The Integration of Toyota Production System (TPS) and Lean Operations.

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Abstract

This paper focuses on the concepts of Just-in-time, Toyota Production System (TPS), and Lean Operations, which are introduced and dealt with in depth. The following key elements must be understood as Kaynak (2002) suggested, the origins of JIT in Japan and how it became a method of decreasing inventory levels, JIT has evolved into an extensive management philosophy. The main aim of JIT is to generate a feasible competitive advantage by focusing on conveying superior performance of goods and services in terms of quality, service, and cost. The aim of the JIT philosophy is constantly eliminating waste, production efficiency, and quality of a product. The advantages of JIT when effectively executed and limitations of JIT in the supply chain.

The purpose of the Toyota Production System which is to eradicate through development activities of different kinds of waste lying concealed within an organization, Ohno (2013). Toyota can make profits during a recession phase by lowering costs through a production system that removes excessive stock and workforce, Liker (2014). This literature examines the main objective of this production system and how it creates products, moreover in areas where Japanese transformation can be seen, Fullerton & McWatters (2004).

Keywords
Just-in-time (JIT), Toyota Production System (TPS), lean manufacturing, Kaizen

1. Introduction
JIT manufacturing is a Japanese management philosophy developed in the 1970s that is used in production which entails acquiring the right items of the correct quality and quantity in the right place and time, Sui Pheng & Joo Chuan (2002). JIT includes the implementation of old management ideas, however, their modification to the contemporary manufacturing firm is the latest practice, Kaynak (2002). It was first endorsed by Toyota Manufacturing plants by Taiichi Ohno, subsequently, after the first introduction of JIT by Toyota many businesses followed up, it eventually gained support and many companies started using it, Ohno (2013).

The production system is reviewed by demonstrating the main goals and ideas along with different methods and tools utilized for achieving them, Cheng & Podolsky (1993). Lean operations are about continuous improvement, it ensures that all aspects of the business are improved, by undertaking correct procedures and adhering to processes, Fujimoto (2012). Lean includes eradicating waste, adding value to products and services, and reducing errors. The vital principles of system design, process models, and technology used to develop lean operations, Hou, Chan & Wang (2011).

1.1 Objectives of the study

1.1.1 Toyota Production System

Toyota Production System is a framework for preserving resources by eradicating waste. People who partake in the system learn to recognize expenditures of material, time, and effort that do not create value for customers, Fullerton et al., (2004). They take part in developing procedures for eliminating waste and anticipating its recurrence, Hou et al., (2011). Lean operation can alter the image of industry and manufacture, the production organizations must implement alterations and improvements to prosper. Traditional procedures cannot keep up with the ever-changing world of current manufacturing, Sui Pheng et al., (2002). Lean production methodology delivers quality for operational excellence, it ensures processes are simplified and costs are minimized, while optimum quality and pace of manufacturing are prolonged, Fujimoto (2012).

1.1.2 Just-in-time (JIT)

JIT's emergence relates to strong cultural features, also the emergence it's because of acquiring optimum levels of utilization amidst restricted resources available. JIT management has an extreme standard of cultural features enclosed in its development, Kaynak (2002). Heika (1989) has proposed some cultural attributes which are associated with JIT as follows:

- JIT manufacturing includes the utilization of many signs showing different products and the status of machinery.
- An element of JIT necessitates that the plant be decontaminated, which means to ensure no waste will obstruct production.
- JIT enables a decrease in raw materials, processed goods, and final products trading stock, which creates more space and time during operations within plants.

1.1.3 Elements of JIT Manufacturing

JIT production comprises numerous elements which must be amalgamated to perform to their best ability to accomplish JIT goals, Sui Pheng et al., (2002).

- People involvement: This involves getting support and agreement from all participants involved in the accomplishment of organizational goals is a prerequisite for JIT success. All participants who have an interest in the organization must be informed and involved when acquiring support and agreement. Which in return will decrease the time and effort spent in implementing JIT and can decrease implementation difficulties. When people from different levels are compelled to work together towards attaining organizational goals it ensures successful JIT.

