The limitations and opportunities to use lean based continuous process management techniques in Nigerian manufacturing industries – a review

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Abstract
The philosophy governing mass production is still a dominant philosophy in industries situated in Nigeria. But, lean concept has long succeeded mass production in most developed economies. This review exposes the constraints and potential benefits of using lean techniques in the transformation of industries in Nigeria based on field experiences elsewhere, where those techniques were used. The review uses method of searching questions or keywords for gathering useful information on the subject at hand from different journals, conferences papers, professional articles, and student thesis, spanning over the period of 1988-2018. However, in evaluating the prospects of implementing lean concepts, the review identified a number of tested lean techniques for possible application in the process and non-process industries. There is suggestive evidence from the article review that no Nigerian small or even large-scale business enterprise is practicing lean. It is expected that transition from the traditional method of manufacturing to lean, if implemented with enabling techniques, will engender sustainable manufacturing and higher productivity for industries in Nigeria.

Key words: lean manufacturing, lean philosophy, lean opportunities, continuous improvement, process management, productivity.

1. Introduction
The manufacturing industry in Nigeria is characterized by high incidence of waste prone activities which are considered as non-value adding actions. The present Nigerian industries are established on traditional mass production principles and methods in which the building blocks are high stock levels in the supply chain (inventory keeping), overproduction, long waiting time of orders (huge cycle times), increase handling process, high work-in-process, rework, material movement and scrap(low material efficiencies). Another source of waste by the industries is incessant power outage resulting in idling of production capacity [1]. The existence of these activities in a production process constitutes a waste in the lean concept and indicates a gap for implementation of lean principles where necessary. The easiest of all wastes and the hardest to correct is the waste of time removing the non-value added wastes [2]. Time waste differs from material because wasted time does not litter the floor like wasted material [3], but has menacing effect on the whole production process. The wasteful activities predispose the industry to inefficiency in production operations and have been the bane of Nigerian manufacturing industries, making them uncompetitive in the global trend of trade and business. Lean system is a production method that emphasizes high quality, flexibility, time reduction and teamwork [4]. To be able to compete favourably with the global trend, many industries of the world have embraced the lean principles and the manufacturing industries in Nigeria cannot be an exception.

The origin of lean concept can be traced to the shop floor of the Japanese foremost auto manufacturers, the Toyota Motor Corporation in the 50s, [5, 6, 7] a feat achieved through innovative practices known then as the Toyota Production System (TPS). The lean manufacturing essentially, is a philosophy of identifying waste in a process and eliminating them, thereby adding value for the customer [8, 9]. Lean production represents a prime milestone in the evolution of manufacturing system [10]. The lean operations management design approach focused on the elimination of waste and excess from the tactical product flows at Toyota (the Toyota "seven wastes") and represented an alternative model to that of capital-intense mass production with its large batch sizes, dedicated assets and "hidden wastes" [11]. These innovations, it can be argued, resulted from scarcity of resources and intense domestic competition in the Japanese market for automobiles. The quest by organizations for cost effective and time efficient continuous improvements in their production systems led to the adaptation and the integration of lean thinking in manufacturing organizations.

Lean thinking has impact on different parts of a production system; however, few deserve special mention such as revolutionized organizational facilities layout, manufacturing strategy, process and production planning. This is
because they are the pillars of production capacity decision-making. The resulting values to the system are obtained in cost saving, quality of finished product and on-time delivery of products to customers. Taiichi Ohno, the founder of TPS summarized the management strategy this way; that, “all we are doing is looking at the timeline from the moment the customer gives us an order to the point when we collect the cash and we are reducing that timeline by removing the non-value-added wastes” [12]. In view of this, lean manufacturing became the main focus of most manufacturing industries in Japan, the United States and Europe, and later part of Asia. Apart from manufacturing, lean can be applied to the service sector [13] as well as the transactional flow processes [14]. Though, the lean production concept has spread to North America, Europe and Asia, the tenet of the concept is yet to be understood and applied in Nigeria.

