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Lean Production: A Frontier for Improving Performance of Oil and Gas Companies in Nigeria

Onyeizugbe Chinedu Uzochukwu* and Ike Felix Ossai

Department of Business Administration Nnamdi Azikiwe University Awka Anambra State Nigeria.

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Abstract

Dwindling oil prices and global recession have created new challenges and opportunities for oil and gas companies in Rivers state of Nigeria to ride out the storm and emerge stronger. The increasing customer's demand for high quality petroleum products and more flexibility all at lower costs have generated a new trend in the global oil industries. This can be mitigated by effective adoption of various production processes. The paper seeks to address how lean production system can improve the performance of these oil and gas companies. The study specifically identified the type of relationship that exists between cellular production as one of the strategies of lean production and service delivery of these companies. The study adopted correlation research design and research question was presented with deceptive statistics and hypothesis was tested with Pearson Product Moment Correlation. The finding revealed that there is a significant positive relationship between cellular production and service delivery of these companies. The study concludes that lean production can be used to resolve severe organizational performance problems in the oil and gas industry in Rivers State of Nigeria. The paper recommends that managements of these companies are encouraged to increase its resource commitment to staff training so as to develop skills and to update knowledge on lean production; internal customer and supplier relationship should be created in the process of this integrative process.

Keywords: Lean Production, Cellular Production, Performance, Service Delivery and General System Theory.

INTRODUCTION

Dwindling oil prices and global recession have created new challenges and opportunities for both upstream and downstream players to ride out the storm and emerge stronger. The increasing customers' demands for high quality petroleum products and more flexibility all at lower costs have generated a new trend in the global oil industries. Therefore securing a competitive edge in the current global competition is becoming increasingly difficult for the oil companies. Consequently many oil companies in Nigeria are finding it difficult to live up to their social responsibility as it is becoming tough for them to catch up with the current challenges. As stated by Ferdousi and Ahmed (2009), the key to competing in the current global market is to simultaneously improve both quality and productivity on continual basis. Abdulmalek and Rajgopol (2007) reported that Lean Manufacturing (LM) is one of the initiatives that many businesses in the United States have been trying to adopt to remain competitive in an increasingly intensive global market. Lean production, a Japanese concept, is a production philosophy which shortens the time line between the customer's order and shipment through the elimination of waste and adoption of continuous improvement in the production system. The time line between the customer's

Corresponding Author Email: edu_phd@yahoo.com

order and shipment is often called production lead time (PLT) which is now a very important performance objective for the manufacturers in a fully competitive market.

Womack and Jones (2003) posit that LM implementation is grounded in five principles. The principles are specifying value from the customer's perspectives, identifying the value stream, creating the flow, introducing pull system and working towards perfection. The chief benefits of LM implantation include the use of fewer resources, rapid and efficient product development cycle, lower work in process inventories, smaller floor space requirements, higher throughout and greater flexibility. Due to the gains of LM implementation, manufacturers in many different business sectors and in many countries across the world have invested in the implementation of lean manufacturing practices. For example Royce Rolls, Jagular and Toyota have secured strong competitive advantages in their respective competitive industries through the adoption of LM principles. To date, most Nigerian oil companies are yet to embrace fully the lean concept thus retarding in adjusting themselves to dwindling oil prices. Pose, Derose, Rahman and Nordin (2011) list more than hundred LM practices available and being practiced by industries. Due to the incapability to implement all practices at once, seventeen LM principles are considered feasible for oil companies. The feasible LM tools include Values Stream Mapping (VSM), Total Quality Management (TQM), Just in Time (JIT) practice, Total Production Maintenance (TPM), Visual Management (VM), Staff Training (ST), Team Work (TW), Supplier Management (SM), Quality Circles or Kaizen, Small Lot Size Production (SLSP), Daily Schedule Adherence (DSA), Single Minute Exchange of Die (SMED) or reduced set-up time, Cellular Production (CP), Equipment layout (EL), Standard Operation Procedure (SOP) and Kaban Pull System (KPS). Since LM implementation is a continuous process, oil companies in Nigeria can sequentially run the feasible practices starting from the easiest or cheapest lean practice.