- Plants: Several changes transpire about the plant which include self-inspection, plant layout, Kanban, materials requirements planning, and continuous improvement. Self-inspection ensures that manufacturing done by workers adds value to the goods and is of high quality, which also minimizes low-quality work that is done by mistake and gives time to be rectified, Cheng et al., (1993). Plant layout in JIT manufacturing is organized according to full worker flexibility and according to product, this requires that workers are trained for specific tasks rather than many tasks. Continuous improvement is a fundamental part of the JIT hypothesis so each affiliate in an organization must adapt to it to ensure organizational goals are met, which will allow the organization to continuously enhance its operations and satisfy customers with its products, Hou et al., (2011).

- Systems: refers to the processes and technologies utilized to plan, interconnect, and coordinate activities and materials utilized in manufacturing. Materials Requirements Planning (MRP) and Manufacturing Resource Planning (MRP 2) are the two systems used to carry out tasks in organizations. Planning in MRP includes a

manufacturing plan which entails the capacity availability and the way it will be assigned to the plant and master production schedule. MRP 2 is a computerized system that is utilized to supply information on financial resources accessible to execute the plans of MRP.

2. Literature Review

The major goals of TPS are the abstinence and minimization of waste, Taiichi Ohno's approach states that the elimination of waste must be based on eradicating unnecessary processes, and any process executed must add value, Ohno (2013). There must be two features that need to be considered when reducing waste, the firstly being the reduction of costs in any improvement done, this manufacturing must be carried out by a smaller number of workers, Kaynak (2002). Secondly, the productivity of employees connected to the production system needs to be examined to detect potential features for reducing waste. There are seven types of waste namely, waste of processing, waste of motion, waste of defects, waste of overproduction, waste of waiting, waste of transportation, and waste of inventory, Hou et al., (2002).

The foundation of the TPS involves three components namely, production leveling, Kaizen, and standardization. With production leveling manufacturing areas and logistics are flattened and the components and sub-assemblies are demanded from suppliers, Liker (2014). The benefit of production leveling is being able to foresee production leads and orders to appease production processes. Production leveling aims to ensure production is flattened through the decoupling of consumers' production orders and the formation of standardized processes as a foundation of efficient continuous improvement processes, Ohno (2013). The understanding of Kaizen to generate standard transparency of the ideal state to work them off with the workers involved.

The standardized work processes are executed in the manufacturing industry and the focus is on a holistic production system, Fullerton et al., (2004). Documentation in standard operations is making standardization possible through employees. The standard operations include three elements as suggested by Podolsky et al., (2012):

- There is a sequence that explains the steps taken to accomplish the tasks and the content is explained by the work sequence.
- The duration time is used to determine how long it takes to create a product.
- The standard stock is required to continue the working process which is less amount of materials.

Toyota recognized the knowledge of its employees and accomplished great improvements by documenting the workflows, these developments can be shown by total quality, less need for space, and short throughput times, Black (2004). TPS Pillars, the two pillars used in TPS are just-in-time and autonomation, which constitute the aim of the TPS. The main goal of JIT is to ensure goods are delivered at the right place and time and are of the right quality and quantity, Fujimoto (2012). The focus of JIT manufacturing and its provision is to have a continuous flow of information and material into markets while maintaining stock decrease in the supply chain, Liker (2014). Components of JIT are manufacturing synchronous, manufacturing segmentation, and integrated information processing.

The second pillar is autonomation which immediately stops the manufacturing process when an issue arises and states what the problem is, because of the sudden stop and detection of a problem in the production machines the TPS machines can be classified as intelligent machines, Ohno (2013). This technique ensures total quality and improvements can be made when defects are detected. Additionally, this technique is cost-effective since inspections are not required to be done daily following repairs within the system, Cheng (1993). The TPS elements are associated with one another, which means there is a possibility of improving processes in each element.