1.1 Present Scenario of manufacturing industry in Nigeria

Industries in Nigeria face much more difficult operating environment today than thirty years ago and have become prone to “muda” tendencies. Muda is a lean term for waste in Japanese language. Then, the industries had better access to foreign exchange, power supply was reliable and ease of doing business was moderately conducive. The current situation is unfriendly, complex and adversely affects productivity by the day. Also, our industrialization policy is anchored to the philosophy of abundance of factors of production. Everybody is ready to observe that Nigeria has abundant population (human), energy resources and clement weather conditions. Paradoxically, major prestigious firms established on this philosophy are moribund. The question then is abundance of production factors a doom or boom to Nigeria? How does it encourage wastage in production operations? How do we reduce the burden industries in Nigeria carry on with production functions? However, to best knowledge of the authors, Nigerian manufacturing industries are yet to embrace the Lean production philosophy. In a study by [15], it is evident that no Nigerian small or even large scale business enterprise is practicing lean as its managerial principle, a trend which has kept the industries backward in and uncompetitive with the world trade. This trend has created a gap and there is necessity to address the limiting constraints in applying lean concepts in the industries in Nigeria. True to the philosophy of lean, there are prospects of effective manufacturing through lean techniques applications for these industries.

The main purpose of this work is therefore to expose the lean principles and methods for the possibility of applying them in industries situated in Nigeria. The main objective of this review is to highlight the limitations and prospects of using lean management techniques in those industries. It is certain that a comprehensive review of existing literature on application of lean techniques will not only create awareness among the manufacturing firms, but will also help highlight issues needing further academic research. The article review is hierarchically organized as follows: introduction is presented in section I. The methodology including the motivation for lean philosophy and definition of the lean concept were presented in section II. In section III, we treated results and discussion in the form of lean techniques in the literature and limitations to lean applications. Conclusion was presented in section IV.

2. Methodology

In order to achieve the objective, a comprehensive search of the literature to gather relevant information on the subject was carried out. For a fruitful search, the topic was broken into key words. Using searching questions about lean production concepts, the information on its implementation techniques from established knowledge database were accessed and evaluated. The key word search method allows for tracking related works in the domain area. Some of documents consulted include peer-reviewed journals, conference presentations, theses and professional articles, spreading over the period of 1988-2018.

2.1 The motivation for lean philosophy and Toyota Production systems

The origin of lean concept in Japan was motivated by the World War II and pioneered by Eiji Toyoda and Taiichi Ohno, both engineers at Toyota auto industry. Then, the Japanese realized that they required huge investment to rebuild their devastated facilities. The success story of TPS attracted attention as the Japanese discovered that Toyota could produce automobiles with lesser inventories, lesser investment, and lesser defects, with lesser human efforts [16]. This led to the rise of Japan to its current economic pre-eminence, as the largest auto industry in the world [17], as other Japanese companies copied this remarkable system which gave rise to high level improvement in investment in Japan and across the globe. This brought about the world focus on the Toyota Company and her production systems, the Toyota production systems (TPS). Nigeria had faced similar circumstance that compelled Japan to develop on TPS. The difference is that we did not utilize opportunities provided by the war situation.

2.2 Definition of Lean

In lean concept, lean manufacturing (LM) is used interchangeably with lean production (LP). Several scholars and practitioners have coined several definitions to leverage their ideas on what is lean. The ideas expressed by different authors could be looked at in the following perspective: a manufacturing paradigm [18, 19], a process or a set of
principle [20], a concept [21], a philosophy [12, 22, 23, 9], a production practice [24], a system [3, 25, 26], a model or a method [27, 28] of production as exemplified by the Japanese automobile production system. Despite the varied perception, the lean concept has been widely accepted by the entire world of manufacturing and scholars. Jaiprakash and Sangwan [16] carried out a literature review on definitions of lean with the intention to compile the scholarly definitions of lean manufacturing showing how the principles, objectives, and scope of the concept have changed overtime from 1988-2012. From the review, they compared the contemporary literature and concluded that there is no consensus on the definition of lean manufacturing among the authors. Womack et al. [20] defines Lean as a dynamic process of change driven by a systematic set of principles and best practices aimed at continuous improvement. Lean manufacturing combines the best features of both mass and craft production. Lean production can be defined as an alternative integrated production model because it combines distinctive tools, methods, and strategies in product development, supply management, and operations management into a coherent whole. Lean concept essentially is a philosophy which tends to look at the process of removing waste from a process [29]. From these vast thoughts or ideas expressed above, however, it can be seen that the authors believe lean is any managerial philosophy or principle that tend to guide a business operations towards eliminating waste; continuously improves a production process. As a concept, it ensures efficient organizational management thereby creating more value for its product from the customer’s perspective. It has been widely applied to a range of activities from discrete in automobile to rapid response service in supply chain management. Hence, it can be defined as a paradigm shift from the old production order of product or service conception, design, production and delivery.