Oil companies in Nigeria can gain competitive advantage from lean production practices. Such practices enable the organizations to get superior performance through reduction of wastes and other related costs (Ohno, 2008). Oil companies are experiencing a problem of broad production this resulting to lots of wastage like what is experienced in oil spillage and gas flaring. This has seen many of the companies experience problems of waste along the supply chain and the liability to make the right products for customer satisfaction. Managers are bound to embrace the essence of adopting lean production which is a business initiative to reduce waste. The initiative leverage companies to achieve long term competitive advantages by putting in place the proper production systems and technologies practically with regard to product quality, shortening product design time, production of wastage, improving customer satisfaction and inventory management.

The general objective of the study is to ascertain how lean production affects performance of oil companies in Nigeria. The study specifically seeks to identify the extent to which cellular production affects service delivery of the selected oil companies.

Review of Related Literature

Lean Production

Lean production is a systematic method for the elimination of waste within a production system. Lean also takes into account waste created through overburden and waste created through unevenness in workloads.

Lean production is a management philology derived mostly from the Toyota production system (TPS) and identified as lean in the 1990's. TPS is renowned for its focus on reduction of the original Toyota seven wastes to improve overall customer value. The steady growth of Toyota, from a small company to the world's largest automaker has focused attention on how it has achieved its success(Bailey, 2008).Lean production refers to a business model that emphasizes on meeting customers' expectations by delivering quality products at the least cost when required. The lean Aerospace Initiative (2002) has defined lean thinking as the dynamic, knowledge driven and customer focused process through which all people in a defined enterprise continuously eliminate waste with the goal of creating value. Bruce and Larco (1999) posit that lean is both a concept that can be viewed and implemented at a number of level and also a commitment process of relentless improvement that can significantly impact upon an organizations' health, wealth and competiveness.

James and Daniel (1996) state that lean can resolve severe organizational problems and additionally can be a powerful approach to gather and unite several change initiatives that are running through. Most organizations pursue lean production in response to their need to fundamentally improve business competiveness by reducing costs while increasing quality and customer responsiveness including meeting delivery time.

Lean production techniques provide one of the most significant methods to improve overall business performance in the upstream and downstream oil and gas business. These techniques are applicable to drilling/completion operations, production/maintenance, operations and facilities construction as well as the suppliers (drilling contractors, service companies, construction companies) businesses that support these operations.

Key Approaches to Successful Lean Production

The key approaches are:

1). The production coy has to be fact based and not just rely on rhetoric about the improvements to be gained.
2). The company has to be willing to share information at a very detailed level to help the suppliers see the savings potential.
3). The coy has to demonstrate a commitment to the long term with its implementation of the lean strategies. Most importantly, the coy has to give its supplier's support in terms of training and troubleshooting.
4). Finally the coy should demonstrate the potential benefits of lean not only for their own coy but also for all their suppliers.

Mustapha Ageh, Maduekwe and Ojulari (2014) identify five principles of lean implementation as:

Identify and specify value from the stand point of the end customer.

1). Identify all the steps in the value stream and eliminate whenever possible those steps that do not create value.
2). Make the value-creating steps occur in tight sequence so the product will flow smoothly toward the customer.
3). As flow is introduced, let customers pull value from the next upstream activity.
4). As value is specified, value streams are identified, wasted steps are removed, and flow and pull are introduced, seek perfection of the process through continuous improvement.

Possible Gains of Lean Production

Altekat (2005) posits that establishment and mastering of lean production system would allow the firms to achieve the following benefits:

1). Waste reduction by 80%.
2). Production cost reduction by 50%.
3). Manufacturing cycles time decreased by 50%.
4).Labour reduced by 50% while maintaining or increasing throughout.
5). Inventory reduction by 80% while increasing customer service levels.
6). Capacity in current facilities increase by 50%.
7). Higher quality, higher profits.
8). Higher system flexibility in reacting to changes in requirements improved.

However, by continually focusing on waste reduction, there are truly no end to the benefits that can be achieved.

Common Key Performance Indicators of Oil Companies in Nigeria

A key performance indicator (KPI) is a measurable value that is intended to show how well a business is adhering to its business model and strategies. The data related KPI help to guide discussion and strategic decision making on lean production. Oil Coys in Nigeria focus on performance indicators such as total shareholder return, net operating cash, project delivery, and production available for sale, and refinery and chemical plant availability.

