Uluslararası İleri Doğa Bilimleri ve Mühendislik Araştırmaları Dergisi
Sayı 8, S. 146-158, 8, 2024

Araştırma Makalesi

International Journal of Advanced Natural Sciences and Engineering Researches
Volume 8, pp. 146-158, 8, 2024

Research Article

https://as-proceeding.com/index.php/ijanser
ISSN:2980-0811

An Overview of the Sustainability of Lean Production

Ayşenur ERDİL* [1]

[1] *Faculty of Political Sciences, İstanbul Medeniyet University, Türkiye*

* *runesyalidre@gmail.com*

(Received: 06 September 2024, Accepted: 18 September 2024)

(3rd International Conference on Scientific and Innovative Studies ICSIS 2024, 11-12 September)

ATIF/REFERENCE: Erdil, A. (2024). An Overview of the Sustainability of Lean Production, *International Journal of Advanced Natural Sciences and Engineering Researches*, 8(8), 146-158.

Abstract – Today, it has become inevitable for companies to develop innovative strategies in order to achieve sustainable success due to increasingly intense competition conditions. Especially organizations operating in sectors where competition is intense and inevitable need to reduce their costs and increase their profits in order to survive in the globalizing world. One of the main elements of achieving these goals is to utilize the philosophy of Lean Management, one of the new management approaches. Lean management approach is a set of systems and techniques that aim to eliminate waste in the production process, to ensure more effective and efficient use of production capacity, and to increase business performance and business profitability. The most important constraint of the lean production technique during the implementation phase is that it requires a long-term and determined work. Within the scope of the research, information on lean philosophy and lean production was given. A general information about lean production was presented and lean production techniques were mentioned. In addition, the benefits of lean production from sectoral applications are discussed and a general evaluation is made.

Keywords –Business, Lean, Lean Management, Lean production.

I. Introduction

Lean systems are production systems that maximize the value added by the activity by eliminating waste and delays in each activity of a company. According to Krajewski and others; lean production system addresses the issue of waste that we encounter in every field in our daily lives and aims to maximize productivity with the new system established by minimizing all kinds of waste in production systems. In other words, it is possible to say that this system is a methodology established to fulfill customer demand in a complete way without wasting the resources available to the enterprise. Currently, lean production systems—which are founded on the fundamental idea of getting rid of waste and non-value-adding tasks—are crucial for offering a different strategy that may boost productivity and profitability. In other words, companies that set up their operations using lean production systematics—that is, using the fewest possible resources, costs, labour hours, and time—can provide their clients with the widest range of high-quality products at the most competitive prices (Krisztina and Zsolt, 2011; Demeter and Matyusz, 2011; Krajewski et al., 2020).

Lean production is an approach that aims to eliminate all waste that burdens production. In lean production, the advantages of labor-intensive production and mass production are brought together. The main strategy of lean production is to improve quality, cost and delivery performance simultaneously by increasing speed and reducing flow time. Lean production serves to distinguish between an activity that transforms or shapes materials or information in line with customer needs and creates added value, and an activity that uses time and resources but does not add value to the product in line with customer needs and does not create added value. The lean production system aims to meet the customer's demand with minimum resources, in the shortest time, cheapest and error-free. This means zero-defect, just-in-time, small batch, high variety production. There are effective methods and techniques that enable the realization of the goals of Master Production Schedule (MPS) (Sengenberger, 1994; Cooke, 1994; Shah and Ward, 2003; Shah and Ward, 2007; Türkan, 2010; Ståhl et al., 2014; Arici and Gök, 2016).

Developing creative tactics has become imperative for organizations to attain lasting success in the current highly competitive environment. It may be anticipated that companies will be organized in line with the three fundamental strategies identified by Porter (Bordean, et al., 2011) as generic strategies in order for new entrants to establish a presence in the market and for established companies to preserve or grow their market share. With today's intense global competition, businesses must support cost-oriented and competitive strategies regardless of which of the three strategies—differentiation, cost advantage, and responsiveness—they choose (Gök and Arıcı, 2016).

