the study area. Construction industries in the study area are aware of Lean Construction Waste Management principles. The barriers for the adoption of lean construction waste management is basically human attitude, educational aspect that include training the employees, and financial aspect which is one of the major problems militating any production and economic sector not in Nigeria but worldwide. Recommendations were made by the research based on the findings of the study.*

Keywords: *Lean principles, Lean barriers, Construction waste, Management.*

Introduction

In every production sector, it is obvious that waste cannot be avoided in totality. The level of waste is assumed to exist in construction industry. Formoso & Soibelman (2018).Wahab andNawal (2011), stated that a significant number of wastes in the construction industry has downgrade the overall performance and productivity of the industry and certain serious measures have to be taken to amend the situation (Aziz & Hafez, 2013). Poor projects delivery still remains a major problem in both developing and developed countries (Flyvbjerg *et al*. 2003). Construction projects are becoming more complex, critical and uncertainty (Winkler, 2010). Construction industry is varied and immensely involved with projects that exposed to an uncertainty which is found in design and planning; waste eventually emanates from design and

construction which occurs during planning, design, estimating, and of cause construction stage. Construction industry has been found to be a major generator of waste and the managing of construction waste has become an issue in the construction industry. However, in any way, the construction industry faces challenges in meeting project requirements and constrains due to the emerging trends of sustainable development, construction waste management has gained special attention as it focuses on preserving health and environment, minimizing the burden to future generations and converting resources. (Yuan *et al*. 2015).

Studies in various countries have confirmed that waste represents a relatively large percentage of production cost however it is difficult to systematically measure all wastes in construction. In pursuing the mission of sustainable development, many countries are working towards maintaining a balance between developing the built environment and protecting the natural environment (Al-Hajj & Hamani, 2016), this balance can be achieved by shifting from the traditional linear production process to a lean construction process. (Almoghany 2015),

Since early 1990's the Construction Research Community has been analyzing the possibility of applying principles of lean production to construction. The International Group for Lean Construction (GLC) has made significant contributions to the formulation of theoretical foundation of lean construction by hypothesizing the core concept of lean production and applying them to the management of construction processes. Koskela (1992) introduced the idea of understanding construction as production. Paez *et al*. (2005) indicated that the nature of operation, planning and execution are the key concepts that emphasize the differences between manufacturing and construction.

Thus, there are many fundamental principles that shaped the philosophy of lean construction emerged as consequence of tremendous impacts of lean production. Principles of lean production stem from Toyota Production System (TPS) (Howell, 1999). TPS Predominantly aims at minimizing all type of wastes in the production process while maximizing the quality of the end product which is defined as value techniques developed within TPS, to realize these purpose transferred to the waste as lean production. Lean construction aims to lessen any kind of wastes, such as inspection, transportation, waiting and materials in construction industry. Expansion of lean principles in construction is to produce unique value for the customer as it focuses on how value is generated rather than how individual activity is managed. This concept is particularly challenging for construction managers whose focus is too much on activities and task based methodologies rather than value streams.

To find a sustainable solution to construction waste management problem, the adoption of integrated construction industry waste management strategies and maintenance of sanitary landfills do really solve the problem (Alinaitwe, 2009). The latest of these was the Egan report, re-thinking construction, which was produced in 1998 to address concerns raised by clients engaging services of construction companies. In the Egan report which was designed to develop a change in the culture, style and management of the industry. The establishment of lean construction institute UK (LCI-UK) and some lean construction consultancy and promotional companies has also helped to enhanced the awareness of lean construction education which has been helpful in moving lean thinking into the mainstream of construction education. In view of these problems, this paper seeks to fills some of the gap in the literature by identifying the factors affecting the adoption of lean principles in construction waste management in Bauchi metropolis.