### 2.3 The concept of Value Addition and Waste Reduction philosophy

The concept of lean seeks for perfection in a production line by simultaneously combining the just-in-time and value addition principles. Oko and Kang [9] have specified five steps to implementing lean known as the fundamental concept or principles of lean. The principles are encapsulated in: 1. Define value from the perspectives of the customer, 2. Identify the value stream, 3. Let value flow, 4. Schedule production using pull, and 5. Seek perfection through continuous improvements. These five steps form core principles of lean concept. Looking at the framework of the ‘value stream’ Womack and Jones [3] pointed out that there is a need to look at three critical activities of business namely product definition, information management and physical transformation for waste elements. Waste in this perspective means specifically any human activity which absorbs resources but creates no value (Womack et al., [20, 17, 30]).

The original Seven Wastes (Muda), as identified under the TPS and extended by [22], are categorized as follows in Table 1.

### Table 1: seven wastes identified under TPS

| s/n | Type of waste (Muda)                   | Description                                                                                       |
|-----|---------------------------------------|---------------------------------------------------------------------------------------------------|
| 1   | Overproduction Producing              | Producing items without a direct order from the customer, that is, producing more than is required, which could be as a result in poor flow of information |
| 2   | Unnecessary inventory                 | Excessive storage and delay of information or products, resulting in excess inventory, such as work in progress inventory (WIP) and storage of finished products inventory, leading to a high holding cost and poor customer service |
| 3   | Waiting                               | Long periods of inactivity of people, machines, products, resulting in long lead times             |
| 4   | Excessive transportation              | Excessive movement of people, material, products, resulting in wasted time and high cost           |
| 5   | Defects                               | Frequent errors in paperwork, material, final product quality problems, resulting in scrap and/or rework, as well as poor delivery performance |
| 6   | Ineffective Motion                    | Process is not well designed so that the operator will waste much more time for excess motions to handle the process |
| 7   | Inappropriate processing              | Means taking longer time or effort than needed to process a product; or responding to communications from customers caused mostly by using the wrong set of tools, procedures or systems |
| 8   | Under utilization                     | Employee’s unrevealed potential skills because of lack of motivation, inspiration or training.    |
For each waste, TPS provides a strategy to reduce or eliminate its effect on a process, thereby improving overall performance and quality. Therefore the following fundamental strategies were provided to combat waste such as,

- To provide predictability by creating stable processes and standardized tasks
- To avoid overproduction and waiting by creating flow and "pull"
- To ensure that quality is created and maintained in every part of the process
- To strive for continuous improvement by constantly challenging the current state [31].

In view of the popularity gained by lean concepts in the advanced economies, one is poised to question if there are enablers to lean success story? Apart from experts who ensure that technical decisions are synthesized and correlated with the constraints of the activity, there are practice toolkits to control and enable lean achieve its success - reduce variability, improve productivity, cost and increase productivity in an organization.

3. Result and discussions
3.1 The lean tools (enablers) applied in industry
A great misconception about lean production system is that it is a single point intervention tool for fixing existing problems. But, the article review has shown it to be a collection of dynamic learning tools (enablers) whose learning curves converge into process improvements, such as productivity and profitability. These enablers are integrated for use to keep an organization on continuous improvement. Tsigkas [32] depicts some benefits that can be attained for applying the lean principles; 1- improved quality of product, 2- Faster delivery time, improved visual management, enhancement of worker efficiency, improved efficiency of human resources, easier to manage work area, total company involvement, safer work environment and improved employee morale. (Mostafa et-al, [33] rather than providing any argument, provided a framework for understanding the evolution of lean not only as a concept, but also for its implementation and benefits within an organization, and pointed out areas for future research.

Several lean tools have been tested and found to be helpful when applied in industries as lean concept enablers, to bring about waste elimination and quality improvement to the process. Such tools include JIT, Kaizen, VSM, six sigma, 5S, quick changeover, automatic line stoppage, TPM, overall equipment effectiveness (OEE) etc. Certain Lean tools effectively help to improve quality such as work standardization, quality management programme, and statistical process control (SPC). Some of the tools are discussed in the following section.