The research of Moyano-Fuentes and Sacristan-Diaz proposes a new categorization of the literature that identifies important components needed for the establishment and management of Linear ProgramingS (LPs). It may offer fresh chances for thorough and pertinent study that will further our understanding of LP in a more transparent manner. An expanded model of LP has been developed as a result of the conclusions drawn from the assessment of the articles that were examined. In particular, two additional categories of variables are introduced that need be considered in order to fully comprehend LP. The supplied model encompasses not only value chain elements and internal features at the shop floor level, but also work organization and the influence of the geographical setting on LP. Furthermore, the critical evaluation of literature has made it possible to identify a number of particular elements for which there is no evidence to support. Since the breadth and importance of LP theory and research have evolved throughout time, it is imperative to employ a retroactive perspective together with an international perspective that highlights the key contemporary LP issues. In order to gain a more in-depth and comprehensive knowledge of LP, we aim to address this topic in this study through highlighting the essential components for LP development and management. We also hope to conduct a critical evaluation, determine relationships that emerge in LP research, make it easier for young investigators to conduct studies on LP, and attempt to offer fresh perspectives to subsequent LP investigation (Womack and Jones, 1998; Moyano-Fuentes and Sacristan-Diaz, 2012).

Although constant enhancement is regarded as the foundation of lean methodology, processes have been improved long before lean was on business agendas. In one of Norway's most significant auto manufacturing groupings, where continuous enhancement has presented a problem for decades, this study will trace the historical development of continuous enhancement. According to a poll with over 600 participants, people view constant enhancement as an inherent component of the jobs they perform on an everyday basis at employment. However, there are variations in what is considered natural based on an individual's position within an organization. Even within businesses in the same business, there are variances in the ways that ongoing enhancement is implemented. A case company has been recognized twice with the Toyota Prize for Single Minute Exchange of Dies (SMED) and continual development. However, the literature's descriptions are not replicated here; instead, clever solutions to real-world issues are provided. The operators stated that copying from others would not have worked. It was argued that since no two manufacturing lines are same, uniform equipment would be ineffective. When speaking with business owners, a cultural situation became apparent as well. The study emphasized goal knowledge, and comparable underlying preconditions were found for tool utilization. Knowledge and the capacity to impact the actual work process were firmly ingrained in the workforce (Holtskog, 2013).

Right now, lean manufacturing (LM) is experiencing a second coming of age. Businesses across several sectors are adopting lean methodologies in order to stay competitive and get superior outcomes. This essay will focus on how lean principles may help businesses increase the performance of their inventory turnover. Our major claim is that companies with a high adoption rate of lean techniques have higher inventory turnover than companies without an LM strategy. However, depending on their contingencies, equally efficient producers might experience very different transfer of inventory rates. A number of performance metrics can be effectively employed since manufacturing performance is correlated with a variety of activities. The most common metrics include unit manufacturing cost, production cycle time, delivery speed and dependability, quality of the product, levels of stock and employee turnover, rejections and scrap, modifying, labour and machinery efficiency, among others (Shah and Ward, 2003; Vastag and Whybark, 2005; Demeter and Matyusz, 2011).

The Relationships within Sustainability and Lean Production: The circumstances required for long-term survival of organizations have shifted and as a result, businesses are starting to experience greater pressure from stakeholders than ever before. From an institutional perspective, and in order to maintain their competitive edge, efficient manufacturing has become a necessary and mandatory requirement to engage in protecting the environment, community sustainability, and improving the performance of the economy. As a result, in addition to financial features, environmental and social performance aspects have been included into their processes, and sustainability has been separated into three basic parameters: economic, environmental, and social (Tãucean et al., 2019). The technological component has been included over the past few years (Rosen and Shawy, 2012; Spiegel et al., 2015). Modern economic and social civilization depends heavily on industrialization, and the effects of its operations are being felt negatively by the environment (Spiegel et al., 2015). Thus, the drive toward sustainability was aided by lean manufacturing. In the production structure, lean manufacturing concentrates on minimizing or doing away with operational wastes and losses through process modifications and ongoing enhancement to cut down on operations that do not add value to the final product, whereas sustainability seeks to do away with waste products and revenue losses which have environmental effects. According to Iranmanesh et al. (2019), lean manufacturing could reduce wasteful spending by doing away with non-value-adding activities like overproduction, excessive processing, transportation, awaiting, inventory, and so forth It may additionally enhance energy, emissions, water, and chemical handling operations. The circumstances required for long-term survival of organizations have changed, and as a result, businesses are beginning to feel greater pressure from stakeholders than ever before. From an institutional perspective, and in order to maintain their competitive edge, efficient manufacturing has grown into a necessary and mandatory requirement to engage in protecting the environment, community sustainability, and improving the performance of the economy. As a result, in addition to their financial features, social and environmental aspects have been included into their procedures, and sustainability has been separated into three fundamental dimensions: economic, environmental, and social (Tãucean et al., 2019). The technological component has been included over the past few years (Rosen and Shawy, 2012; Spiegel et al., 2015).