Statement of the Problem

Considering the high cost of materials and devaluation of Naira in Nigeria couple with economic resin worldwide, it is obvious that waste management techniques most implemented to maximize profit for continuous growth and development of the construction industries to compete favorably at the international scene. The Nigerian Construction Industry is consistently blamed of being wasteful, inefficient and falling short of quality and quantity targets, and being late in project delivery, (Abdelhamid, 2003). Studies in various countries clearly shown that waste has globally represents a relatively large percentage of production cost, project time delays and poor project delivery, this is clearly reflected in statistical and environmental reports in several countries. For example, about two (2) billion tons of waste is generated every year in European Union (EU) and its share of construction wastes is 31% Al-hajj & Hamani (2011). One hundred and seventy (170) million tons of waste is generated in the USA in 2003 and that 1,900 constructions and demolitions (C&D) landfills in the USA to receive disposed construction waste based on the report of the US Environmental Protection Agency (USEPA), (2003), this is the same in many counties of the world.

With the continues decline in profit margins and increasing competition in construction projects, Construction Contractors are continues searching for ways of eliminating wastes and increase their profits Many approaches have been made to improve effectiveness and efficiency of construction processes (Osmani, 2011) whereby lean construction offers the promise to minimize, if not completely eliminate non-value adding activities.

However, in any context, the construction industry faces challenges in meeting its project requirements. These challenges need a special developed treatment to come over them. To survive in a very competitive market like construction industry, it is essential for companies to improve the quality of their outcomes, increase work efficiency, minimize waste and expenses, and maximize profits. This is required to compete within the current global situation and the economic recession due to the emerging trends of sustainable development. With all these aims and purposes yet, lean construction faces many challenges that hinders the adoption of lean principles in construction waste management. In view of these problems, this research work seeks to identify the important factors that affects the adoption of lean principles in construction waste management with a view to enhances construction waste management in Bauchi metropolis.

Aim and Objectives of the Study

The aim of the study is to identify the factors affecting the adoption of lean principles in construction waste management in construction site in Bauchi metropolis with a view to enhance construction waste management on construction site. The specific objectives of the study were: -

I. To identify the current practice of construction waste management.
II. To assess the level of awareness of construction professionals on lean construction in construction waste management in Bauchi metropolis.
III. To formulate the barriers for adoption of lean principles in construction waste management in Bauchi metropolis.

Scope of the Study

All works in this research is limited only to some selected building construction Firms: Capital Cribs Nig. LTD, Homes Group Nig. LTD, ADC Turnkey Nig. LTD, Imabad Nig. LTD, MUK Building and Civil Engineering Construction Nig. LTD and A. A. Shafaa Construction Nig. LTD. The target respondents to the instrument for data collection are Architects, Quantity Surveyors, Builders, and other relevant professionals in the field of construction. The research will use building construction works carried out in Bauchi state as case study. This research will also focus on the applicability of lean construction principles and Identifying the potential barriers to the implementation of the lean construction principles which will minimize construction waste and improve project performance, enhance value for individual customers and have a positive impact on the national economy in order to achieve minimum cost in construction projects.

Significance of the Study

`This study will be of utmost importance to the Bauchi state government in policy formulation on landfills and attitudes towards lean construction in the study area. The study will also be of great significant to professionals involved in the design, conceptualization, construction and authorities concerned with decision making. This will give the professionals a good understanding of the lean principles concepts and measures to adopt to solve the identified problems. Construction industry players can also avoid and alert about how the waste was generated. Construction waste management is an aspect of sustainable development which is fuelled by the growing concern for the effect of man's activities on the construction environment. Also the outcome of the study would be useful to identify, work procedure, and re-design to eliminate waste in the field of operation, through identifying the importance causes of waste generation. The study will also add significantly to the existing literature gap by proposing a framework for eliminating construction waste in the study area.

Review of Literature

Construction Industry

Construction industry includes all civil engineering works and all types of new building projects as well as the maintenance and repairs of existing facilities (Gann & Salter, 2000). More so, Radosavljevic and Bennett (2012) define construction as series of activities undertaken by construction companies that produce or alter buildings and infrastructure. Therefore, construction simply means as any act of building or erecting structured products to prepared shape using appropriate resources and machineries. Previous researchers have also developed feasible public education foundation (PEF), designed with the sole purpose describing the applicable performance evaluation standards in construction projects. For instance, Zuraidi, Rahman and Akasah (2017) developed a framework for evaluating project performance in the construction industry, while Zuraidi *et al* (2017) developed a process performance framework (PPF) for use in the construction industry.