3.1.1 Just In Time (JIT)

Just-in-time' is a management philosophy as well as a set of techniques for manufacturing [34, 35]. JIT originally refers to production of goods to meet customer demand exactly, in time, quality and quantity [36, 37]. JIT is an approach which seeks to eliminate all sources of waste in production activities by providing the right part at the right place at the right time [38]. JIT is now synonymous with producing at minimal waste with full devotion to quality. "Waste" taken in this context means time and resources as well as material losses. Elements of JIT include:

- Continuous improvement.
- Elimination of waste
- Good housekeeping - workplace cleanliness and organization.
- Set-up time reduction - increases flexibility and allows smaller batches. Ideal batch size is 1item
- Levelled / mixed production - to smooth the flow of products through the factory.
- Kanban - simple tools to 'pull' products and components through the process
- Jidoka (Autorotation) - providing machines with the autonomous capability to use judgment, so workers can do more useful things than standing watching them work.
- Andon (trouble lights) - to signal problems to initiate corrective action.

3.1.2 Kaizen elements

Kaizen is a Japanese term meaning continuous Improvement, as Kai means Change and Zen means Good. The Kaizen approach has resulted in huge and confirmed on-going improvements in Japanese firms. Hence, it cultivates a culture of continuous improvement where all employees are actively engaged in improving the company, that is a strategy where employees at all levels of a company work together proactively to achieve regular, incremental improvements to the manufacturing process. In a sense, it combines the collective talents within a company to create a powerful engine for improvement. Kaizen strategy is the start-point of the successful lean journey, which focuses on eliminating
waste and non-value added activities and improving productivity and quality [39]. The following five key elements can be considered to be fundamental to implementation of Kaizen [34].

- 1. Team work
- 2. Selection of activities or sections
- 3. Waste identifications
- 4. Improvement initiatives
- 5. Tool identifications

### 3.1. 3 Total Productive Maintenance

Total Productive Maintenance (TPM) is a holistic approach to equipment maintenance that strives to keep the machines in perfect operating conditions throughout the period of production. TPM has been developed on the basis of productive maintenance concepts and methodologies. This concept was first introduced by Nippon Denso Company Limited. of Japan, a supplier of Toyota Motor Company, Japan in the year 1971 [40]. In an efficient maintenance system, operators are involved in maintaining their own equipment, emphasizing proactive and preventive maintenance which lays a foundation for improved production so that there will be:

- Fewer or no breakdowns (down time)
- Efficient running condition
- Product errors of defects
- No accidents and therefore a safe working environment.

TPM is distinct from other maintenance models because its process is segregated into success factors. The success factors, also known as eight pillars including autonomous maintenance. The autonomous maintenance factor implementation will also significantly increase the production performance, employee morale and job satisfaction [41]. However, OEE is an important measurement in the application of TPM for assessing the performance of equipment; a practice rarely applied Nigerian industries. With effective application of TPM, manufacturers can meet the demands of modern manufacturing strategy such as JIT. Literature reveals that in process industries TPM and 5S are closely applied for efficient maintenance culture. According to Tourki [34], 5S programme is an integrated part of TPM.

### 3.1. 4 The 5S process

The 5s (derived from Japanese words) is one of the methods of determining an organization’s approach to its business, and to evaluate its workplace organizational capability as well as visual management standards. 5S engages people through the use of ‘Standards’ and ‘Discipline’. The 5s programme includes:

1. seiri (orderliness or sort out),
2. shitsuke (strengthen, discipline),
3. seiketsu (tidiness or cleanliness),
4. seiton (standardise) and
5. seiso (sustainability).

The 5S helps to incorporate an effective maintenance programme, which results in a positive impact on quality. For this reason, 5S is a commonly used lean tool in process industries [42].

### 3.1. 5 Overall Equipments Effectiveness (OEE)

OEE measures the percentage of planned production time that is truly productive. Many manufacturing lines are only 60% productive, meaning there are tremendous opportunities for improvement. It was developed to support TPM initiatives by accurately tracking progress towards achieving “perfect production” and also considered as the “best practices” metric that identifies the percentage of planned production time that is truly productive. An OEE score of 100% represents perfect production: manufacturing only good parts, as fast as possible, with no down time and therefore useful as both a benchmark and a baseline.

Since OEE helps focus on continuous improvement of the performance of industrial machinery by identifying those performance opportunities that will have the greatest impact to the bottom line, the lack of maintenance culture in our system frustrates its application.