The study focused on project or service delivery as a performance indicator. This is because services are becoming increasingly important in the petroleum sector as the industry is facing increased competition. These services are based on specialized knowledge or technology or a combination of both. The development of excellent customer relationship or service delivery entails adopting production principles.Services is deeds, processes and performances. Deeds are activities designed to solve problems for customers. Lean production processes are identified approaches used to carry out these deeds as performance relates to service quality and customer satisfaction

Cellular Production

Cellular production is a process of production which is an aspect of just- in–time production and lean production encompassing group technology. The goal of this production is to move as quickly as possible, makes a wide variety of similar products, while making as little waste as possible. Cellular production involves the use of multiple "cells" in an assembly line fashion. Each of these cells is composed of one or multiple different machines which accomplish a certain task. The product moves from one cell to the next, each station completing part of the manufacturing process. The most frequently used machines in a cell include lathes, milling machines, drill presses, etc.
Often the cells are arranged in a "U" shape design because this allows for the overseer to move less and have the ability to more readily watch over the entire process. One of the biggest gains of cellular production is the amount of flexibility that it has. Since most of the machines are automatic, simple changes can be made very rapidly. This allows for a variety of scaling for a product, minor changes to the overall design, and in extreme cases entirely changing the overall design. These changes, although tedious,, can be accomplished extremely quickly and precisely (Likert, 2004).
A cell is created by consolidating the processes required to create a specific output, such as a part or a set of instructions. These cells allow for the reduction of

extraneous steps in the process of creating the specific output, and facilitate quick identification of problems and encourage communication of employees within the cell in order to resolve issues that arise quickly. Once implemented, cellular production has been said to reliably create massive gains in productivity and quality while simultaneously reducing the amount of inventory, space and lead time required to create a product. It is for this reason that the one- piece – flow cell has been called "the ultimate in lean production" (Likert, 2004).

Implementation Process of Cellular Production

A wide variety of methods for the implementation of cellular production have been proposed. These range from complex computer and mathematical models to straight forward operations, such as production flow analysis. The first step in implementing cellular production is to break down the various items produced by the organization into a member of part sets or families. The grouping process (group technology) involves identifying items with similarities in design characteristics or manufacturing characteristics, and grouping them into part families. Design characteristics include size, shape and function; manufacturing characteristics or process characteristics are based on the type and sequence of operations required. Design families may be distinctly different from processing families. This grouping of part or product families requires a systematic analysis that often proves to be a major undertaking. Usually, there is a considerable amount of data to analyze and this in turn can be quite time- consuming and costly. Three primary methods exist for accomplishing the grouping process: visual inspection, examination of design and production data, and production flow analysis. Visual inspection is the least accurate of the three but nonetheless the simplest and the least costly. The most common used method of analysis is the examination of design and production data. This method is more accurate but is also more time consuming. Production flow analysis examines operation sequences and machines routing to uncover similarities. However, unless the operation sequencing and routines are verified, this method could be far from optimal.

The resulting number of families determines the number of cells required within each cell. The cell usually includes all the processing operations needed to complete a part or subassembly. The families will also help determine where within the cell each machine will be located for the most efficient flow, and how many employees are needed within each cell.

Influence of Cellular Manufacturing on Employees

The decision to implement cellular production requires a deep commitment to excellence and a desire to permanently change the way factories are viewed and managed. Cellular manufacturing affects workers in a number of ways. Among the factors now discussed are:

Self Management

Some management asks cells workers to set improvement targets for themselves and measure their performance in compare to these targets. In addition, workers are given the freedom to plan, coordinate and control their work within their cell as long as they meet organization standards of quality, volume, time, and cost.

Motivation

Flexible work assignments within the cells ensure that employees are consistently learning new tasks and constantly being challenged. Industrial work is productively accomplished in a group work setting. Cellular manufacturing can energize the group, attacking the lethargy found in many industrial solutions.

Employee Input

As the workers see their own creative output being implemented, they begin to develop self- esteem and a stronger desire to succeed. They even begin to challenge each other to improve on their prior accomplishments. Cellular manufacturing can be the structural catalyst that starts, contains, and sustains the improvement process.

Supervision

The intense use of manufacturing cells tends to flatten the factory management structure and reduce overhead costs. When work group autonomy, worker versatility and small group improvement activities converge, the need for supervision is drastically reduced, if not eliminated all together. Cell manufacturing perpetuates the idea that the work group should supervise itself.