Toyota Superior Quality

Toyota has gained notoriety for the development of exceptionally great vehicles in all nations all over the planet. This has been accomplished by a way to deal with quality control and quality confirmation, which is one of a kind for Toyota and has been created over numerous years. From the beginning phases of the plan interaction up until our vehicles fall off the line, quality is key at Toyota.

Quality is the fundamental essential to accomplishing client grins and is implicit in each movement they do. How we fabricate their vehicles is exemplified in the Toyota Production System (TPS). The following diagram depicts the TPS strategy that Toyota uses (Figure 1).

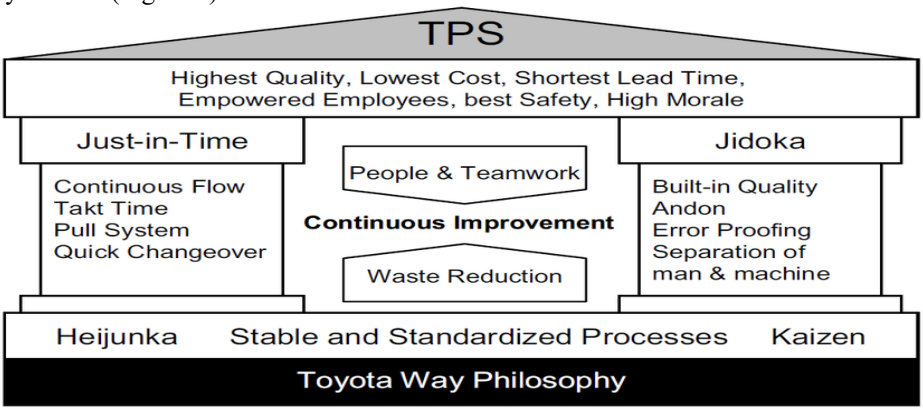

Figure 1. The core Principles of Toyota Production System. Uploaded by Magnus Wiktorsson.

A Holistic View

The holistic concept in lean manufacturing suggests the interconnectivity and subordination among the five key lean manufacturing elements, Lean manufacturing tools (2015). Each element has its importance and necessity for the thriving deployment of a lean operation program, but the performance cannot be achieved if the elements are not combined, Kaynak (2002). These elements encompass lean principles which when they collaborate, provide to the development of a world-class manufacturing environment. There is also an important relationship that must be followed when these elements are positioned, McWatters et al., (2004).

3. Methods

The study suggested that researching the main barriers and obstacles to the application of the Lean approach and cautions while developing models to use in the lean methodology can result in safety from the failures to occur in the manufacturing industry in the future (Elkhairi et al., 2019).

Moreover, kaizen is a process-oriented framework, thus, to implement this, two practice situations are used for the improvement process. Initially, there is a need for management to support and encourage the efforts of members working in the organisation. Thus, this process can be enhanced. In addition, the process must be understood comprehensively to improve the process. Secondly, process orientation can bring attention and monitor to the overall process of improvement itself which enhances the productivity of the organisation. People orientation is mainly based on the kaizen team which means the implementation of the kaizen methodology can be seen regularly by all employees of the company. Kaizen 5S philosophy is a way of managing and organizing the work and workspace. 5S enhances efficiencies by reducing waste, enhancing flow as well and eliminating process unreasonableness (Shukla & Ganvir, 2018).

The methodology of the Kaizen Teams needs strong leadership backing and active participation to be implemented successfully. Leadership should create clear objectives, provide resources, establish expectations, and remove any obstacles to the team's growth. The team's efforts are valued and incorporated into the organization's broader strategy with the help of the leadership.

