



**PLANT AND EQUIPMENT PROCUREMENT IN SELECTED TERTIARY INSTITUTIONS IN NORTH WESTERN NIGERIA: AN ANALYSIS OF LEAN AND AGILE PROCESS**

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**Abstract**

*The intense global competitive environment seeking efficient and effective operations has pushed management practices to be driven generally by economies of scale principles. In this regard, lean and agile methods are increasingly being adopted by both private sector practitioners as well as public institutions. The main objective of this study is to determine the applicability of lean and agile strategies in enhancing risk-reduced plant and equipment procurement in tertiary institutions in North Western Nigeria. The study employed a descriptive case study design and three research questions were formulated to identify the efficient metrics that affect procurement performance, through the implementation of lean and agile strategies designs. The study found that the diversity of the work involved in public procurement necessitates that procurement stakeholders need to be competent in generic procurement skills. The findings further support the fact that a lean and agile system will provide an efficient procurement of plant and equipment through the better supply chain, elimination of waste, minimising cost, increasing value for money and fitness for purpose which work toward a just-in-time process. It is recommended that there is the need to identify, assess and develop the competencies of procurement stakeholders in public procurement to ensure that procurement activities are efficient, compliant with regulations and obtaining value for money. Further recommendations are there is need to review Government policies on plants and equipment procurements in Nigeria with regard to direct procurements to improve value for money; Professional engineers should be involved in plant and equipment procurement as consultants to reduce cost and delay in completion, as well as to increase quality, improve risk control and management; creation of new procurement models that will enhance just-in-time delivery of projects and improve procurement process timelines; and in a situation where companies are faced with longer lead times, and demand is predictable, a lean strategy should strictly be applied.*

**Keywords:** Agile, Equipment, Lean, Plant, Procurement



## **1. Introduction**

The intense global competitive environment seeking efficient and effective operations has pushed management practices to be driven generally by economies of scale principles. Lean and agile methods presently considered the most efficient and effective delivery process, are increasingly being adopted by both private sector practitioners as well as public institutions. Leanness protocol eliminates the non-value adding activities while agility focuses on timeous market responsiveness. Lean and agile strategies are, therefore, being implemented across industries beyond the automobile where it has dominance, with great successes. Nonetheless, this resource management process is continuously evolving across the world and spreading through all production and service sectors of economies, to as remote as the procurement processes.

Thus, given the growing importance of lean and agile in business management, it emphasizes the need to evaluate its application to government establishments, especially in the procurement process given the quantum of registered wastes therein. Very relevant in this regard, is assessing its expected value-relevance to tertiary institutions. The Tertiary Institutions in Nigeria are of concern on our growth trajectory as they are places where large sums of monies and a lot of time are put into procurement. The *Daily Trust* (Abdallah N. M., 2018) analysis of both the Federal and 36State governments' investments on education in 2019 showed that N1.03 trillion (8.44 percent of budgetary allocation) was spent. On the other hand, collectively the 19 northern states budgeted to expend N361.13 billion on education from their total projected expenditure of NN2.5 trillion; making about 14 percent. The approved budget of the states in the north central alone is N101.71 billion or 14.86 percent of the totally approved budget. Also, according to the Vanguard Newspapers (2017), the Tertiary Education Trust Fund (TET Fund) has provided infrastructure development support to tertiary institutions of about N300 billion between 2011 and 2016.

However, there is no evidence of meeting the target needs of providing adequate facilities in the tertiary institutions in both the state and federal establishments. It could be argued, therefore, that most of the failure could be attributable to procurement processes, especially of plants and equipment. Procurement of plants and equipment in Nigeria, like most developing countries, has experienced a lot of financial wastages, delay in completion and specification related issues due to incompetency of some of the contractors and contracting authorities, which encourage corruption and other procurement related problems and abandonments (Bashek & Bisangabasajja, 2010; Mahmood, 2010).

Thus, proper plants and equipment procurement throughout history have been mostly neglected in Nigeria, and the fact that procurement is seen as a traditional business it has been very slow to adapt to changes. It is, however, necessary to study the market competitive trends to proffer solution(s) on how the procurement process would change. As plant and equipment procurements shape our institutions in providing quality research and graduates, researchers should, therefore, be interested in an optimal procurement process.