### 3.1. 6 Six-sigma

Six-Sigma is a quality program that improves a customer’s experience, indicates lower costs, and builds better market leaders. Six-Sigma in many organizations simply means a measure of quality that strives for near perfection. It is a disciplined, data-driven approach and methodology for eliminating defects (driving toward six standard deviations between the mean and the nearest specification limit) in any process – from manufacturing to transactional and from
product to service [30, 29]. The fundamental objective of the Six Sigma methodology is the implementation of a measurement-based strategy that focuses on process improvement and variation reduction through the application of Six Sigma improvement projects. This is accomplished through the use of two Six Sigma sub-methodologies known as DMAIC process which stands for: Define, Measure, Analyze, Improve and Control). DMAIC is an improvement system for existing processes falling below specification and looking for incremental improvement.

3. 1. 7 Total Quality Management Technique

The total quality package of an organization is represented in total quality management strategy. It contains all the efforts of an organization concerning quality. TQM ingrains quality at the heart of customer satisfaction.

3. 1. 8 Work standardization

In process industries, several processes are carried out at a particular temperature and for a particular time such as heat treatment, mixing, separating or melting. Process variations can be associated with temperature and time changes induced by contingency factors which are minimized with work standardization and visual control. Work standardization operates hand-in-hand with Kaizen and involves a certain control of production preparation and process methods for a product of an enterprise. With standardization, the resulting products are simpler and easier to manufacture, often referred to as design for manufacturability [2], as it eliminates multiple production and process steps. Hence, product quality is enabled through standard procedures, in-process audits and qualified personnel.

3. 1. 9 Value Stream Mapping (VSM)

Value Stream Map (VSM) is a major tool that is used to achieve efficient utilization of the existing resources and assets through elimination of non-value added activities or waste in manufacturing process. Oztetmel [44] defined manufacturing system as the “integration of manufacturing functions such as design, process planning, quality assurance, storing and shipment, etc. The entire process can be visualized in a value stream map (VSM). VSM is a special type of flow chart that uses symbols known as “language of lean” to depict and improve the flow of inventory and information. It is an analytical tool that allows one to see and identify waste in the process, and plan to eliminate it [2]. The VSM usually includes people, tools technologies, physical facilities, communication channels, policies and procedures [45]. The purpose of a value stream map manufacturing process is to provide optimum value for the customer through a complete value creation process with minimum waste in design. Many organizations pursuing “lean” conversion have realized that improvement events alone are not enough, therefore the application of value stream mapping and analysis which strengthens its gain by providing vision and plans that connect all improvement activities.

3. 1. 10 Value Stream Map with Simulation

Value stream mapping (VSM) is deficient in some ways, such as efficient time management, its inability to detail dynamic behaviour of production processes and to encompass their complexity, have necessitated the use of simulation methods along with VSM. It has been analyzed by different scholars that simulation models are often developed to replicate the operation of an existing system, and that of a proposed system that modifies the existing design to an incorporated lean manufacturing shop floor principles [7]. Also, simulation approach is often used to reduce uncertainty and create consensus by visualizing dynamic process views for a given future state. Simulation is often believed to helps explore alternatives generated by different responses to those design questions and is capable of generating resource requirements and performance statistics whilst remaining flexible to specific organizational details. Different simulation packages are available which can be applied depending on the situation and approach, such as SIMUL8, WITNESS, Pro-MODEL, ARENA, etc [46].

3. 2 Distribution of reviewed papers according to type of industry

In the literature, there is preponderance of process industry cases. As the name implies, the process industry is characterized by the continuous flow of material from the point of feeding with raw materials to the point the finished products are turned out. Such industries have high demand for automation with less skilled workers who monitor the process from start to finish. These industries are associated with manufacturing processes such as mixing, separating, forming and chemical reaction, which are generally used to produce non-discrete materials [47]. In these industries, workers are segmented at various stages of manufacturing process at strategic areas to monitor the process of manufacturing most especially in case of problems arising like break downs. Industries that are involved in such manufacturing process includes chemical, food and beverage, pharmaceutical, steel, paper and pulp, rubber, plastics, textile, cement and many other types. But process industries such as cement, ceramics, paper and pulp, plastic, refinery and sugar only have a few studies carried out on them. However, the literature distribution as presented in table 2 suggests that lean has been tried in almost all types of industries but very few in manufacturing industries.