Close Supplier Relations: In a lean system, it is often necessary to reduce inventory, therefore maintaining constant touch with suppliers might make the procedure smoother. The goods or supplies scheduled to be delivered have to be transported regularly, without a long flow time, and of the greatest quality. The necessity of communication shines through here, as it does in other aspects of our life. Good collaboration with providers has numerous advantages for both parties. For instance, a supplier that understands what materials a company requires can develop an effective stock scheduling and distribution process. Suppliers are frequently viewed as collaborators in business, therefore both parties are anticipated to make compromises for their mutual advantage. The initial step to close cooperation is having a small number of providers who can communicate effectively. Furthermore, it is vital to collaborate with a supplier geographically close to the business for the purpose to reduce lead time and prevent waste of time (Sengenberger, 1994; Cooke, 1994; Türkan, 2010; Ståhl et al., 2014).

Business Benefits and Implementation: Lean systems can be beneficial for firms that operate in a competitive climate or require little resources. Furthermore, it can be a quick and secure approach for firms with small workstations that cannot be stocked, as well as organizations looking to boost their profitability. This technique, which ensures employees' active engagement in procedures, appears to be effective for human resources and performance management as well. It is a smart system that solves problems instantly through just-in-time production and continual development. The following areas should be examined by firms looking to implement a lean system: employee income costs, synergy and trust, reward systems and employee categorization, processes/processes, supply chain purchasing, and logistics. The cost of employee remuneration is a problem that has arranged in a lean system so that employees themselves, in addition to experts, are responsible for improvement. After a while, workers can get distracted or lose motivation from processes that demand a lot of focus and have strict deadlines for completion. At this time, it might be prudent for managers to prioritize workflow above employee speed and preserve motivation among employees. Synchronization and cooperation; because employee engagement is critical in the lean production system, an employee at the bottom of the organization and a mid-level employee may occasionally have to handle the same process. As in any business, it is critical to foster a climate of collaboration and trust among positions. Once the appropriate synergy setting is built, it is feasible to build a more productive workplace. In a lean production system, supply chain, purchasing, and logistics play a significant role in the relationship with suppliers. Regular dispatches are crucial in lean systems, which emphasize the need for few, self-suppliers. One of the methods of frequent shipping may be the supplier's location, which is close by geographically. The process will be impacted by the way the material is delivered, thus it needs to be carefully considered and prepared for. Reliability of the supplier is also crucial. Because the material should always be available to a business with low stock levels. If not, manufacturing might be disrupted since it won't be able to get the material it needs when it wants it (Sengenberger, 1994; Cooke, 1994; Shah and Ward, 2003; Shah and Ward, 2007; Türkan, 2010; Ståhl et al., 2014; Arici and Gök, 2016).