In this regard, the main objective of this study is to determine the applicability of lean and agile strategies in enhancing risk free plant and equipment procurement of plant and equipment in tertiary institutions in North Western Nigeria. Other objectives are to determine the factors that



would be enablers to achieve value for money; specifically: to establish the relationship between value for money, current procurement practice and lean and agile procurement strategies in tertiary institutions to determine variety of different ways of enhancing efficient plant and equipment procurement; to determine the relationship between the use of lean and agile procurement practice and value for money; to determine relationship between the value for money and plant and equipment procurement performance, and to determine the relationship between the value for money and the challenges of lean and agile plant and equipment procurement.

The study is, therefore, a survey of the opinion of stakeholders with a view of creating new procurement approach using lean and agile strategies to provide an optimal solution to the plant and equipment procurement problems in the tertiary institutions in Northern Nigeria. The regressed data is obtained from stakeholders within the selected tertiary institutions in the North West, Nigeria. The foci of the research are the adoption of lean in the enterprises' demand management, waste management and timeliness across the supply chain.

The scope of the research focused on evaluating the procurement processes, identifying the shortcomings of the tertiary institutions and development of a software for the procurement process to assist in the application of lean and agile strategies as the way forward to the plant and equipment procurement in tertiary institutions in the North West Nigeria.

## **2. Literature Review**

Lean originated from Toyota's production system – TPS (Liker, 2004; Womack, Jones & Roos, 2006) and was coined in late '80s by John Krafcik (Lean Enterprise Institute, 2009). However, the lean philosophy had been known in the Europe and America from the beginning of the 1980s consequent upon global competition within the automobile industry largely led by the Japanese growing corporations (Liker, 2004).

One strategy that was considered key in coordinating firms with the desire for achieving high efficiency, waste elimination as their core enablers on one hand, and those that have enablers as creating value in products in face of changes in the markets on the other, is the concept of lean and agile management (Womack & Jones, 1996). Consequently, Vonderembse and Koufteros (2006) highlighted on the strategies and methodologies for designing supply chains that meet specific customer expectations.

### *Lean and Agile Concepts*

Lean is defined as a systematic approach to production and services by identifying and eliminating wastes, keeping only value adding activities while not compromising product continuous improvement to increase market outreach (Bubzy, 2002). Thus, it is synonymous with creating more value for customers with minimal resources and at least cost, while minimising waste. The term "Lean" was first coined by MIT professors to put meaning to the Japan's new production system structured to eliminate mass production identified as the major source of waste (Conti, Angelis, Cooper, Faragher & Gill, 2006; Macduffie & Helper, 1997; Womack & Jones, 2003). Anand and Kodali (2008) and Womack and Jones (2003) classified waste into eight categories, viz-inappropriate processing, unnecessary motion, overproduction, unnecessary inventory, defects, waiting, excessive transportation and underemployment of employees.



So, lean as a philosophy, has connected activities based on tools and improved methods of operations strictly based on kaizen (continuous improvements) with high premium on people's value (Arnold & Chapman, 2004; Langley, Coyle, Gibson, Novack & Bardi, 2008; Liker, 2004). This emphasises that enterprises would work as systems rather than incoherent activities with the objective of maximisation of customer satisfaction at minimal waste (cost) (Arnold & Chapman, 2004; Lean Enterprise Institute, 2009). In the same manner Wu and Wee (2009) considered lean to mean a series of activities or solutions resulting in significant reduction in wastes and non-value added (NVA) operations, as well as improvement on value added (VA) activities.

To succeed in lean operations environment, it is necessary for a paradigm shift in the management thinking in order to move away from optimising separate resources in form of assets and technologies, as well as the vertical structure of its departments, to galvanizing the entire value streams flowing horizontally across resources, technologies, and department in optimising the flow of products and services (Lean Enterprise Institute, 2009). This way, waste would be eliminated along the entire value chain instead of at isolated activities thereby requiring less human resources, physical space, capital, and time. Goods and services would also be produced at reduced costs and with fewer defects, when compared with traditional business approach. Efficient information management would make companies to respond to changing customer tastes with variety of offerings of higher quality at lower prices.

On the other hand, an agile manufacturing system is seen as a strategy for profitable operations within a competitive environment that is facing incessant and unpredictable changing demands, seeking products redesigns and/or new offerings. The survival tactic in such volatile markets would require quick and effective response to the changing customer needs. Sharifi and Zhang (2001) viewed agility as comprising of two main factors: proper and timeous response to market changes, and exploiting the opportunities created by the changes. This means that agile concept's focus is on volatile demand through market knowledge to timely respond to market opportunities created by the unpredictable short run conditions. Tsourveloudis and Valavanis (2002) viewed the main capabilities of an agile production system to be the ability to easily change products or services offering without changes in investments.