Group Cohesiveness

The creation of small–scale production dedicated to production of a few similar parts increases work group cohesiveness. Since each cell has few employees, typically less than fourteen, extensive interpersonal contact is unavoidable. The workers are now part of a single identifiable unit with operating autonomy end responsibility for a specific product, linked by the productive unit for which they are responsible. Cell manufacturing builds a cohesive subculture within the wider social environment of the plant. The use of flexible work assignments contributes even more to the group's cohesiveness and loyalty.

Theoretical Framework

The study is anchored on General Systems Theory which was originally proposed by biologist Ludwig Von Bertalanffy in 1928. He proposed that a system is characterized by the interactions of its components and nonlinearity of these interactions. This theory was developed by Katz and Kuhn (1978) into Paradigms of management. They stressed the relationship and interdependence of the parts, rather than reducing an entity into its parts, systems theory focuses on the relationship between the parts and how they work interdependently as a whole. This theory explains how lean production as a holistic or integrative approach creates value in production by linking value creating activities all the way from supply of basic raw materials (inputs) to efficient value creation processes that have zero waste as output, to providing the best quality product to customers at the lowest cost and in the shortest time. Through the feedback from the customers, the oil companies will understand how to continually improve on the production processes.

Empirical Review

Keitany and Riwo- Abudho (2014) carried out a study to assess the effects of lean production on organizational performance: A case study of flour producing company in Kenya. The study adopted a descriptive research design. The study found out that improving management style and involving all employees at all levels, as well as better inventory management lead to a more efficient practice of lean production. Material management and physical distribution are positively related and are therefore critical determinants of successful lean production practice within the organization. With a response rate of 75% the study concluded firms should adopt the use of lean production system as a means to improved performance.

Farhana and Amir (2009) conducted a research on the lean practice in the Bangladeshi garment industry. A field survey with a semi-structured questionnaire, interviews and site visits were conducted to get necessary information from the respondents. The findings indicated that the selected Coys have adopted a wide variety of lean tools and techniques and gained many performance improvements.

Ahmad, Zakun, Jusoh and Takala(2012) carried out a study on relationship of TQM and Business performance with mediators of statistical process control (SPC), Lean Production (LP) and Total Productive Maintenance (TPM). They found out there is relationship of the practice using structural equation modeling (SEM).

Mustapha, Ageh, Maduekwe and Ojulari (2014) demonstrated the application of lean methodology in hydrocarbon development and production to eliminate wastes, improve operational efficiency and bring about a culture change. In their conceptual study, they found out that lean implementation methodology is not just focusing on improving operational processes, but geared towards becoming part of an organizations way of working. They also posited that without building a lean culture, sustainable, long- term gains are unlikely.

Liana (1997) proposed a method of design and implementation of cellular manufacturing in a job shop environment. The study showed that when a job shop manufactures a group of products with similar characteristics and stable demand, cellular manufacturing can be very effective way to obtain performance improvements.

Risyawati, Razil and Halim (2012), in a study meditating impact of manufacturing technology, lean and strategic flexibility on manufacturing performances identified that these strategies could positively improve manufacturing performances. The research approach used was quantitative with data analyzed using smart PLS.

Okpala (2013) in an exploratory research paper investigated the application of lean accounting as a strategy to achieve lean business philosophy in Nigerian manufacturing firms. The study emphasized a correlation analysis and the findings revealed lean accounting correlated positively with lean business philosophy but due to ignorance, implementation is insignificant in Nigeria.

Maleka, Hove, Karodia (2014) carried out a study on assessing the implementation of a lean six stigma improvement programme in Rail Engineering Organization in Gauteng Province, South Africa. The study adopted correlational analysis. The findings revealed that lean six stigma is an improvement strategy that focuses on process improvement, waste and variation reduction as a means towards performance improvement. These studies carried out by the authors revealed that lean production improved performance of the organizations. But most of the studies did not critically look at cellular production and service delivery in the oil and gas industry in the Nigeria environment. This study seeks to address that research gap.