4. Data Collection

To implement 5S, sorting elements of the space is the initial step which should be organised and clean. Afterward, they should be normalised by determining the elements as per the organisational standards as demonstrated in Figure 2. Brito et al. (2020) stated that lean manufacturing in manufacturing firms has proven to be an efficient approach to increase efficiency and cost competitiveness as well as value delivered to the consumer. Lean manufacturing, established from TPS, implements some results and resources in a huge range of products and at a similar period high range of quality and services of product. Moreover, lean manufacturing is mainly employed in various US

manufacturing industries. The lean manufacturing approach has been implemented not just by large firms, but also implemented by small businesses.

Krafcik first coined the word "LM" in 1988, and Womack further popularised it in his book "The Machine That Changed the World." The phrase was used to contrast the Western economies' mass production practices with the Japanese Toyota Production System (TPS). Toyota was not exempted from the severe pressure on material resources that followed World War II.48 In 1950, the business experienced several labour disputes, incurred a pre-tax deficit, and was in danger of going out of business.49 As a result, Taiichi Ohno developed the TPS concept to reduce waste in the engine machining shop.50 As a result, the TPS house is now frequently used as a reference in most global sectors.51.

Kaizen has a long, illustrious history that can be traced to Japan's post-World War II period. The name "Kaizen" itself is a combination of the Japanese terms "Kai," which means change, and "Zen," which means good or for the better. Kaizen developed into a fundamental tenet of the Toyota Production System (TPS) and had a significant impact on the restructuring of Japan's manufacturing sector.

5. Results and Discussion

3.9 Lean Manufacturing Integration

The goals of the production approach known as "lean manufacturing" include waste reduction, shorter lead times, and increased productivity. It is predicated on the ideas found in the Toyota Production System (TPS) (Frey & Osborne, 2013). The manufacturing business can profit in several ways from adopting lean manufacturing practices. Aspects of lean manufacturing integration include the following:

5.1 Reduction of waste

The "7 Wastes" or "TIMWOODS" are several categories of waste that are the focus of lean manufacturing. Transportation, inventory, motion, waiting, overproduction, overprocessing, and flaws are a few of them (Banga & te Velde, 2018). The manufacturing industry may reduce waste and optimise operations, resulting in higher productivity and cost savings, by applying lean practices including value stream mapping and standardised work.

5.2 Value Stream Optimization

Value stream mapping is crucial for identifying operations that contribute value and waste that doesn't. This is something that lean manufacturing emphasizes (Banga & te Velde, 2018). Organisations can optimise processes, cut lead times, and get rid of operations that add nothing to the value of the finished product by looking at the flow of resources and information from supplier to customer.

5.3 Constant Flow

Continuous flow is a principle emphasised by lean manufacturing, in which goods travel uninterruptedly through the production process. Companies can achieve a more effective and streamlined production flow by balancing workloads, minimising setup times, and reducing batch sizes. As a result, lead times are shortened, inventory is decreased, and customer response is enhanced.

5.4 Pull System

A pull-based system's implementation is yet another crucial component of lean manufacturing integration. A pull system makes sure that production is only started in reaction to client demand, as opposed to production based on projections or predetermined schedules. This strategy lowers the price of keeping goods on hand and improves overall productivity by preventing overproduction.

5.5 Unvarying Work

Lean manufacturing's key tenet is standardised work. It entails capturing and putting into practice the most well-known techniques for carrying out particular jobs. By offering a benchmark for assessing and improving processes, standardised work maintains consistency, minimises variation, and promotes continuous improvement.

5.6 Employee Empowerment and Engagement

Employee engagement and empowerment at all organisational levels are key components of lean manufacturing (Duhigg, 2016). Organisations can take advantage of employees' knowledge and creativity to find solutions to

problems by involving them in continuous improvement initiatives and giving them the required training and tools (Duhigg, 2016). This encourages a culture of continual development and contributes to the success of the entire organisation.

5.7 Quality Boosting

Integrating lean manufacturing emphasises preventing errors and guaranteeing quality at the beginning of the process. The manufacturing sector may improve product quality and customer satisfaction by putting error-proofing procedures (poka-yoke) into practice, performing root cause analysis, and giving employees more control over quality.