The agile concept would, therefore, be flexible and responsive to changes in the supply chain process (Christopher, Aitken & Towill, 2002). The functional product is suited to applying the lean concept to its efficient supply chain as demand is predictable (Suzaki, 1987), while fashion products are suitable for application of the agile concept to responsive supply chain as demand is unpredictable (Mason-Jones, Naylor & Towill, 2000).

From the foregone, both agile and lean strategies have concern for customer responsiveness with lean pulled by customers in working a trade-off between inventory and long lead time. On the other hand, agile trades-off between time, information, and knowledge. In lean strategy, customers deal with specific products, while in agile strategy, customers are concerned with timeliness (Mchugh, Merli & Wheeler III, 1995). The total value received by the customer is the cost linked to leanness and the service delivered through agility (Christopher & Towill, 2000).



Cursorily, therefore, the concept of Lean is to develop a value system that would eliminate all wastes, including time element, while agility refers to leveraging market knowledge to increase market opportunities in a volatile marketplace (Purvis, Gosling & Naim, 2014; Sternberg *et al.*, 2013). Thus, lean and agile are characterised by waste elimination and market responsiveness, respectively. Earlier and consistent with this, Narasimhan *et al.* (2006) have reviewed the then existing literature on leanness and agility, proposing the following definitions:

*“Production is lean if it is accomplished with minimal waste due to unneeded operations, inefficient operations, or excessive buffering in operations; while production is agile if it efficiently changes operating states in response to uncertain and changing demands placed upon it.”*

In relation to this study, procurement as an enterprise, comprises all activities undertaken to acquire goods and services in accordance with requirements agreed with clients or as per the act of buying goods or services as simplified by Langley, Coyle, Gibson, Novack and Bardi (2008) and Weele (2002). In this way, procurement is a great determinant of revenues and costs that when effective; it could give a competitive advantage to any organisation (Langley *et al.*, 2008). Weele (2002) add value to this by stating that purchasing function has increased in scope through Supply Chain Management (SCM) which incorporates improved administrative activities and supplier development like imbibing the lean and agile culture.

#### *Lean and Agile Strategy*

High level of efficiency in service delivery is the goal of every enterprise that seeks to remain at the top of its market as a going concern. However, the intense competitive environment has made top-rate performance a moving target that requires an unending and high alert processes to seek improvement, as well as strategies to stay ahead of competition. One way to achieve this is application of the lean and agile paradigm. In this regard, and in a broader sense, the strategy is termed enterprising rather than paradigm, theory or method, because an enterprise represents a collection of business processes that are time-specific that when combined produce desired output (Narasimhan, Swink & Kim, 2006).

Both lean and agile processes are a collection of practices generally grouped into sub-practices used in facilitating measurement of waste or NVA and the market responsiveness over short run. Houshmand and Jamshidnezhad (2016) argued that lean is designed to execute three tasks: managerial role of operating system design, control of the operating system to be in tandem with set goals and providing leadership for continuous improvement of system.

A very important distinction between lean and agile operations according to McCullen and Towill (2017) is that agility is information based while leanness is inventory based. They argue further that good working relationship with suppliers, quality of employees, JIT production, and application of advanced technologies are important enablers of agile manufacturing.

An overlap between the two practices is obvious; hence the literature indicates chronological and/or dual relationships between lean and agile while keeping the key characteristic of each concept (McCullen & Towill, 2016). While McCullen and Towill (2017) suggests that agility can be a trigger for leanness, Hormozi (2001) reverses the chronology by suggesting that



achieving world-class performance is by sequencing agility after leanness is well established. Hassan and Sherif (2015) argued that Hormozi's (2001) position is dominant in the literature.

The application of these concepts is within a supply chain management framework - a system comprising material suppliers, production facilities, logistics and customers connected through inflow of materials and outflow of information (Mason-Jones, Naylor & Towill, 2000; Naylor, Naim & Berry, 1999). Hassan and Sherif (2015) stated that even though the lean and agile paradigms are distinct, organisations combine them to design world-class supply chain processes via a decoupling point, termed leagility. The leagility identifies decoupling points within the supply chain that segregates activities geared towards meeting customer orders from the activities that are pure planning. The type of leagility is a function of the position of the decoupling point in the supply chain, and Purvis and Gosling (2014) argued further that for successful leagility "leanness and agility cannot be employed at the same point in any supply chain. Lean should be applied upstream the decoupling point whereas agile should be applied downstream the decoupling point".