The automotive industry gave rise to the lean production idea, which is now widely applied in other industries. Its application in mining is challenging due to the dynamic nature of mining operations, which introduces a high level of uncertainty into different unit operations. Eliminating ambiguity and making the most accurate predictions about the behavior of the process are necessary to minimize effort waste. Moreover, the whole mining chain must be taken into account in order to implement a lean approach to mining, beginning with mine discovery, mine planning, drilling operation, blasting, loading and transportation, ore dressing procedures, reclamation, etc. Being lean in mining is based not only on mine production systems made up of equipment and machinery, but also on the quality and reliability of information flow in real time, which generates action plans. Furthermore, reliability and maintenance readiness have a significant impact on the amount of waste generated during the process. For example, if the ore body is not appropriately delineated/characterised, drilling operations are not completed correctly, and the charge and loading processes are incorrect, all of this can contribute to resource waste. In current times of intense rivalry, businesses may resort to rationalization in order to stay profitable. Lean Production is one idea that has been successful in rationalizing the industrial and even the healthcare sectors. This piece presents an overview of lean production and its application to the mining industry based on a review of the literature. (Wijaya et al., 2009; Klippel et al., 2008a; Yingling et al., 2000; Jon et al., 2000).

Lean Production Systems- Historical Process: Henry Ford was the first to truly integrate a whole production process. He established what he dubbed flow production at Highland Park in 1913, using pieces that could be continually changed by a moving belt in addition to regular production and continuous manufacturing. Ford defined the steps of manufacturing and constructed a framework that fit perfectly onto the part by fabricating and assembling the vehicle's components in a matter of minutes utilizing specialized machinery and pre-made gauges. It is represented a radical departure from the American System. Ford went astray when the world began to want more diversity than the T model. Numerous models, each with a plethora of choices, were being met by other automakers. They gradually increased the size of the machinery in their manufacturing facilities so that it could run quicker and lower costs per step in the process; yet, they hardly ever increased production times or inventories, unless they were in extremely uncommon circumstances like engine processing lines, where all the process stages might be. Kiichiro Toyoda, Taiichi Ohno, and other Toyota executives saw that change was desperately needed, initially in the 1930s and then again after World War II, and that a number of little improvements may increase the likelihood of achieving process flow continuity. Consequently, they built upon Ford's initial concept to create the Toyota Production System (TPS) (Cooke, 1994; Sengenberger, 1994; Türkan , 2010; Balcıoğlu and Gözel, 2019).

After the Second World War, Taiichi Ohno observed the Ford Production System firsthand and applied what he learned to the production processes at the Toyota factory, laying the groundwork for the lean management concept. The following is how Toyota Motor Company President Fujio Cho explains why this strategy has been successful. "There isn't just one feature that defines the Toyota style and sets Toyota apart. Maintaining the components' unity as a system and applying them consistently each day is crucial. By maximizing the flexibility and utilizing all of the potential of all production factors, lean production ensures that all customer demands are met in an identical manner while using the fewest resources possible and the shortest amount of time possible. Additionally, it is inexpensive and error-free. It is the shortening of the time from order to delivery by continuously improving and eliminating wastage that does not provide any value to the customer and only increases the company's activities. A key contributor to the conceptual development of the lean production system, lean production as a system aims to produce with the least amount of labour, the least amount of space needed for production, the least amount of resources used, the least amount of stock kept on hand, the fewest mistakes made, the quickest turnaround time, and the least amount of customer dissatisfaction. Getting the best results with the least amount of input is the goal of lean manufacturing. One of the most crucial aspects of any lean production process is getting rid of unnecessary components in order to maximize output while minimizing input (Sengenberger , 1994; Cooke, 1994; Sengenberger, 1994; Pettersen, 2009; Türkan , 2010; Balcıoğlu and Gözel, 2019).

II. MATERIALS AND METHOD

Lean Production Techniques: For enterprises, lean production is essential. Only when lean manufacturing concepts are applied throughout the organization can there be sustainable competition in the global marketplace. The following are the direct and indirect objectives that are directed towards businesses that use lean thinking: Zero-defect production; cost reduction; meeting client requests in any amount at any time; avoiding extra inventory; and continual development via waste elimination. The main goal of the lean production strategy is to minimize or completely eradicate the wastes listed above, which are commonly observed in businesses. For this reason, several strategies and tactics have been created. The following is a summary of these approaches and procedures:

A. *The 3M Method (Muda-Muri-Mura)*

Businesses make smaller-scale purchases as opposed to larger-scale purchases because they collaborate with their suppliers. That being said, there are instances in which other companies are compelled to maintain a substantial level of safety stock due to the primary supplier failing to provide the required information. Suppliers are therefore required to cover these expenses. because suppliers fear that the big corporation may stop working with them. Just-in-time shipping can occur in supply chains that have implemented Total Quality Management (TQM), eliminating the need to create inventory. In order to do this, the primary firm prepares a defined delivery timetable based on realistic estimates produced by the marketing departments and requests from the last links in the supply chain. As a result, the following chart details the modifications that took place within the chart's validity period. Reductions in stock lead to hidden issues, which can be resolved by improvement initiatives. Because of their assignment as a consequence of the TQM strategy, staff are able to act quickly to correct production problems. Defective items are therefore either discarded or maintained in stock. A supply chain is made up of a number of different business processes, such as obtaining the parts and raw materials needed to produce products, turning those materials and raw materials into finished goods, adding value to those goods, distributing them to customers and retailers, and facilitating communication and information sharing among various business stakeholders along the chain. It is a framework that permits individuals to behave in unison (Croxton et al., 2001; Hugos, 2003; Casadesús and de Castro, 2005; İslamoğlu, 2006; Yıldırım, 2009; Yayla, 2019).

B. *Just In Time (JIT) and Pull Method:*

Just In Time (JIT), or just-in-time, production, is a method whereby every component in a manufacturing line is manufactured as soon as it is required by the line that comes behind it. This phase guarantees that manufacturing will not proceed without the request of the client and enables the consumer to obtain the good or service whenever they want. The production line runs according to demand. It is believed that non-value-adding manufacturing processes can be terminated, as well as superfluous capacity or inventory, in order to minimize waste. Stated differently, an internal customer is one that was created and promoted by the prior manufacturing unit, not the goods, but the goods it takes from that manufacturing facility in accordance with its Requirements. The goal is to reduce each unit's overall production time. (Jon et al., 2000; Shah and Ward, 2007; Türkan, 2010; Ståhl et al., 2014; Rüttimann and Stöckli, 2016).

Just-in-time (JIT) production is a method that uses the least amount of labour, equipment, materials, and space to produce a product in the quantity and time requested by the client.

Principles like assuring production in the form of flow, applying flow time, balancing the production warehouse's pace with the demand, and setting up a pull production system are the foundation of just-in-time (JIT) manufacturing. It decreases flow time, minimizes production waste, and builds a system that cannot withstand disturbances to the production System (Hopp and Spearman, 2004; Shah and Ward, 2007; Arıcı and Gök, 2016; Rüttimann and Stöckli, 2016).

C. *Planning in a Just-in-Time Production Setting*

A novel method of production control called the KANBAN system is employed to organize production tasks and manage the movement of materials in a just-in-time (JIT) environment. There are two types of production control systems: push and pull systems.

-*Push Systems:* Forecasted demand values serve as the basis for production and inventory control in traditional systems, which are push systems. Push systems are also known as schedule-based or schedule-pushed systems since the production schedule is established based on this schedule and production is executed in line with it over time. Production processes in this setting always generate in order to satisfy the demands of the subsequent phase. But in this instance, it is difficult to immediately adjust to modifications brought about by a failure with one of the production processes or variations in demand. It is necessary to update the schedules and send them to the appropriate units in order to adjust the production speed to the changes. Push (in classical systems) adjusts to changes by keeping stock between operations because such modifications take time. Working with high intermediate stocks has become necessary to maintain output (Hopp and Spearman, 2004; Shah and Ward, 2007; Arıcı and Gök, 2016; Rüttimann and Stöckli, 2016).