Despite their valuable insights, neither framework offers findings that are directly relatively the unique circumstances of skill development in Bauchi, specifically, the framework should facilitate communication between independent parties during the construction process, establish planning objectives and milestones, and serve as preventive mechanism for cost overrun and quality concerns. The author argued that such a framework can provide professionals with visible and defined parameters to evaluate project performance.

Zakaria, Syuhaida & Aminah (2012) identified construction industry as that sector which consists of housing, commercial and infrastructure development. Dania, Kehinde, and Bala (2007) defines construction industry as the subdivision of manufacture and trade based on the building, maintaining and repairing structures. Building and construction industry of erecting, analyzing, restricting, renovating, changing, demolishing, relocating, maintaining or repairing any form of building constructed whether on or off site (CSQ, 2012). The functions that construction has made it to be big, lively and difficult industry division that plays a vital in the nation economy. Building houses, places of works, markets and places of worships, roads and repairing and maintaining nation physical infrastructure are part of the functions of construction industry (Munir, Abdul Manan Z & Wan Alwi, 2012).

Construction Waste

Waste is a materials or products that is unwanted in any production sector. Waste can also be referred to product of human and industrial activity that has no residual value. Waste was defined by researchers in different ways in which it could be classified and recognized, excess materials, delays, rework and defects are some of those wastes commonly mentioned by researchers. Oladiran (2009), recommended a broader definition of waste to include not only material waste, but also waste generated in a construction project such as waiting times, transportation times, and setup time. This reveals the production of non-physical waste within the construction processes which is the basis of waste concept adopted by lean construction approach and by this research as well. According to Hafez (2013), a systematic attempt to identify waste in construction processes (flow wastes in lean thinking terms) has not been done by the construction management practitioners until the lean construction concept was introduced. Construction waste can be classified into four groups namely the physical waste, non-physical waste, direct waste, indirect waste and natural waste.

Physical Waste

Physical construction waste can be defined as a mixture ofnon-inert andinert materials arising from construction, excavation, renovation, demolition, roadwork and other construction-related activities as indicated by Al-Moghany (2007), Construction and demolition waste are generally defined as wastes which arises from construction, renovation and demolition activities including land excavation or formation, civil and building construction, site clearance, demolition activities, roadwork, and or building renovation. It can also refers to concrete debris, different types of bricks and blocks, various kinds of tiles, steel reinforcement, wood, plastic materials and paper, as well as gravel and soil. (Katz & Baum 2011).

Direct waste

According to Skyoles (2018), direct waste is any waste that can be prevented and which involves the actual loss or removal and replacement of material is called direct waste. Most of the times, the cost of direct waste do not end up in the cost of materials alone but followed with the cost of removing and disposing. Thus, by preventing direct waste straight forward financial benefits can be obtained. Direct waste can occur at any stage of the construction process on or before the delivery of materials to the site and after incorporating the materials at the building (Formoso et al 2017).

Indirect waste

Indirect waste could be any human activity that absorbs resources but creates no value, such as mistakes that require rectification, production of items no one wants, process steps that are not needed, unnecessary movement of employees, and people waiting for the conclusion of upstream activities. Ekanayake and Ofori (2000), describe waste as any inefficiency that results in the use of equipment, labour, materials and capital in larger quantities. In other words, waste in construction is not only occur in the quantity of waste of materials on-site, but also related to several activities such as overproduction, processing, waiting time, material handling, inventories and movement of workers across the construction units.

Natural Waste

Natural waste is the kind of waste that costs more than is saved if tried to prevent. There is a certain limit up to which waste of materials can be prevented. Beyond that limit, any action taken to prevent waste will not be viable, as the cost of saving will surpass the value of materials saved. Thus, natural waste is allowed in the tenders. The amount of natural waste is subjective to the cost effectiveness of the approaches used to manage it, the approaches vary from one scenario to another and so do the natural waste. For example, cost of preventing wastage in a project with a good material controlling policy will be lesser than that of a project, which lacks such a policy. Thus, the acceptable level of natural waste in the former situation will be lesser than of later (Formoso *et al*., 2017). Significant factors determine the sources of material waste in construction includes the following; frequent design changes; wrong material handling; effect of weather; poor planning; ordering errors of workers and or site condition and left over materials on site as described in previous topics.

