

Lean Manufacturing Methods for Process Improvement

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Abstract - The business environment of today is dynamic, and various businesses are figuring out how to become more skilled and adapt to consumer demands. The necessity for ongoing production process and overall management enhancement is becoming important as a result of the competitiveness's requirement for survival. The study aims to identify wastes in a production process and propose recommendation for improvements. The purpose is also to evaluate the usefulness of various Lean Management tools. A single case study was selected as the research methodology for the study. The approach of value stream mapping has been used to generate the process's present state. Following the mapping, wastes were analyzed and suggestions for improvement were offered.

Keywords: Value Stream, Lean Tools, Waste, Visual Management, Business

1. INTRODUCTION

For businesses to succeed in today's rapidly expanding industrial sector, maintaining their competitiveness is crucial. Companies must therefore increase their commitment to resource and process optimization if they want to remain as competitive as feasible. Businesses concentrate more on identifying new opportunities and global trends that enable optimization to be most effective with fewer resources in order to satisfy client demands. They must concentrate on devising new strategies to withstand the growing competitive pressure brought on by globalization and innovation. Companies must meet or exceed client expectations while maintaining the lowest pricing if they want to remain competitive in the business world.

Companies with a highly competitive edge are those that can produce products quickly and precisely. The goal is to complete the work with perfection, minimizing waste, and operating accurately in order to meet client demand and deliver the product on schedule. The value stream is a valuable tool since speed is its essential component. Given the restricted supply of time, delivering sooner gives you a significant advantage over your competitors.

One of the most popular techniques for cutting expenses and waste is lean management. It aids in enhancing productivity, which helps businesses survive in the increasingly cutthroat business environment and so aids in their own growth. Knowing the history and key traits of lean management is essential to comprehending its fundamental aspects. Lean

implementation entails understanding the best strategies to utilize given a particular company's features and how to do so in the most practical and straightforward way possible.

2. LEAN MANUFACTURING

2.1 History of Lean

Taiichi Ohno has defined the Lean Production as:

"All we are doing is looking at the timeline from the movement the customer gives us an order to the point when we collect the cash. And we are reducing that timeline by removing all the non-value-added wastes."

Going back to the start of mass manufacturing is crucial to comprehending where Lean Management techniques came from. In particular, Henry Ford's American factory introduced the first conveyor-style production line in 1913. "Flow production," he gave it the name. It was a significant advancement for the entire industrial world. Henry Ford had to take care of a lot of things beforehand to get there. All of the products and assemblies of those that would be produced on the conveyor had to be standardized for that. Additionally, it was crucial to guarantee that product assembly would go smoothly and be achievable without the need for any additional assembly at the line. All the tools and measurement devices have to be standardized. Calculating the time, it takes to complete each production step in accordance with the regulated pace. Finally, it was crucial to teach employees so they could carry out precise and standardized labour processes. The introduction of Ford's conveyor-line is regarded as the start of the history of mass production.

Prior to Ford's introduction of mass production, craft manufacturing practices were the norm. Workers with a variety of skills were used to create products from start to finish. Both the products and the tools that were employed lacked any kind of standardization. Since each product was made specifically for the customer, the production process took an unknown amount of time.

Eiji Toyota, the CEO of Toyota Motor Company, paid a visit to the Ford manufacturing facility in the United States in 1950. The goal was to observe the resource use throughout production and the manufacturing process for thousands of cars that were comparable. At the sight, he knew right away that it is not possible to make vehicles in Japan with the same level of resources as in America.

Japan's economy was in a dire state after being recently decimated by two nuclear bombs. The nation lacked both resources and foreign money. The industries experienced issues with material supply, a lack of funding, and a scarcity of personnel. Additionally, the Japanese internal market was far smaller than the American one. American companies produced thousands of the same goods in a single day, leading to the conclusion that Japan should concentrate on producing much smaller patches. Despite this, Toyota nevertheless chose to adopt the conveyor-line production method after making minor modifications to it. Several new approaches were incorporated while some of Ford's guiding concepts were modified (Kanban system, 5S etc.).

Toyota had to make considerable modifications in order to survive in the cutthroat business industry. Toyota had to concentrate on doing the right thing and only delivering what the consumer desired because they were short on money and resources. It involved picking the appropriate technology and making the appropriate material investments. Producing items that are based on order became crucial. Production did not begin before a consumer placed an order. Toyota divided the needs of the customers into three categories in order to implement those production procedures.

