

## Application of Lean Manufacturing Method in Small and Medium Scale Industries in Nigeria

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**Abstract:** Globally large scale industries are in the fore-front of industrial engineering and for Small Medium Enterprises (SMEs) to remain competitive in the global competition which is largely controlled by large scale enterprises. The search for new revenue sources and implementing new cost cutting initiatives should be adopted by SMEs. To sustain their competitive advantages, one of these measures is the application of lean manufacturing system that was first introduced in the 1990. The purpose of this study is to apply lean manufacturing principles to small and medium scale industries in Nigeria. This study first describes the origin and concepts, specifically the concept of Value Stream Mapping (VSM) of lean production system to pinpoint how this system can be applied. The result from this study demonstrates that applying lean production system in small scale industries can reduce waste and increase values for customers.

**Key words:** Small Scale Enterprises (SMEs), Value Stream Mapping (VSM), overproduction, waste of transportation, work-in-progress, takt time, single minute exchange of die, total productive maintenance, Material Requirement Planning (MRP)

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### INTRODUCTION

With the recent reform of world economic recession, Small Manufacturing Enterprises (SMEs) has faced so many challenges competing with the large scale manufacturers in the global market. Some of the challenges are unstable demand, customer's requirements/expectations, production lead time, production cost, product quality, cheap labors, easy access to professional workers and available land space amongst others. To survive, enterprises start searching for new revenue sources and implementing new cost cutting initiatives. In other words, they want to be able to supply high quality and customized products of appropriate quantities and qualities at the appropriate market timing.

Internally, enterprises want a stable, flexible and adaptive production system that can manufacture products meeting market demands. To achieve this goal, enterprises start implementing lean production system to eliminate wastes, improve company bottom line and production status.

Globally, large scale manufacturing companies find it extremely simple to adopt the lean manufacturing concept because of the stable market. However in Nigeria, small

manufacturing enterprises find it difficult to adopt this concept. The reasons are the huge capital involved in the reconfiguration of the whole production system, inability to embrace changes, fear of the unknown and instability of the market. Recent research proved that though the process may be capital intensive and difficult at the start, it is much more profitable, especially on the long run. Also, it has been discovered that it is the only means by which SMEs can remain competitive in the global competition which is largely controlled by large scale enterprises (Berg and Ohlsson, 2005). Lean manufacturing or lean production is defined in terms of waste reduction or elimination of unnecessary processes of manufacturing. Working from the perspective of the customer who consumes a product or service and relied on the value which the consumers would be willing to pay for. The waste aspect is seen as any action that does not add value to the product. Basically, lean is centered on preserving value with less human effort in the factory, less manufacturing space, less investment in tools, less engineering hours to develop a new product (Womack *et al.*, 1990).

Lean manufacturing is a manufacturing philosophy which shortens the time line between the customer's order and shipment through the elimination of waste and the

adoption of continuous improvement in the production system (Gerald, 2009). In manufacturing, lead time is the latency (delay) between the initiation and execution of a process, i.e., the time from the moment the customer places an order to the moment, it is received by the customer which includes the time required to ship the parts from the supplier to the consumers.

## **MATERIALS AND METHODS**

One of the key steps in lean is the identification of which steps add value and which do not. By classifying all the process activities into these two categories, it is then possible to start actions for improving the former and eliminating the latter. Once value-adding work has been separated from waste then waste can be subdivided into needs to be done but non-value adding waste and pure waste. The clear identification of non-value adding work as distinct from waste or work is critical to identifying the assumptions and beliefs behind the current work process and to challenging them in due course.

Taiichi Ohno specifically defined seven types of wastes. The following seven wastes identify resources which are commonly wasted. The method employed would be analyzed in the real sense of manufacturing optimization which minimizes waste with an improved products output.

**Waste of overproduction:** Overproduction occurs when more products is produced than is required at that time by the customers. One common practice that leads to this waste is the production of large batches as often times consumer needs change over the long times large batches require. The thought that resource utilization is to be maximized actually leads to overproduction. Machines and humans should only be busy when they have useful task to accomplish. Over production is considered the worst waste because it leads to excess inventory which requires the expenditure of resources on storage space and preservation, the activities that do not benefit the customers.