Situation of Construction Waste in Nigeria

Material wastage has been a serious problem in construction industry which requires urgent attention in the Nigerian construction industry. This constraint harmfully affects the delivery of many projects (Adewuyi & Otali, 2013). Teo, Abdelnaser & Abdul (2009) observed that, extra construction materials are usually purchased due to material wastage during the construction process. Adewuyi & Otali (2013) argue that despite the 5 percent allowances made to take care of material wastage in the course of preparing an estimate for a project, this is usually inadequate because there is a lot more waste generated by construction projects in Nigeria. Babatunde (2012) emphasizes that the problem of construction material waste is well known in Nigeria but it seems not to be given the recognition or the attention it deserves. Similarly, Wahab & Lawal (2011) revealed that in the last decade, little attention has been paid to the management of waste generated in the Nigerian construction industry. This could be resulted as the low level of awareness of the construction workers, a low level of available means of waste disposal, or the slow adoption of environmentally sustainable practices. Akanni (2007) identified the contribution of various waste sources to material wastage on siteand found the following percentages: on-site storage 43percent, transportation and delivery to site 14percent, theft on site 14percent, incorrect specifications from the Architect 6percent, intro-site transportation 5percent, fixing and setting of materials 5percent, incorrect usage 5percent, conversion of waste 3 percent, carelessness of the workers 3percent,and administration and management 2 percent. Wahab & Lawal (2011) concluded that 85.72percentof the respondents in the Nigerian construction industry disclosed that a sorting exercise of the generated materials waste is not common on the

construction sites. Most of the material waste is sent to landfills without considering its economic importance through recycling or reprocessing into new products, which would reduce the burden on the landfill as well as the environmental effects (Wahab & Lawal, 2011).

The factor contributes significantly to construction material wastage in the Rivers State of Nigeria, as outlined by Adewuyi & Otali (2013) are: "rework as a result of non-compliance withdrawing sand specifications variation and modification in design; and "waste from inefficient and wasteful shapes" respectively. Insufficient construction materials waste was rated least among the factors. Adewuyi & Otali (2013) highlighted the fact that contractors and consultants have the same insight on the factors causing construction waste generation in the Delta state of Nigeria. In the view of Ameh & Itodo (2013), poor supervision of construction workers is the major factor contributing to material wastage in the Nigerian construction industry.

Management of Construction Waste

The practice of waste management for construction activities has been promoted with the aim of protecting the built environment and the recognition of waste from construction and demolition works which contributes significantly to the polluted environment (Shen *et al*, 2002, cited in Shen *et al*, 2004). This increases awareness of environmental impacts from construction wastes which has led to the development of waste management as an important function of construction project management (Shen *et al* 2004). There are several approaches to construction waste management. The process of managing construction waste goes far beyond the disposal of these wastes itself. It is an all-encompassing strategy to effectively utilizes construction resources, with the view to reducing these quantities of waste and also utilizing the generated waste in the most effective manner. The most common approach to management of construction waste is dumping in landfill sites.

However, decreasing landfill space has led to the increasing costs of landfill disposal to the contractor. Also, a relatively large amount of materials is being wasted because of poor material control on building sites (Poon, et al, 2004). This has prompted the need for alternatives for waste prevention and the initiatives to reduce, reuse and or recycle waste produced which are referred to as the three R's (3R's) of construction waste management. A waste hierarchy has been widely adopted as a guide for construction managers, in line with the principles of sustainable construction. The Waste hierarchy suggests that: The most effective environmental solution may often be to reduce the generation of waste. Where further reduction is not practicable, products and materials consume times be reused, either for the same or a different purpose. Failing that, value should be recovered from waste, through recycling, composting or energy recovery from waste. Only if none of these solutions is appropriate should waste be disposed of, using the best practicable environmental option.

According to Hafez (2013), there are two fundamental reasons for reducing, reusing and recycling waste: the economic advantages, and the environmental advantages. The environmental advantages include the minimization of the risk of immediate and future environmental pollution and harm to human health while the economic advantages include lower project costs, increased business patronage, lower risk of litigation regarding wastes among others. In view of these advantages and the negative impact of construction waste on successful project delivery causes of the position of construction firms and professionals in the Nigerian construction industry on

construction waste management and constraints to effective site waste management such as policy and legislative issues.