1. What (What kind of product) does the customer want?
2. When does the customer want the product?
3. What quantity does the customer want?

Toyota created a "pull system" to do this, where production only began in response to a customer request. The various stages of the production were regarded as one flow throughout the entire process. It was established inside the process when and how much are needed in order to ensure the best possible utilization and flow of resources. The "Toyota Production System" is the term Toyota gave to this new production philosophy.

2.2 Principles of Lean Manufacturing

Jones and Womack have defined Lean Production as a five-step process:

1. Defining customer value - Determining the value that the business provides with its products from the viewpoint of the end user is the first stage.
2. Defining the whole value stream - The tasks required to deliver that value must all be mapped, which comes second. As it is crucial to recognize the steps in the process from the start of production to the point at which it reaches the customer. based on the value added at a specific point in the product's development.

3. Making it "Flow" - Thirdly, in order to ensure that the product reaches the consumer as quickly as possible and at the lowest possible cost, it is crucial to ensure that all operations are running properly along the whole value stream. The value stream's waiting time for the customer should be eliminated or minimized to the greatest extent practicable.

4. "Pulling" from the customer back - The fourth phase is to set up a pull system, in which the product is connected to the final consumer whose desire initiates manufacturing. In other words, the business should begin producing the requested product as the client requests it. For pull production, the management tool "Just-in-time" (JIT) is used to avoid over-production. The main idea of pull production is to reduce unnecessary production and unnecessary inventories to minimize the amount of waste production.

5. Striving for "Perfection" - The process of continuous improvement in the process of production aims to achieve perfection in the process and the product. It means to deliver a product to the customers according to his/her expectations and demands within the schedule and without any defects or mistakes. The only solution to achieve perfection is to have close communication with customers, managers, and the employees that are attached to the production process

2.3 Lean Manufacturing Tools

Lean management techniques are implemented using a wide variety of effective instruments. What situation needs to be analyzed determines which implementation method should be used. Therefore, understanding how a certain process functions as a whole is crucial. While many Lean practices can be used alone, many of them are more effective when combined, and hence they support one another. It's critical to establish the objective and the requirements for success before selecting the best strategy for improvement.

2.3.1 Value Stream Mapping

The value stream is the basic building block of lean, so mapping it is the first step in beginning to adopt lean management into a production. The purpose of mapping is to focus on and perceive the broader picture. It includes both value-adding and non-value-adding activities since it includes all the steps necessary to deliver a product. It is crucial to begin mapping the full value stream of a chosen product in order to make improvements. By mapping the current state of a production, it is possible to see and review how the value flows within a process.

Term "*value stream*" refers to all the activities that a company must do to design, order, produce and deliver the products or services to a customer. Therefore, there is always a value stream when there is a product being made.

The value stream has two main flows:

- The production flow, from the raw material to the customer.
- The design flow, from the concept to launch.

Production flow includes two flows, the information and material flow that are equally important. The two flows are connected to each other and in order to make improvements it is important to map both of them. As to the production flow is the movement of material through the factory and the information flow tells each process what to do next.

2.3.2 Just - in - Time (JIT)

One of the essential elements of lean manufacturing is the use of the pull approach. The pull strategy is considered to be the most important and fundamental way to improve work flow. Just-in-time (JIT) production is one of the techniques connected to the pull approach in order to produce what is necessary, when it is required, and in the quantity that is required. With a pull system that reacts to actual client demand, inventory, material waste, and storage problems are all reduced.

It is regarded as the most advanced and frequently utilised lean construction technique for eliminating non-value-adding tasks. It is founded on the idea that website inventory that does not provide value to customers is viewed as waste. It implies that the appropriate tools and materials must be made available for the manufacturing as needed.

2.3.3 Layout

Layout refers to the manner that supplies and tools are organized throughout production. According to Hales (1984), the layout is an arrangement of the operations, machines, and places, as well as the relationships that exist between them.

The arrangement of materials and equipment is crucial for achieving a successful and effective Lean manufacturing facility. The output will eventually be hampered whether the materials are properly preserved or the placements are not well thought out.