The key characteristics of lean and agile paradigm are waste elimination and market responsiveness respectively

*Waste elimination refers to reduce/cut the Non-Value Added (NVA) activities from the supply chain process. Market responsiveness includes reacting (sensitivity) and replying (flexibility, rapidness, and reliability) to the real demand volume and product types. Accordingly, lean is suitable when the customer demand is relatively stable and product variety is low while agile suits volatile demand and high product variety. (Purvis & Gosling, 2014, p. 478)*

This suggest that leanness calls for emphasis of make-to-stock operations, while agility is pro make-to-order operations, making it feasible for the two to be combined in assemble-to-order operations, operating leanness in the upstream of the customer order decoupling point for operations that are forecast-driven while agility occurs downstream for the operations that are customer order-driven.

Waste comes in three categories - obvious, less obvious and unobvious; example of obvious wastes are inventory level, unreliable or wrong equipment, inappropriate process, unneeded/inappropriate process, excess time and reworkings. Variabilities are the causes of less obvious wastes, such as in processing or delivery times, in yield or demand rates, as well as staffing levels (Mostafa, Dumrak & Soltan (2013). Lean technology when properly applied could eliminate the obvious wastes and cause significant reduction in the less obvious waste. For instance, it replaces inventory as expensive stock with capacity that is less expensive. Thus, according to Soltana and Mostafab (2015), lean operations generate improvement in performance with regard to cost efficiency, output quality, delivery timeliness and reliability.

#### *Applying Lean and Agile in the Procurement Task: Empirical Analysis*

This section discusses the empirical analysis of the nature of the procurement strategies corresponding to the supply options to which educational institutions in the North Western Nigeria could adopt as purchasing portfolio models. However, given the poor multi-disciplinary collaboration between Management and Engineering disciplines, there are limited



research in the area of engineering procurement projects in terms of developing model, approaches and techniques. It is expected that with global expansion of the influence of business school concepts, this would change. This research focused on improvements in major plant and equipment procurement in tertiary institutions.

The objective of procurement is the acquisition of resources- material and human, as well as services through mutual agreement with suppliers with intended high value achievement proposition. The principle of value in procurement is defined by customers' perception which is subjective and complex and supported by many researchers prevalent in lean construction procurement papers (Koskela, 2000). Value Management is critical in procurement discussions because it is a process where meeting requirements is the value for the customer (Bertelsen & Koskela, 2002). Ballard and Howell, (1998) stated that such values are achieved through a process of mutually beneficial negotiation between customers' ends and means. Lindfors, (2000) sees value as those products or services that result in increased benefits in form of profit, decrease time and cost, as well as improved quality for the company engaged in procurement negotiations. Hence, the focal point in this section's analysis is how to maximize the size of this value to the referenced institutions as they set out to procure goods and services.

Continuous improvement process in lean supply chain is aimed to eliminate waste or non-valued-added functions, achieving cost reduction, flexibility and aiming for external responsiveness (Aziz & Hafez 2013). Behrouzi and Wong (2011), stated that companies adopt time-specific competitive paradigm to achieve higher responsiveness and profitability, as well as justifying higher prices at points of improved services. In this regard, Hofer, Eroglu and Rossiter (2012) stated the requirement of the use of qualified professionals who have required expertise in lean procurement in order to establish a strong relationship between lean procurement team and supply chain.

A lean supply chain empowers organisations that seek to be cost efficient to more easily deliver better customer value in timely, as well as efficiently and predictably. Drake, Lee and Hussain (2013) argued that long-term relationship should determine agreement on both cost and quality. This manifested in the efficiency programs Toyota's Construction of Cost Competitiveness for the 21st Century (CCC21) developed with suppliers to improve cost and quality. Firms dealing with purchases in procurement relationships are built overtime to achieve such leverage. Such agreement could lead to standardization of components that would lead to holding stock levels and thereby significantly reduce operating costs; giving chance to increased economies of scale (Liker & Choi, 2004). This enhances chances for large quantities that further increases cost efficiency as well as quality of products (Monczka *et al.*, 2011).

In face of stable and predictable demand, a push production system is more appropriate than a pull system (Naylor *et al.*, 1999). The re-order point stock control method can be an effective method for managing globally sourced components in particular (Chandra & Grabis, 2004). On the other hand, and as discussed earlier, transactions that require flexibility and timeliness are suited to agile supply process. Again here, long-term close relationships should also be key to ensure continuous improvement of flexibility and timeliness. Christopher *et al.*, (2004) cited an instance where a local company networking with local suppliers, Zara and Benetton, was able to achieve high levels of flexibility. Monczka *et al.* (2011) also found that significant reduction



and reliability of delivery times is far more achieved by using local suppliers. Lysons and Farrington (2007) found that the attentive and responsive disposition of small suppliers, provide good sources for agile supply chain.