Methods

The study was limited to three (3) selected oil and gas companies out of twelve (12) oil and gas coy operating under the producers' forum in Rivers states. The oil and gas companies are South Atlantic Petroleum (SAPETRO), Sterling Oil Exploitation & Energy Productions Nigeria Limited, Agip Energy and Natural Resources. The population of the study is one hundred and sixty- seven and consists of workers in the selected oil and gas companies. Simple random sampling technique was used to select the three Coys and sample size was determined using Taro Yamane model.

This is stated below:

$$n = \frac{N}{1+N(e)^2} = \frac{167}{1+167(0.05)\ (0.05)} = 116$$

Validity of the instrument was tested by giving out the copies of the draft questionnaire, research question, and hypothesis along side with the objective of the study. Experts in evaluation and measurement tested the content and face validities and the corrections were affected in the drafted questionnaire. The reliability of the instrument was tested using split half method. A pilot study was carried out with 20 employees from the three selected oil and gas companies. Cronbach's coefficient alpha was used to determine the internal consistency and of the multiple item scales. Table 1 and 2.

Interpretation

$R_{sb} = \frac{n\ 2r_{hh}}{1+ r_{hh}}$

$R_{sb} = \frac{2r_{hh}}{1= r_{hh}}$

$R_{sb} = 0.912$

This showed that the instrument is reliable. The research design was survey design involving the questionnaire administration. Data for the study were sourced from selected oil and gas companies in Rivers state. Copies of questionnaire were administered to the one hundred and sixteen (116) respondents selected from each oil gas coy, but 78 copies were returned. Data obtained were analyzed using Pearson Product Moment Correlation to test the relationship between the variables of the study.

Analysis

The research question was analyzed using mean scores, any item that is 2.50 on a 4 point likert scale and above was accepted while an item below 2.50 was rejected.

Hypothesis Testing

H_A: There is positive significant relationship between cellular production and service delivery in selected oil and gas companies in Rivers state.

DISCUSSION OF FINDINGS

The findings from the study revealed that there is positive significant relationship between cellular production and service delivery of selected oil companies in Rivers State. This implies that adoption of lean production practice will improve the performance of oil companies in Rivers State in this period of dwindling oil prices. This affirms the strategic importance of cellular manufacturing and other lean production strategies in the Nigerian oil and gas industry. This is in line with the studies of Keitany and Riwo-Abudho (2014), Farhang and Amir (2004), Ahmad *et al.,* (2012). Mustapha *et al.,* (2004), Liana (1997) and Risyawati *et al.,* (2012).

Summary of Findings

Correlation analysis showed the interdependence of the variables. Table 3 shows that cellular production and service delivery are highly positively correlated with each other with the correlation coefficient of 0.965. This means that cellular production as one of the strategies of lean production in the oil and gas Coys will boost service delivery, customer satisfaction, reduces operation cost, waste which on the long run improve performance. Finding of the table 3 shows that the research hypothesis is accepted.

CONCLUSION

The study concludes that lean production can resolve severe organization problems and additionally can be an integrative approach to gather and unite several change initiatives that are running through. Most organizations pursue lean in response to their need to fundamentally improve performance by reducing cost while increasing quality and customer responsiveness including meeting delivery time. From the findings, it was strongly agreed that cellular manufacturing improves service delivery.

Lean production reduces all forms of non-value added activities in organization and improves its performance. It appears that Coys that adopt lean production as a working philosophy can make significant improvement in terms of their operational performance even if it is in a modified format that best suits their particular business culture.

RECOMMENDATIONS

Based on the findings of the study, the following recommendations were made:

1). The oil companies in Rivers State should practice lean production systems through making arrangement for relevant training programs and development of necessary physical infrastructure. The management is encouraged to increase its resource commitment to staff training so as to develop skills and to update knowledge on lean production. This training should not be restricted to top management only.

2). Quality consciousness through capability surveillance, that is, constant touch with suppliers/factory to ensure production conforms to product specification and quality, should be constantly advocated. This can be necessitated by adopting the lean production strategies like cellular production.

3). As lean production is a fully integrated management philosophy it is recommended that the idea of continuous improvement is also transferred into those organizational functions which support production and operations. It is therefore relevant that all departments understand their role in the lean production process. The best way the oil Coys can do that is by creating internal customer and supplier relationships.

4). Board and top management should actively drive and support the change with strong leadership especially the top management support during the whole change process.

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