When modifying or upgrading the layout, it is crucial to consider the positions and motions of both personnel and materials. Lessening the time spent on the moves or storages of the semi-finished goods that take place between machines is one way to do. As a result, they ought to be arranged logically or wherever it is possible to link them together. The idea behind this is that a machine's input should be close to a warehouse for raw materials and its output should be close to one for finished goods. Additionally, there should be a minimum number of backward movements and transportation path crossings. Every transportation route

consumes precious resources because building space is expensive and moving time adds no benefit. The ideal would be that there should be as few transportation paths and crossing as possible. The main goal that the layout has in the Lean production, is to increase the overall efficiency.

2.3.4 5S

The simplest and most popular instrument for implementing lean management is the 5S technique. The 5S is a system that organises the workplace and encourages the culture of continuous improvement. "A place for everything and everything in its place" is the guiding principle of the 5S technique. The process of creating a clean, efficient, and productive workplace is utilized to minimize waste and increase productivity.

The five phases of 5S include an overview of the workplace's objects, the removal of anything unnecessary, arranging them, cleaning, conducting maintenance, and ensuring that the aforementioned actions become habits. By implementing 5S, the workplace becomes more organized, making it simpler to spot issues and improving material flow. The 5S together create a continuous process for improving the work environment.

The 5S are:

- Seiri (Sort)
- Seiton (Set in order)
- Seiso (Shine)
- Seiketsu (Standardize)
- Shitsuke (Sustain)

Sort is the initial phase in the process, where the objective is to clear the workspace or room of any superfluous materials so that the spaces can then be arranged. Additionally, it suggests a clean slate on which to construct and carry out the next four processes. Everything that is unnecessary will be taken out of the target area at the beginning of the Sort process. Even if it merely involves moving stuff from one location to another and piling useless items on top of one other. Choosing between objects that are still needed or utilized and those that are no longer needed or used is made easier by doing this.

The second step of the 5S process, "Set in Order," concentrates on returning the products that were determined to be vital in the Sort part to the workspaces, but in a precise and well-organized manner. Finding the most practical and effective locations for those goods in that region is the aim of this stage. This phase can be put into practice in a workspace using a variety of methods and strategies.

Shine, the third stage, is intended to clean or sanitize. This process involves thorough cleaning of the entire workplace. Workers sweep, vacuum, dust, and polish the entire area. An organized workstation equates to a secure one. The likelihood of tripping, slipping, and falling will be decreased if the floors are clean. Additionally, when workplaces are tidy and clean, there is less risk of contracting various diseases or other health risks. These cleanings are to be carried out often and according to a schedule.

The fourth phase of the 5S process is "Standardize," where the tips that were encountered in step one is directly applied. The concept of regularly inspecting and reviewing the 5S activities will be developed in this level. It functions as a link between the "Shine" and the fifth 5S stage. Therefore, by standardizing the 5S method, it helps to assure that organizational efforts will be sustained over the long term. Poor standardization can cause the task to become sloppy over time, which will reduce its efficiency. It is critical to go beyond an oral agreement in order to standardize 5S processes. All parties must be certain of what each person is required to perform through a clear, understandable approach. Implementing 5S audits, where there is a list that must be covered and checked on a regular basis, is one way to do this. Specific questions about the specified work area should be included on the checklist to help ensure that the procedure is carried out as intended. Making guidelines is crucial in this step since everyone needs to know exactly how and when a specific activity is to be completed.

The final and most challenging phase of the 5S process is "Sustain," which focuses on turning all of the preceding steps into continuing routines to assure their continuous improvement.

In order to get the most benefits out of this step it is important to follow four steps:

- Demonstration – everything that is required from the workers should be demonstrated correctly by a person who has the right skills, training and knowledge. Thus, workers will gain the understanding of what is actually needed from them to do.
- Supervised undertakings – for worker to know what is expected they need to work with closely. Monitoring workers through the very first steps in order to ensure that the daily used 5S methods are being formed into expected and de-sired habits.
- Periodic check-ins – regularly checking if those techniques that were obtained in the standardizing step are running smoothly.
- Make changes as necessary – having a continuous undesired behaviours and un-desired result that

might have various consequences thus lead to faulty systems.