Finally, leagile supply chain occurs with products or services requiring combined enablers of both lean and agile (flexibility and time; quality and cost, respectively). Drake, Lee and Hussain (2013) argued that even though the cost and quality might not be as important as the flexibility and timeliness, reduced cost and improved quality would provide the leverage to keep market share. Drake, Lee and Hussain (2013) further stated that in adopting leagile supply strategy, organisations would evaluate which of the three methods would lead to achieving its objectives. To contextualize this, Bruce, Daly and Towers (2004) have stated that any supplies considering low-cost not minding longer delivery time, global suppliers would be adequate for lean supply; but when cost is not the issue, a fast and flexible local supplier should be ideal for agile supply.

### **3. Methodology**

A convenience sampling procedure was adopted in selecting the North Western tertiary institutions as true representation of the Nigerian population based on three facts: that there is generic guideline across the country for accessing such funds from Tertiary Education Trust Fund (TET Fund) where all procurement are similar but only would differ in application of the procurement process. Secondly, there is structural uniformity in tertiary institutions across the country's Universities, Polytechnics, and Colleges of Education. Lastly, the selection further considered the different regulatory bodies and academic programs the segmented samples are operating within. Therefore, the selection of the North Western institutions was based on proximity which allows for constant visitation required to source for data and the eased to update the relevant data. For adequacy, the data were collected based on the university, polytechnic, and college of education strata as follows:

2 universities	(Ahmadu Bello University, Zaria and Bayero University, Kano)
2 Polytechnics	(Kaduna Polytechnic, Kaduna and Kano Polytechnic, Kano)
2 colleges of education	Federal College of Education, Katsina and Federal College of Education, Zaria

The data collection was handled by using both semi and un-structured interviews where mainly the semi- structured questions guided the interviewees into giving relevant information.

### **4. Results**

#### *Descriptive Result*

As stated earlier, the main objective of the study among others is to determine the procurement portfolio model choice between three strategic decisions of the four-finite set of supply (procurement) options – lean, agile and leagile, excluding the non-strategic option. Other objectives are to determine the factors that would be enablers to achieve value for money. To achieve these, data were collected from 125 respondents and were analysed with the Statistical Package IBM 23 version. The frequencies of options and their means of each item were presented as well as their rank in terms of level of agreement among the items. The cumulative





means are compared with the standard mean of 3.0 to determine general response level whether in agreement or disagreement. Regression Analysis was used to determine the relationship between the dependent variable of Value for money and each of the other independent variables. The hypotheses were tested at 0.05 level of significance.

Table 1 presents the respondents' perception regarding the practice of the lean and agile strategies. in their various institutions. Out of the nine listed items, six of them turned out to be above the 3.0 threshold, indicating an overall satisfaction of practice assessment across board.

Table 1: Perception of respondents on the use of lean and agile procurement practice

Items	Response categories					Mean	Ranking
	VG	G	M	B	P		
Proper planning and need assessment	50	22	36	14	3	3.864	3
Supplier relationship management	7	102	10	4	2	4.632	1
Continuous improvement	107	5	4	3	6	3.176	6
Value stream analysis in procurement	10	9	102	1	3	2.024	7
Procurement models	18	7	12	11	77	1.208	9
e-procurement knowledge	0	1	0	23	101	1.904	8
Total Quality Management strategy	12	5	12	26	70	3.584	5
Value for money analysis	55	7	27	28	8	3.920	2
Fitness for purpose	5	110	7	1	2	3.816	4
Cumulative mean						3.125	

Note: Decision mean = 3.000

Source: Generated by the Authors

In specific terms, it shows that the use of the lean and agile procurement practice is good given the cumulative mean response of 3.816, which is above the decision/standard mean of 3.0. The Supplier relationship management turned out to be very good as this ranked first with the highest mean response of 4.632. On the other hand, the procurement models and e-procurement are rated very poor as these had the least mean of 1.208 and 1.904, respectively. This might be a good indication of rudimentary level of the implementation of the strategies because both require some significant levels of computerisation and knowledge which are very low in the institutions. In summary, the overall use of the lean and agile procurement practice is high, especially the supplier relationship management, even though the procurement models is very low.

Table 2 presents the respondents' perception about lean and agile performance in their institutions. Poor Except for item on proactivity that appeared with an average of 1.872, the level of satisfaction with the performance is very high with overall average of 4.242.