Table 2: distribution of article review in the literature

| s/n | Authors | Work carried out | Principles |
|-----|---------|-----------------|------------|
| 1   | Ohno 1988; Womack & Jones 1998; Tsigkas (2013) | describe some benefits that can be attained for applying the lean principles; 1- improved quality of product, 2- Faster delivery time, improved visual management. | Lean principles |
| 2 | Y.-H. Lian & H. Van Landeghem (2007)[43] | Introduces two new elements to the value stream mapping method. First, it describes how the value stream mapping paradigm can be adapted for use in simulation, introducing specially designed VSM objects. Also, the work presents a formal modeling method and its related database structure, that drives a generator which automatically yields a simulation model of the value stream map. |
|---|---|---|
| 3 | Lyons, A. C., K. Vidamour, R. Jain, M. Sutherland (2011) | This work showed that lean practices associated with the elimination of waste are consistently used for improving manufacturing performance throughout the taxonomy of process industries but practices associated with other lean principles are inconsistently applied. It further provided explanations on the appropriateness of lean thinking as a manufacturing philosophy and a strategy for improving manufacturing performance in process industry types. |
| 4 | P. A . Saleeshya & P. Raghuraram, N, Vamsi (2012)[48]. | Highlights some major tools and techniques which are applied for successful implementation of lean as highlighted in a radar diagram. Such tools are Value Stream Map (VSM), 5s, Kanban, Kaizenpoka-Yoka and visual control which they argued, when applied appropriately in a manufacturing process can bring about a positive change to value creation and through put. |
| 5 | Khalil, R. A., Stockton, D. J., Tourki T., Mukhongo L.M (2013) | Stated that Lean engineering is a proven method for reducing waste in a production process and increasing its efficiency a wide range of product and services industries. |
| 6 | Wei Xia, Jiwen Sun(2013) [49] | Describes a typical Value stream mapping (VSM) application enhanced by the discrete event simulation (DES) to a dedicated tubular manufacturing process which highlights process inefficiencies, transactional and communication mismatches, also guides improvement areas and used to reduce uncertainty and create consensus by visualizing dynamic process views. |
| 7 | Y. Tiamaz, N. Souissi (2017)[50]. | Present a classification of Lean models which aims to capture all the concepts and thus facilitate its implementation and allows the identification of the most relevant models according to several dimensions. From this perspective, a review is presented and an analysis of Lean models literature which proposes dimensions for the classification of the current proposals while respecting among others the axes of the Lean approach, the maturity of the models as well as their application domains. |
| 8 | Mitrogogos, K., K. Mohammed (2018) [51] | Argued that the high demand in market for quality products has pushed many organisation to embrace lean production to be competitive with the global market through improved production by the use of the appropriate tools and practices. |
| 9 | Peter Hines, Matthias Holweg, Nick Rich (2004) | Provided a framework for understanding the evolution of lean not only as a concept, but also its implementation and benefits within an organisation, and point out areas for future research and concluded that the distinction of lean thinking at the strategic level and lean production at the operational level is crucial to understanding lean as a whole in order to apply the right tools and strategies to provide customer value. Lean Implementation Frameworks |
| 10 | Sherif Mostafa et al (2013) | Stated that lean is an integrated socio-technical system comprising of managerial practices that can be applied to eliminate waste and reduce the variability of supplies. |
customers and internal resources and processes and contend that failure to manage lean implementation properly is often consolidated to poor mindset and inadequate understanding of the lean concept itself and proposed a framework to overcome the limitation.

11. Jaiprakash Bhamu and Kuldip Singh Sangwan (2014) provides a lean implementation framework, which considers the strengths and weaknesses of the present way of operation. The novelty of the proposal is that it provides easy to understand steps to be followed during lean implementation phases and self-assessment at critical milestones.

12. (Lyons et al. 2011). Investigates the lean tools which are most helpful in reducing waste and improving process through waste elimination such as: VSM, 5S, quick changeover, lot size reduction, automatic line stoppage, TPM, visual control and mistake proofing. Lean tools which effectively help to improve quality are work standardization, quality management programme, statistical process control (SPC) and zero defects.

13. Jimenez et al. (2012) provides an easy to understand steps to be followed during the lean implementation phases and self-assessment at critical milestones.

14. M. E. Nenni, L. Giushniano, L. Pilolo (2014) demonstrates the positive effects of lean management approach to increasing efficiency even in a pharmaceutical company which is subject to critical market issues and concludes that the company was able to increase efficiency steadily over a long run application of lean principles.