Overall, the 5S approach is an element of lean management and is used to reduce waste in order to increase quality standards. It is most frequently utilised because it doesn't demand significant investment from businesses, which will increase productivity. The strategy has the added benefit of increasing the workers' excitement and punctuality throughout the procedure, creating a safer working environment.

2.3.5 Heijunka

Leveling is the meaning of the Japanese word heijunka. It is a lean approach to lowering the possibility of overburden and reducing variance or unevenness in the production process. It aids in managing fluctuations in consumer demand and making the most use of available manpower and resources. Heijunka implementation assists in transitioning from batch production to production in response to customer demand, which lowers inventory costs associated with retaining resources and goods while demand is low. Even when demand is great, Heijunka is required to complete the process or flow of work at a takt-time. Takt-time "is the unit of time within which a product must be produced (Supply rate) to match the rate at which it is required (Demand rate).

2.3.6 Kanban

The word "sign" or "visual sign" is translated as "kanban" in Japanese. In the west, it is commonly referred to as a "card," which indicates that something needs to be delivered or produced. A visible goal and an unseen goal are both part of the Kanban system.

The overt goal of Kanban is to provide a method to control production between processes, resulting in the production of only what is required and when it is required.

The system's hidden goal is to facilitate process improvement by establishing the desirable systemic linkages between processes, hence revealing areas that require improvement. Even though Kanban has two objectives, they are interdependent.

Kanban aids in maintaining control over product and component stockpiles as well as inventory levels. In rare circumstances, it can also be applied to the most effective management of raw material inventories. By utilizing the Kanban system, it is possible to manage product and stock levels such that they are constantly present in the production unit. Additionally, it verifies that there aren't too many of those items or materials present.

This method of scheduling has the benefit of eliminating the daily scheduling tasks required to run the production

operations. Additionally, the strategy eliminates the need for ongoing schedule status and changeover time monitoring.

The flow of materials or pieces during manufacturing is triggered or controlled by the Kanban system using cards as a visual indicator, synchronizing both internal organizational activities and external supplier-related procedures.

The movement of components and materials across production processes is governed by cards that are utilized as a Kanban system. The production line is moved using the same material the entire time. The card serves as a work order, so when more supplies or parts are required, it sends the necessary Kanban to the supplier.

Typically, a Kanban card contains the following information about the production of items:

- What to produce
- How to produce it
- When to produce it
- How much to produce
- How to transport it
- Where to store it

Production and withdrawal Kanban cards are the two varieties now in use. a creation Kanban is a term used to define the quantity of an item that must be produced. When the Kanban card is held in the hand, production of that particular item begins. To retrieve objects from earlier processes or storages, the second type is employed. The Kanban card must be affixed to the actual item so that it can travel with them.

3. CONCLUSIONS

The purpose of this study was to identify the categories of waste in the chosen manufacturing process using fundamental Lean Management principles, analyze the causes of their occurrence, and offer solutions to prevent them. This is crucial since, in order to compete effectively, production processes and productivity must always be improved.

By limiting tasks that do not boost profitability, lean management aims to maximise the cost- and time-effectiveness of each process. Maximizing customer value creation while reducing waste is Lean's key objective. Simply defined, the goal is to increase customer value while using the least number of resources. a business that adheres to lean concepts, comprehends how to add value for clients, and concentrates on crucial procedures

REFERENCES

- [1] Arunagiria, P., Gnanavelbabub, A. (2014). Identification of High Impact Lean Production Tools in Automobile Industries using Weighted Average Method. *Procedia Engineering*, 97, 2072–2080. <https://doi.org/10.1016/j.proeng.2014.12.450>
- [2] Coetzee, R., van der Merwe, K., & van Dyk, L (2016). Lean Implementation Strategies: How are the Toyota Way Principles Addressed? *South Africa Journal of Industrial Engineering*, 27(3). <https://doi.org/10.7166/27-3-1641>
- [3] Gross, J., M., McInnis, K., R. (2003). *Kanban Made Simple. Demystifying and Applying Toyota's Legendary Manufacturing Process.* Amacom.
- [5] Liker, J., K. (2004). *The Toyota Way. 14 Management Principles from the World's Greatest Manufacturer.* McGraw-Hill Education.
- [6] Mahmood, K., Shevtshenko, E. (2015). Productivity improvement by implementing lean production approach.