**Waste of transportation:** Each time a product is moved it stands the risk of being damaged, lost, delayed, etc., as well as being a cost for no added value. Transportation does not make any transformation to the product that the consumer is supposed to pay for. In a well design system, work and storage areas are properly positioned to minimize the transportation work (quantity and distance).

**Waste of inventory:** Inventory, be it in the form of raw materials, Work-in-Progress (WIP) or finished goods

represents a capital outlay that has not yet produced an income either by the producer or for the consumer. Any of these three items not being actively processed to add value is referred to as waste. Apart from being wasteful itself, inventory also hides other problems and prevents their solutions.

**Waste of motion:** As compared to transportation, motion refers to the producer, worker or equipment. This has significance to damage, wear and safety. It also includes the fixed assets and expenses incurred in the production processes. Reducing waste of motions surrounds everything from describing detailed hand motion in assembly to selection of machines and design of fixture to reduce the time for set-ups and material handling.

**Waste of making defective products:** Defectives will always exist in the manufacturing processes. Defectives do not create values for products and consume extra resources for the following clean up tasks. Manufacturing parts and products that are defective and therefore needs to be reworked are waste. Thus, lean production emphasizes that workers should perform their tasks right from the beginning. Whenever defects occur, extra costs are incurred reworking the part, rescheduling production, etc.

**Waste of process itself (Over-processing):** Over-processing occurs any time more work is done on a piece than what is ordinarily required by the customer. This also includes using tools that are more precise, complex or expensive than absolutely required. This type of waste must be eliminated in typical manufacturing process.

**Waste of waiting (Time):** This includes idle time that workers spend on waiting for machines to complete operations and also the time managers spend on waiting for information to make and take decisions. Whenever goods are not in transport or being processed, they are waiting. In traditional processes, a large part of an individual product's life is spent waiting to be worked on.

**Setting the tools for lean manufacturing:** Lean is the set of tools that assist in the identification and steady elimination of waste. As waste is eliminated, quality improves while production time and cost are reduced. Examples of such tools are; Value Stream Mapping, Takt time, six sigma, Single-Minute Exchange of Die (SMED), Five S, Kaizen and Total Productive Maintenance.

**Value Stream Mapping Method identifying and decreasing waste:** The Value Steam Mapping Method

(VSM) is a visualization tool which helps to understand and streamline work processes using the tools and techniques of lean manufacturing. The goal of VSM is to identify, demonstrate and decrease waste in any manufacturing processes. In other to do this, the VSM Method visually maps the flow of material and information from the time products come in the back door as raw material through all manufacturing process steps and off the loading dock as finished products.

**Takt time:** Takt time can be defined as the maximum time per unit allowed for producing a product in order to meet the demand. It is derived from the German word Taktzeit. Lean production uses the Takt time as the rate that completed product is done (Gerald, 2009). Takt time sets the pace for industrial manufacturing lines. Therefore, the time needed to complete work on each station has to be less than the Takt time in order for the product to be completed within the allotted time.

**Six sigma:** The term originated as a set of practice designed to improve manufacturing processes and eliminate defect but its application was subsequently extended to other types of business processes as well. In a Six Sigma, a defect is defined as any process output that does not meet customer specification or that could lead to creating an output that does not meet customer specification. Six Sigma rating indicating its yield in a manufacturing process as it reduces, the percentage of defect-free products.

**Single-Minute Exchange of Die (SMED):** Single-Minute Exchange of Die (SMED) is one of the many lean production methods for reducing waste in a manufacturing process. It provides a rapid and efficient way of converting a manufacturing process from running the current product to running the next product. This rapid changeover is the key to reducing production lot sizes and thereby improving flow (Kocakulah *et al.*, 2008). The phrase single minute does not mean that all changeovers and startups should take only 1 min but that they should take <10 min, i.e., single-digit minute (Cheung *et al.*, 2009).