On individual statistics, Table 2 shows that Lean and agile procurement systems allow a procurement to not only be more efficient, but also faster and responsive, as this was rated first with mean of 5.000 as all the 125 respondents strongly agreed with this view. In the same vein Lean and agile create a good procurement satisfaction as this is rated second with a mean of 4.990.



Table 2: To what extent do you agree with the following statements in relation to lean and agile procurement performance in your institution?

Items	Response categories					Mean	Ranking
	SA	A	UD	D	SD		
Lean and agile deliveries are flexible; help procurement to meet changing demand between manufacturer and user	78	15	19	10	3	4.240	7
Lean and agile can help to minimise need assessment and planning time and expense	2	105	5	8	5	3.728	10
Lean and agile procurement reduces lead time	113	3	6	0	3	4.784	3
Lean and agile procurement reduce wastages in the procurement process	72	24	11	13	5	4.160	8
Lean and agile procurement systems allow a procurement to not only to be more efficient, but also faster and responsive	125	0	0	0	0	5.000	1
Lean and agile create a good procurement satisfaction	124	1	0	0	0	4.990	2
Lean and agile strategy reduced overall procurement cost	105	5	13	0	2	4.688	4
Lean and agile strategy give end-user satisfaction	78	44	3	0	0	4.600	5
Ease the procurement activities through new approach(software)	48	74	3	0	0	4.360	6
Ability to envisage problems and provide alternative solution	0	0	42	25	58	1.872	10
Cumulative mean						4.242	

Note: Decision mean = 3.000

Source: Generated by the Authors

In summary, lean and agile procurement performance in the institutions is generally high, especially as lean and agile procurement systems allow procurement to be more efficient, faster and responsive.

Change processes are generally difficult to happen seamless, as such it is relevant to find out how the respondents perceive transition from the traditional practice to lean and agile protocols.

As per Table 3, there is general agreement that the challenges toward the introduction of lean and agile procurement determine the challenges facing plant and equipment procurement in the institutions (with cumulative mean response of 4.034). Specifically, the greatest challenge is lack of support from suppliers, other stakeholders, top management with the highest mean agreement of 4.192. Another serious challenge, and which is highly significant for the growth and sustainability of the process, is the lack of skills and expertise generally within the institutions as it has exhibited a mean agreement of 4.184. Thus, this is consistent with the reported challenges towards the introduction of lean and agile in plant and equipment procurement in the institutions.



Table 3: To what extent does institution face the following challenges toward the introduction of lean and agile procurement determine the challenges facing plant and equipment procurement in your institutions?

Items	Response categories					Mean	Std.Err
	SA	A	UD	D	SD		
Lack of support from suppliers, stakeholders, top management	50	53	20	0	2	4.192	1
Resistant to change	54	41	15	13	2	4.056	4
Poor planning	47	49	19	0	10	3.984	5
Lack of adequate resources	50	42	16	14	3	3.976	6
Lack of skills and expertise	50	51	22	1	1	4.184	2
Lack of clarity of plant and equipment procurement waste	61	40	12	8	4	4.168	3
Lack of communication between stakeholders	49	40	20	5	11	3.888	7
Lack of enough research, which leads to poor procurement performance	55	25	24	10	11	3.824	8
Cumulative mean						4.034	

Note: Decision mean = 3.000

Source: Generated by the Authors

Table 4 below shows the rating level of the measures of plant and equipment procurement performance in the sampled organisations. The general level of rating measures is very low, given 2.261 as the cumulative mean which is below the 3.000 decision mean. On item by item, installation and training measure is very low as this had the least mean of 1.120 as all the 125 respondents rated this as bad or poor. In the same vein, waste reduction was rated very low as this measure had a very low mean of 1.240 as details showed that only 1 person rated this good

Table 4: How do you rate the following measures of plant and equipment procurement performance in your organisation?

Items	Response categories					Mean	Std.Err
	EX	G	M	B	P		
Customer satisfaction	0	0	6	20	99	1.256	6
Cost and flexibility	3	78	0	23	21	3.152	3
Waste reduction	0	1	3	21	100	1.240	7
Value for money	3	0	18	77	27	2.000	4
Fitness for purpose	3	0	18	13	91	1.488	5
Quick delivery	0	103	0	13	9	3.576	2
Installation and training	0	0	0	15	110	1.120	8
Process improvement	101	0	0	3	21	4.256	1
Cumulative mean						2.261	

Note: Decision mean = 3.000

Source: Generated by the Authors



while 3 rated it moderate and the rest 121 rated this poor. Also, customer satisfaction is very low as this had a mean response of 1.256 as details showed that while 6 rated this moderate the rest 119 rated this poor or bad. However, the process improvement measure was rated very high with a mean response of 4.256 as details showed that while 101 rated this excellent, the rest 24 rated this poor. Overall, therefore, level of rating measures of plant and equipment procurement performance in the institutions was very low. This indicates that some core enablers are weak in the process.