15. T. Bonavia, J. A. Marin (2014) examines the possibilities which await firms that switch to Lean Production. For this they can take advantage of a set of clearly defined practices for improving the efficiency of their production systems. Consequently, one expects some degree of implementation of Lean Production techniques in any sector that is subject to intense competition.

16. F. A. Abdulmalek, K. J. Rajgopal, Kim LaScala Needy (2016) demonstrates the positive effects of lean management approach to increasing efficiency even in a pharmaceutical company which is subject to critical market issues and concludes that the company was able to implement Lean Production techniques in any sector that is subject to intense competition.

17. Khalil, R. A., Stockton, D. J., Tourki T., Mukhongo L.M (2013) proposes a road map for implementation of lean in the process industries with emphases on the cement production.

18. Tahar Tourki (2010) proposed a road map for implementation of Lean in the process industries with emphases on the cement production.

As shown in Table 2, lean applications are primarily to industries situated in Asian, European and American continents, with growing proportion in Japan. The proportion of process industries is dominant in the overall applications. From Table 2, it can be seen that industries situated in Africa, particularly Nigerian work environment, either in process or jobbing/discrete industries, the researchers have not covered them. Therefore, the research gaps provide new vista of research opportunity to researchers from Africa to explore.

3.3 Major limitations to implementation of Lean concept in industries in Nigeria
3.3. 1 Non integration of the different factors of production into a network for the manufacturing sector

In Nigeria, the production factors are not integrated into a network to optimize profitability and productivity, as well as to ensure smooth running of operations and, in turn, keep a competitive edge for the industry. The most challenging source of discontinuity in the system is incessant power outage. In many cases, industries own their power infrastructure (design, build and operate), data does not transfer easily (freedom of information requests are censored), and sharing information through a database brings fear to workers as well as managers. This fosters opposition to the integration of vital production statistics to the sectoral database. The obstacle this poses to application of lean techniques is evident. Hence, to avail the benefits of lean for the manufacturing sector, a computer integrated production system is more of a technological necessity than an option.

3.3. 2 Need for cultural affinity for a serene and disciplined work environment

Culture has a role to play in the work ethics of a people. Owing to a lack of space and natural resources, the Japanese developed an aversion for waste. Therefore, their culture abhors anything which does not add value to a customer’s need. The lesson Nigeria should pick from Japan’s experience is that in the midst of abundance of resources wastage has no room.

3.3. 3 Incestuous human capacity development and capability gap

Nigeria lacks the right mix human resources to drive manufacturing activities. Onah et al, [56] argues that Nigeria suffers serious capacity gap, particularly in manufacturing sector. The national agency responsible for manpower planning is yet unable to come up with the ratio of engineers, technicians and craftsmen required for effective technological development in Nigeria. However, Fadahunsi [57] suggests a ratio of 1: 6: 60 against 1: 4: 16 respectively, being used for the 4th National Development Plan. The problem is becoming more complex with the on-going incestuous human capacity utilization in the manufacturing sector. This is a situation which only permits in breeding and non inflow of human capacity into the system. The result is a lingering skill or capability gap. Therefore, Nigerian manufacturing sector requires inflow of cognisant labour readily adaptable to lean techniques.

4. Conclusion

Majority of previous research work in product manufacturing in Nigeria has only focused on how firms satisfy product demand through mass production. The lean philosophy as it originated from Japanese in early 1950 was originally associated with the automobile manufacturing. However, the applications of lean thinking have spanned through the discrete, jobbing industries to process manufacturing and service industries today, helping them to achieve continuous improvements. However, with evolution of events and time, the lean principle was able to transform industries that diligently apply the techniques. But those previous researches have only focused on industries in Asia, Europe and America continents. This review paper attempts to demonstrate that the lean philosophy is not only limited to those areas but all organizations, including situated in Nigeria, can benefit from implementing lean thinking within their organization. The preceding statement is true when implemented holistically and bearing in mind the principles and approaches of minimizing all forms of non-value added activities. The literature reviews and ensued discussions have further proven the opportunities that are await organizations that explore lean practices. The research also attempts to convey the message to decision makers that the principles of lean can equally be applied in the continuous manufacturing industries in Nigeria, with due observation of necessary guidelines. The conviction from article review is that the philosophical underpinnings of the lean concept do adapt to any culture and work environment. Hence, lean techniques as the future of manufacturing management strategies should be explored in industries in Nigeria for their global competitiveness.

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