**Five S (methodology):** Five S is the name of a workplace organization methodology that uses a list of five Japanese words which are seiri, seiton, seiso, seiketsu and shitsuke. Transliterated or translated into English, they all start with the letter S. The list describes how items are stored and how the new order is maintained. The decision-making process usually comes from a dialogue about standardization which builds a clear understanding among

employees of how work should be done. It also instills ownership of the process in phases of Five S. There are 5 primary phases of Five S; Sorting, straightening, systematic cleaning, standardizing and sustaining. Additionally, there are three other phases sometimes included; safety, security and satisfaction.

**Kaizen:** Kaizen is a system of continuous improvement in quality, technology, processes, company culture, productivity, safety and leadership which involves every employee from upper management to the cleaning crew. Everyone is encouraged to come up with small improvement suggestions on a regular basis which are not ideas for major changes. Kaizen is based on making little changes on a regular basis; always improving productivity, safety and effectiveness while reducing waste. Suggestions are not limited to a specific area such as production or marketing. Kaizen is based on making changes anywhere that improvements can be made which involves setting standards and then continually improving those standards. To support the higher standards, it also involves providing the training, materials and supervision that is needed for employees to achieve the higher standards and maintain their ability to meet those standards on an on-going basis and must be a continuous exercise.

**Total productive maintenance:** TPM is a critical adjunct to lean manufacturing. If machine uptime is not predictable and if process capability is not sustained, the process must keep extra stocks to buffer against this uncertainty and flow through the process will be interrupted. Unreliable uptime is caused by breakdown of badly performed maintenance. If maintenance is done properly, uptime will improve as well as the overall equipment effectiveness which basically determines how many sellable item are actually produced as opposed to how many machines should produce in a given time.

One way to think of TPM is deterioration prevention. Deterioration is what happens naturally to anything that is not adequately taken care of. For this reason, many people refer to TPM as total productive manufacturing or total process management. TPM is a proactive approach that essentially aims of identifying issues as soon as possible and plan to prevent any issues before it is occurrence.

**Lean Production Techniques:** The Lean Production Techniques involves:

**Material Requirement Planning (MRP):** Material Requirement Planning (MRP) is a production planning

and inventory control system used to manage manufacturing processes. The basic function of MRP system includes inventory control, bill of material processing and elementary scheduling. MRP helps organization to maintain low inventory level. It is used to plan manufacturing, purchasing and delivering activities with the following procedures.

**Kanban system:** Kanban is not an inventory control system. Rather, it is a scheduling system that tells you what to produce when to produce it and how much to produce. Kanban uses the rate of demand to control the rate of production, passing demand from the end customer up through the chain of customer-store processes.

Kanban is typically the card that authorizes production of a certain product. When a product has been consumed from the finished goods inventory or supermarket, a Kanban card is passed upstream to allow for replenishment of the product. Kanban can be applied only in plants with repetitive production, i.e., assembly operations (Cheung *et al.*, 2009).

**Just-in-Time (JIT):** Just-in-time entails producing products in exactly the required quantity just when they are needed and not before being requested. Implemented correctly, JIT focuses on continuous improvement and can also improve a manufacturing organization's return on investment, quality and efficiency of production.

**Value Stream Mapping Method:** In this study, the concept of Value Stream Mapping (VSM) was explored in order to introduce Lean Production Control Methods in small scale industries. This involves mapping out the activities in the manufacturing process with cycle times, down times, in process inventory, material movement, information flow paths which helps to visualize the current state of the process activities and guides towards the future desired state. The process usually includes the physical mapping of the current state while also focusing on the present status or the future state map which serves as the foundation for other lean improvement strategies. It is the basic for implementing lean manufacturing. It helps managers identify the classic seven wastes in processes in lean manufacturing principles.