*Regression Analysis*

Turning on hypothesis testing, the major hypothesis states that there is no significant relationship between the value for money (dependent variable) and the independent variables. The regression analysis below showed that significant relationship exists between the value for money (dependent variable) and the independent variables of measures of plant procurement, challenges of lean procurement, use of procurement practices and the challenges of lean procurement. This is because the calculated p value of 0.001 is lower than the 0.05 alpha level of significance and the computed F value of 169.127 is higher than the 3.00 F critical value.

Table 5: Multiple Regression Analysis

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	1831.861	4	457.965		
Residual	324.939	120	2.708	169.127	0.001
Total	2156.800	124			

*Note: a Dependent Variable: VALUE\_FOR\_MONEY; b. Predictors: (Constant), measures of plant procurement equipment Performance, Challenges of lean agile procurement, Use of Lean Agile procurement Practices, Lean Agile Procurement performance*

*Source: Generated by the Authors*

The Model summary analysis showed that the relationship between the value for money and the independent t variables is very strong; this is because the computed R value of 0.922, the computed R square value of 0.849 and the Computed Adjusted R value of 0.844 are all higher than the 0.400 standard R. Therefore, the null hypothesis which states that there is no significant relationship between the value for money (dependent variable) and the independent variables, is hereby rejected.

Table 6: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	0.922 <sup>a</sup>	0.849	0.844	1.64555	0.849	169.127	4	120	0.000	1.410

*Note: a. Predictors: (Constant), measures of plant procurement equipment Performance, Challenges of lean and agile procurement; b. Use of Lean and Agile procurement Practices; c. Lean and Agile Procurement performance*

*Source: Generated by the Authors*



Results of the multiple regression analysis on the complete model showed that there is significant relationship among all the variables when related with Value for money. Reasons being that the computed p value of 0.000 is lower than the 0.05 alpha level and the computed F ratio value of 169.127 is higher than the 3.000 critical F value. In the same vein, the Regression value of 0.922, the computed R square value of 0.849 and computed Adjusted R square value of 0.849 are all higher than the 0.40 Standard Regression critical values.

Therefore, the null hypothesis which states that there is no significant multiple relationship between the dependent variable of value for money and all the other remaining variables is hereby rejected.

Table 7: Coefficient<sup>a</sup>

Model	Unstandardized Coefficients		Standardized Coefficients Beta	T	Sig.
	B	Std. Error			
(Constant)					
1 Use of Lean Agile procurement Practices	37.880	1.284	-.818	29.498	.000
1 Lean Agile Procurement performance	-0.879	.376	1.324	-2.337	.021
Challenges of lean agile procurement	1.401	.508	.116	2.756	.007
Measures of plant procurement equipment Performance	0.124	.217	.291	.572	.568
	0.308	.392		.785	.434

Note: a. Dependent Variable: VALUE\_FOR\_MONEY

Source: Generated by the Authors

Table 8: Case wise Diagnostics<sup>a</sup>

Case Number	Std. Residual	Value for Money	Predicted Value	Residual
17	5.800	77.00	67.4551	9.54487
18	5.193	76.00	67.4551	8.54487
22	3.977	74.00	67.4551	6.54487

Note: a. Dependent Variable: Value\_for\_money

Source: Generated by the Authors

Table 9: Residual statistics for multiple regression analysis

Variables	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	58.5999	77.9494	69.5600	3.84358	125
Residual	-3.45513	9.54487	.00000	1.61879	125
Std. Predicted Value	-2.852	2.183	.000	1.000	125
Std. Residual	-2.100	5.800	.000	.984	125

Note: a. Dependent Variable: VALUE\_FOR\_MONEY

Source: Generated by the Authors



*T-test analysis*

This analysis tested the difference in the respondents’ use of lean agile procurement practices, Lean Agile Procurement performance, Challenges of lean agile procurement, measures of plant procurement equipment Performance and Value for money.