Organisations can significantly increase productivity, quality, lead times, and customer happiness by applying lean manufacturing principles to the manufacturing business. It enables the sector to cut costs, quickly adapt to shifting market demands, and foster a culture of constant development. However, a methodical strategy for adoption and continuous improvement, commitment, leadership support, and employee involvement is necessary for successful lean manufacturing integration.

In the last two decades, the concept of staff participation has changed dramatically with the improved suggestions and techniques that are being innovated and used for tool cutting and waste management. The other companies have approximated the efficiency of the industry with increased reliance on the tools of total quality management (TQM) or the more Japanese forms, such as company-wide quality control (CWQC), the Production System of Toyota, and lean manufacturing (TPS).

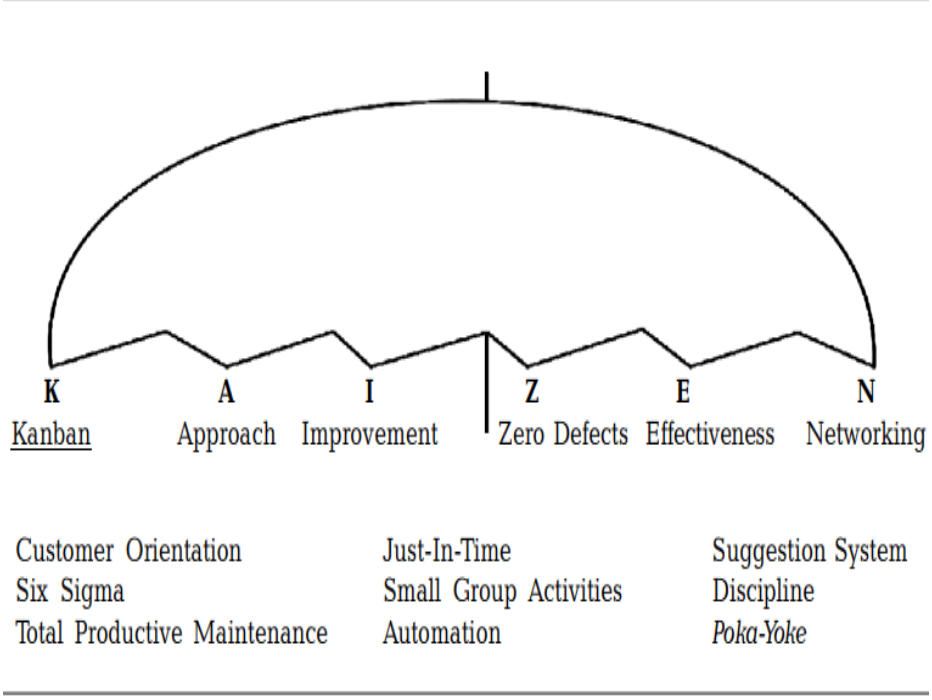

Figure 2. Progression in the approach of Kaizen
(Source: Mahabub Rehman, 2012)

6. Conclusion

Five primary elements constitute different aspects needed to support a lean manufacturing program, and the full distribution of these elements will drive an organization to a greater path of achieving world-class manufacturing, Wang et al., (2011). Manufacturing flow is the feature that conveys physical alterations and design quality that are distributed as a segment of the cell. Organization facet deals with the recognition of employees' functions and roles, providing training to employees and lastly communicating. Process controls the feature is aimed at observing, controlling, maintaining, and following ways to enhance the process. Metrics addresses perceivable, results-based

performance standards, chosen improvements, and teamwork recognition. Logistics ensures rules and mechanisms for the implementation of lean operations are planned and controlled for the flow of material. Each of these elements focuses on a certain area of development and capitalizes on the activities, these steps should be followed to ensure implementation and success of the lean manufacturing program are not criticized and maximum benefit is achieved, Pheng et al., (2002).

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