Lean manufacturing is a performance-based process used in manufacturing organizations to increase competitive advantage. The basics of lean manufacturing employ continuous improvement processes to focus on the elimination of waste or non value added steps within an organization. The challenge to organizations utilizing lean manufacturing is to create a culture that will create

and sustain long-term commitment from top management through the entire workforce. Lean manufacturing techniques are based on the application of five principles to guide management's actions toward success:

**Value:** The foundation for the value stream that defines what the customer is willing to pay for.

**The value stream:** The mapping and identifying of all the specific actions required to eliminate the non-value activities from design concept to customer usage.

**Flow:** The elimination of all process stoppages to make the value stream flow without interruptions.

**Pull:** The ability to streamline products and processes from concept through customer usage.

**Perfection:** The ability to advocate doing things right the first time through the application of continuous improvement efforts.

**Value stream:** Involves all the activities, both value adding and non value adding required to bring product from customer request to customer receipt or delivery. It involves:

- High level perspective of the process following the process from beginning to the end and drawing a visual representation of primary transformation steps, information flow, process flow/delays and key time metrics (process time, lead time, etc.)
- Documenting the current state and barriers to flow
- Designing a future state of how value should flow
- Creation of an implementation strategy and plan

In carrying out these, focus is made on one product family at a time. Products are in the same product/service family if they pass through common process types.

**Preparation of current state value stream map:** The current state map was prepared using icons for various processes to visualize the flow of material and information (Rother and Shook, 2003).

**Current state mapping steps:** The following processes facilitates the documentation of the current state value stream map:

- Identify the customers need/requirements
- Scope the process being map first and last steps

- Walk the process. List the major process step, start with the customer
- Add key metrics for each step, e.g., Process Time (PT), Lead Time (LT)
- Determine the trigger that initiate action at each process, it may be information flow
- Identify and quantify the waste/delays between the processes (LT)
- Investigate the causes of the waste
- Identify the barriers to flow
- Summarize the map (total PT, total LT)

**Designing the future state value stream map:** The future state began with the identification of waste and their sources. Targeting all waste and designing the lean flow by carving out the waste and how to best utilize the resources already in place, i.e., creativity before capital. The following logics would facilitate the design of the future value stream map (Mc Donald *et al.*, 2002; Womack and Jones, 1996):

- What does the customer really need?
- How often will the performance be checked?
- Which steps creates value and which generate waste?
- How will work be controlled between interruptions?
- How can work flow with fewer delays and interruptions?
- How will the work load and/or activities be balanced?
- What process improvements will be necessary to achieve the future state?

**Carving out the wastes:** Waste only adds cost and time, it adds no value. The process improvement priorities involves:

- Eliminate the unnecessary non-value-added activities
- Minimize necessary non-value added activities
- Optimize value added activities (as required)

## RESULTS AND DISCUSSION

The discussion will be addressed in two perspectives, since the lean production is an approach to enhance maximum production with acceptable qualities and to eliminate waste of production resources. The interest of the researchers is therefore, how to make the approach more widely accepted and adopted in terms of the overall advantages and its acceptability worldwide for the small and medium scale enterprises. It would therefore, be necessary to identify how the approach can assist in

the general manufacturing sectors to meet their target in terms of service delivery. Generally, the effectiveness of this manufacturing techniques can be quantified in two perspectives as:

**Problem-solving:** Continuously, solving root problems encourages the organization to become a learning organization. The same problem will re-occur if the root problem is not identified and solved at the first time, they appear. Also, teams and individual employees will learn from the problem solving process to build a stronger foundation.

**Achievements:** Lean manufacturing if properly applied, significant improvements could be achieved after eliminating some activities, i.e., waste that does not add value the final product, reduction in production lead time, reduction in production cost and low inventory level.

## CONCLUSION

This study describes Lean Production System which is originally used in the manufacturing industry. A typical company, Toyota spent 25 years (1940-1960's) to perfect the system and reduced the cycle time from 3 h to 3 min. The study can now be applied to system on both small and medium scale industries and developed an evaluation method. This method can alleviate the impact that demand variability generates on SMEs and reduce the inventory level. Most SMEs use the mass production approach to manufacture their products. The process also affirm that Pull-based Production Method can effectively lower the inventory level with the impacts caused by demand variability alleviated with project status and production decision more clear and precise.

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