Table 10: One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Use of Lean Agile procurement Practices	125	33.3200	3.88047	.34708
Lean Agile Procurement performance	125	33.2560	3.94090	.35249
Challenges of lean agile procurement	125	33.2480	3.91164	.34987
Measures of plant procurement equipment Performance	125	33.2880	3.94072	.35247
Value for money	125	69.5600	4.17056	.37303

Source: Generated by the Authors

Table 11: One-Sample Test

	T	Df	Sig. (2-tailed)	Test Value = 0		
				Mean Difference	95% Confidence Interval of the Difference	
				Lower	Upper	
Use of Lean Agile procurement Practices	96.001	124	0.000	33.32000	32.6330	34.0070
Lean Agile Procurement performance	94.347	124	0.000	33.25600	32.5583	33.9537
Challenges of lean agile procurement	95.030	124	0.000	33.24800	32.5555	33.9405
Measures of plant procurement equipment Performance	94.442	124	0.000	33.28800	32.5904	33.9856
VALUE_FOR_MONEY	186.475	124	0.000	69.56000	68.8217	70.2983

Source: Generated by the Authors

The above T test statistics table showed the significant differences in the level of respondents responses on the use of lean agile procurement practices, lean agile procurement performance, challenges of lean agile procurement, measures of plant procurement equipment performance and value for money. This is because the calculated p values of 0.000 in each of the aforementioned variables was lower than the 0.05 alpha level and the computed T values of 96.00, 94.34, 95.03, 94.64 and 186.007 respectively is each higher than t critical value of 19.96 at df 124. This implies that the respondents level of perception on their use of Lean Agile procurement Practices, Lean Agile Procurement performance, Challenges of lean agile procurement, measures of plant procurement equipment Performance and Value for money is significantly different. Hence the null hypothesis which states that there is no significant differences in the respondents’ Use of Lean Agile procurement Practices, Lean Agile



Procurement performance, Challenges of lean agile procurement, measures of plant procurement equipment Performance and Value for money, is hereby rejected.

### **5. Conclusions and Recommendations**

The result presented shows that there is general satisfaction across the institutions studied concerning lean and agile practice in their procurement processes. Respondents are happy with planning and need assessment processes, supplier relationship management, and value for money. The low rating of the procurement models applied, and application e-procurement might be an indication of need for improved computerisations, as well as engaging qualified personnel and training/retraining procurement officers to improve knowledge.

Challenges are high in the respondents' perception especially lack of management support and commitment, resistant to change, lack of clarity of what is waste and poor skills as well as expertise. Poor communication also featured as significant, and it is to be noted how effective communication is central to work culture maintenance and sharing in organisations that desire to be on top of their niche.

Generally, respondents are very well satisfied with the performance of lean and agile models in their environments; however, when they assessed the enablers on value for money in the process, they overall rated the items low. Of significance, their low perceptions on customer satisfaction, waste reduction, value for money, fitness for purpose and installation and training indicate the real need for improved operating structures.

On the other hand, the regression result shows good relationship between 'value for money' and the use of lean and agile methods in procurement processes. The model summary shows a strong relationship by showing that the computed values of the R, R square, Adjusted R are all greater than the standard R of 0.400. There is positive relationship between 'value for money' and performance of procurement systems as the model summary show that the computed R value, R square value, Adjusted R value are all greater than the standard R of 0.838. This indicates that the optimum value of money is derived at the optimum performance of the lean and agile system put in place with regard to procurement operations. The relationship between 'value for money' and the challenges of lean and agile plant and equipment procurement has been established by the model summary through the computed R value, R square value, Adjusted R value that are greater than the standard R of 0.838. Challenges such as lack of support and information sharing among procurement stakeholders, resistance to change, poor planning, lack of adequate resources, skill and expertise, lack of clarity of plant and equipment procurement waste, and the absence of continuous improvement through research and development was established to be among such challenges. There is significant relationship between the measures adopted for plant procurement of plant equipment and the Value for Money. This is because the calculated p value of 0.000 is lower than the 0.05 alpha level of significance and the computed F value.

Based on findings and analyses carried out in this research, it is strongly recommended that; there is the need to identify, assess and develop the competencies of procurement stakeholders in public procurement to ensure that procurement activities are efficient, compliant with regulations and obtaining value for money; there is need to review Government policies on plants and equipment procurements in Nigeria with regards to direct procurements if value for



money is to improve; professional engineers should be involved in plant and equipment procurement as consultants to reduce cost and delay in completion, as well as increase quality, improve risk control and management; creation of new procurement model that will enhance just-in-time delivery of projects and reduce procurement process timelines is required; and in a situation where companies are faced with longer lead times as the research project indicates and demand is predictable, a lean type approach is necessary.

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