Lean concepts

The Lean Enterprise Institute defines Lean thinking as a systematic method for maximizing the customer value while minimizing waste. Simply, lean means creating more value for customers with fewer available resources. Lean was developed starting from the Ford Production System (FPS) which was utilized to collect autos. FPS was the premise for the Toyota Production System. Then, just in-time production philosophies joined with the Toyota Production System (TPS), which evolved into Lean with smart automation and some other factors, George & Alukal, (2003). Since the 1950s, after WWII, Lean production or TPS has been developed and implemented successfully by the Toyota Automotive Company. There are eight categories of waste in the lean concept according to Odomirak (2015). These types of waste have been described by Womack, James & Daniel T Jones, (2003, 1966) as:-Unnecessary Transportation:- Unnecessary movement of people, machines, goods or part between processes. Unnecessary Motion: - Unnecessary movement of people, machines, goods or parts within a process. Over / under Production: - Producing or receiving more than required. Waiting (waste generated by waiting for a process to be completed or process to start or between the processes). Excess Inventory (either for raw material or final products which have storing expenses without any value adding to the costumers or consumers). Over processing (processing more than required). Defects: - more defects result in extra time, costs and losses. Unused Creativity of Team Members:- This occur when a team loses time, ideas, skills, improvements and learning opportunity by not engaging or listening to employees.

Lean Construction is a concept which is derived from Lean principles for manufacturing and focuses on continuous improvement of work flow, increasing the value throughout the system and eliminating waste. Although the waste generated from construction is often immense, whether in terms of materials or time, and this concept can help companies reduce waste. Lean construction is not exploited efficiently in the construction industry. This study focused on assessing the factors that affects the adoption of lean principles in waste construction management in the local construction industry.

Lean Construction

Lean construction has been defined in several ways as the concept continues to evolve. The Construction Industry Institute (CII) defined lean construction as “the continuous process of eliminating waste, meeting or exceeding owner requirements, focusing on the entire value stream and pursuing perfection in the execution of a construction project.” Lean Principles in Construction Project Team, PT 191). As per Ahmed & Forbes (2011), Koskela (2002) described lean construction as “a way to design production systems to minimize waste of materials, time, and effort in order to generate the maximum possible amount of value for the customer both external and internal. According to Antillon, (2010), lean construction refers to the new application and adaptation of the underlying concepts and techniques of lean production as a new philosophy of production for construction. The industry has adapted this production model as a means for improving its performance and reducing the waste that tends to exists in the construction industry. Lean production focuses on the reduction of all waste, increase of value to the owners, and continuous improvement. Several of these lean productions concepts and

techniques have been successfully implemented in the construction industry from which effective lean construction tools, such as the Last Planner System, have been developed (Antillon, 2010). According to Ballard, & Howell, (2003), Lean construction aims to minimize waste and increase value, which affects the time, cost and materials. Lean Construction Improvement (LCI) puts it, "Lean Construction (LC) is a project management philosophy based on a set of approaches developed in production management and adapted for the project management. LC targets the objectives of a Lean Production system, maximizing value and minimizing waste". According to Salem& Zimmer lean construction is a continuous process to eliminate waste, marching customer requirements with a focus on the value stream map and pursuing perfection in the execution of construction projects Salem & Zimmer (2005). The activities within the construction industry can be divided into two major activities: conversion activities, which create a tangible value-added change, and flow activities, which connect the conversion activities. Although all the construction activities consume money and time, the lean philosophy insists that the conversion activities have a value-adding impact and so should be more efficient while the other non-value adding processes and activities should be removed or decreased. Koskela (2002).

Methodology

Survey research design was adopted for the study. Survey research design is a research procedure in which information is gathered from a sample for the purpose of making inferences about the population of interest. Specifically, the study adopted a cross-sectional survey research design in which data are collected at a particular time from a large sample for the purpose of describing the population represented by the sample at that particular time. This study covers a population of building construction professionals within Bauchi Metropolis, from which a sample were selected. The population of this study include the entire personnel of the construction industries in Bauchi state. The sample of the study was drawn from the entire skilled labour of the construction industries in Bauchi metropolis which are 150 professionals. The sample size was 108 according to the Krejcie & Morgan table, (1970). As cited by (Yusuf et al. 2018). The instrument for data collection for this study was a structured questionnaire which has been used as primary measuring instrument for the research. The questionnaire was designed to achieve the research objectives tag: Lean Construction Management Questionnaire (LCMQ). The instrument consisted of two sections, namely section a, bio data of the respondents and section B, consisting of the items to be responded to. A likert scale was used in the data collection instrument to collect the responds of the respondents. It is made of four scales. Namely, very high, high, moderate and fair which were scores as 4, 3, 2, and 1 respectively.

The instrument was trial tested in another response of Bauchi state using different construction companies as a pilot study with a reliability 0.78. After through validation process by the experts. This study collects data from professionals that are working under construction companies in Bauchi through physical infection, published data and questionnaire. The motive of the study was to find out the factors affecting the adoption of lean principles in construction waste management in Bauchi. Consultations with the management staff of the targeted construction companies were carried out after the permission was granted, the questionnaire was administered and retrieved for onward data analysis.

The research questions were answered using mean score (x) to answer the research questions. Real limit of the numbers were used to arrive at decision and it was determined using the mean

range as follows: real limit of numbers; 3.5 - 4.00 (Very high), 2.5 – 3.49 (High), 1.5 - 2.49 (Moderate) and 0.5 – 1.49 (Fair).

RESULTS

1. Current practice of construction waste management in Bauchi metropolis.

Table 1: Current Practice of Construction Waste Management in Bauchi metropolis

SN	ITEM	SD	MEAN RESPONDS	LEVEL
1	Reuse	38	1.89	Reject
2	Disposal	62	1.61	Reject
3	Treatment	21	1.99	Reject
4	Recovery	58	1.48	Reject
5	Recycling	42	1.93	Reject
6	Reduction	6	2.83	Accept
	GRAND MEAN		**1.96**	
			Moderate	

Source: Field survey, 2023

Table 1 revealed that the practice performed mostly on construction waste management in the study area is item 6, with mean score of 2.83, item 4 is fair while item 1, 2, 3, and 5 were moderate because they are less than the real limit of this study, (2.50) little practice of reuse and treatment.

2. The level of Awareness of Construction Professionals on Lean Construction in Construction Waste Management in Bauchi Metropolis.

Table 2: Level of Awareness of Construction Professionals on Lean Construction in Waste Management in Bauchi Metropolis

SN	ITEM	SD	MEAN RESPONDS	LEVEL
1	Decisions based on long term philosophy even at the expense of short-term financial goals (Philosophy);	59	1.49	Reject
2	Create continuous process flow to bring problems to the surface (Process);	4	2.85	Accept
3	Use ‘‘Pull’’ systems to avoid overproduction (Process);	17	2.64	Accept
4	Level out the workload (Process);	22	2.30	Reject
5	Build a culture of stopping to fix problems to get quality right the first time (Process);	8	2.65	Accept
6	Standardized tasks are the foundation for continuous improvement and employee empowerment (Process)c	4	2.78	Accept
7	Use visual control so no problems are hidden (Process);	50	1.93	Reject
8	Use only reliable, thoroughly tested technology that serves people and processes (Process);	7	2.47	Reject
9	develop exceptional people and teams who follow your company’s philosophy (People and partners);	7	2.77	Accept
10	Respect your extended network of partners and suppliers by challenging them and helping them improve (People and Partners);	6	3.07	Accept
11	Go and see for yourself to thoroughly understand the situation (Problem Solving);	11	2.68	Accept
12	Make decisions slowly by consensus, thoroughly considering all options; implement rapidly (Problem Solving); and	2	2.61	Accept
13	Become a learning organization through relentless reflection and continuous improvement (Problem Solving).	19	2.32	Reject
	GRAND MEAN		2.50	Accept

Source: Field survey, 2023

Table 2 revealed that item 1, 4, 7, 8 and 13 were below the real limit of acceptance. (1.49, 2.30, 1.93, 2.47, 2.32). Therefore, they were moderates based on the mean responds scores. While item 2, 3, 5, 6, 9, 10, 11, and 12, were above the real limit of 2.5. Therefore, they were high at the

mean of (2.85, 2.64, 2.65, 2.78, 2.77, 3.07, 2.68, and 2.61). The grand mean score was (2.51) indicating that the professionals in the construction industries are aware of the lean construction waste management system in practice but not knowing that the system is called lean construction.

3. Barriers for Adoption of Lean Principles n Construction Waste Management.

Table 3: Barriers for Adoption of Lean Principles in Construction Waste Management

SN	ITEM	SD	MEAN RESPONDS	DECISION
1	Managerial aspect: Lack of continuous support from top management,	25	2.29	Reject
2	Human attitude: attitude is the tendency regarding intent, commitment and co-operation	7	2.73	Accept
3	Educational aspect: Education and training the employees take effort and time.	7	2.58	Accept
4	Technical aspect: architectural designs were lack of construct ability elements due to the limited knowledge about construction practices.	33	2.14	Reject
5	Financial aspect: construction cost and poor salaries of professionals, inflation due to unsafe market	21	2.60	Accept
6	Government aspect: Frequent changes in government polices	59	1.51	Reject
7	Number of involve parties (Fragmentation).	38	2.26	Reject
	GRAND MEAN		2.30	REJECT

Source: Field survey, 2023

Table 3 revealed that item 2, 3, and 5 were accepted at (2.73, 2.58, and 2.60) because they are above the real limit of 2.50 respectively. On the other hand, item 1, 4, 5, and 6 are rejected (2.29, 2.14, 1.51 and 2.26) were rejected, because their mean scores are below the acceptance level of 2.50. The grand mean scores of responses revealed that a lot of barriers exist among the professionals in adopting lean principles in respect to waste management.

Discussion of Findings

This study was conducted to find out the factors affecting lean construction waste management in Bauchi metropolis. Based on the findings, the major lean construction waste management strategy practice in the study area is reduction in the provision of materials for construction purpose. Other lean practices like recycle, reuse, recovery and treatment were not adequately practices. Meanwhile the result of this study on lean construction strategy has contradicted the findings of (Osmani (2011, Adams, Johnson, Thornback, & Law 2011; Formoso, 2018, & Auckland City Council, 2018). This might be due to the lack of technological and attitudinal nature of the professionals in the construction industries in the study area.

Secondly, the awareness of mean score of construction professionals on lean construction in construction waste management in Bauchi metropolis is positive because of the responses provided which is 2.51 above the real accepting limit of 2.50. This is an indication that professionals in the construction industries are aware of lean construction waste management but with indifferent behavior of adopting the strategies. This findings is corroborating the results and guide lines of (Antillon, 2010). Furthermore, this study revealed that mean scores on barriers for adoption of lean principles on construction waste management in the study area partially reflect the findings of Aziz and Hafez (2013), and Formoso (2002). On areas like Managerial aspect: Lack of continuous support from top management, Technical aspect: architectural designs were lack of constructability elements due to the limited knowledge about construction practices, Government aspect: Frequent changes in government policies, number of involved parties and Fragmentation of construction flow of authorities was all rejected respectively. On the other hand, this study accepted that the major barriers for the adoption of lean construction waste management is basically human attitude which is the tendency regarding intent, commitment and cooperation.

Conclusion and Recommendation

Lean construction waste management strategy practiced in the study area is reduction of wastes at early commencement of each task; other lean practices like recycle, reuse, recovery and treatment were not adequately practices. Construction industries in the study area practice Lean Construction but not knowing it is called Lean Construction Waste Management. Barriers for the adoption of lean construction waste management is basically human attitude, educational aspect that include training of employees, and financial aspect which is one of the major problems militating any production and any economic sector not in Nigeria but worldwide. Finally, the driving factors for the adoption of lean principles in construction waste management include Increase process transparency, focus control on the process and Continues improvement of process.

Principles of lean construction waste management should be adopted in all construction industries to minimise loss of material, time and efforts. Positive development of attitudinal behaviours towards lean construction waste management should be adopted in all construction industries. Basic salaries, allowances and other remunerations should be provided to the employees for better work performance.

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