-*Pull Systems:* These are systems where components are only required and drawn from upstream operations in the quantity and timing at which they are consumed by downstream processes. They're also known as demand pull systems as a result. It is only transmitted to the manufacturing process in pull systems, as opposed to push systems. This process could involve able to take only the components it requires from the preceding processes because only the final process can determine which product will have been manufactured, when, and in what amount. Pulling systems make certain that modifications in the marketplace are transmitted to the production system instantaneously and easily. Rather than sending production schedules to every stage in central planning systems, sending schedules only to the final production stage and completing the schedule demands from the last stage backwards through kanbans would accomplish this. Push systems require higher inventory carrying costs than pull systems, although intermediate inventories between stages will still allow for the adaptability of demand fluctuations. To put it another way, kanbans in pulling systems ensure demand adaptability, whereas intermediate stock in pushing systems does the same. The production schedule is not delivered to any operations other than the last production stage, and schedule information is transmitted to all production stages other than the final stage via Kanban. In this system, the quantity of each part to be manufactured is indicated on kanban cards. Kanbans constantly move in the opposite directions of the production circulation, but with tangible components that connect the different phases. As a result of this connection of production steps, the components needed are manufactured in the appropriate amount and time, with no intermediate inventories between phases. When this chain is broadened to providers outside the organization, raw material stocks are eliminated (Hopp and Spearman, 2004; Shah and Ward, 2007; Arıcı and Gök, 2016; Rüttimann and Stöckli, 2016).

D. Planning in a Just-in-Time Production Setting

JIDOKA guarantees on-time delivery, lowers waste, boosts efficiency, and enhances manufacturing quality. The foundational principles of JIDOKA include granting operators the authority to halt production and guaranteeing the identification and elimination of the problem's source, empowering machines to control output, enabling them to stop automatically or to indicate abnormalities, distinguishing the workforce of operators from the operation of the machine, guaranteeing the management of multiple machines, and acting quickly to identify and resolve problems (Shah and Ward, 2003; Shah and Ward, 2007; Ståhl et al., 2014; Arıcı and Gök, 2016).

E. 5S Approach

The 5S management system originated in Japan. This method was developed by combining and using five terms that begin with the Japanese initials S. Its goals are to guarantee workplace order, avoid material stock that isn't needed, boost worker productivity, make suitable and accessible archiving, and cut down on labour and material waste. Every worker is involved with this system, and it organizes the workspace. An efficient and practical working environment is therefore created. Additionally, it increases visibility of the process and work environment. Here is an explanation of the 5S principles (Pepper and Spedding, 2010; Apilioğulları, 2019; Balcıoğlu and Gözel, 2019; Selim Balcioglu and Gozel, 2019);

(i) Seiri (Classification): Discard the useless and separate the required. It is important to consider if and to what extent this content is required.

(ii) Seiton (Organizing): Tidily arrange the remaining items. Assign a location for everything and arrange items in their correct order. All items have to be arranged in groups based on their categories and purposes, then put in the proper locations.

(iii) Seiso (Cleaning): Give it a wash and clean. All items and the surrounding area must be cleaned. Cleaning offers control as well as inspection.

(iv) Seiketsu (Standardization): Assure consistent, ongoing use of the first three S's. By fixing errors, work should be monitored, evaluated, and standardized.

(v) Shitsuke (Discipline): To accomplish the first 4S, practice discipline. Discipline is the most challenging step in making sure the set standards continue. Every person involved in this process should assume accountability for maintaining continuity, and audits should be carried out.

Employee cooperation and common sense are first required to establish a neat, orderly, and well-maintained work environment. In this sense, management ought to encourage and assist staff members as well.

F. KAIZEN Approach

Japanese words for change, goodness, and constant progress are kai and zen, respectively. Masaaki Imai invented this method, which is used in all fields. Its objectives are to do away with tasks that don't offer value for the client, keep production methods improving, and get rid of waste. For a leader and those around them, a mindset and style of thinking are fundamental to both Kaizen and learning. It is introspection, introspection, self-criticism, and a strong desire to get better. An essential component of Kaizen is the investigation of the five whys. A technique that helps us identify the source of an issue and find a workable solution is to ask why five times when a problem comes up. This technique is essential to lean management problem solving. (Analyzing Problems with Five Whys). The plan is to develop and execute a countermeasure, then track the outcomes. The new procedure has to be standardized as the last stage. In this case, learning and standardization work hand in hand and serve as the cornerstone of ongoing development (Liker, 2015). Kaizen attempts to improve the present state of affairs in the first phase. It initially plans on making modest (the human being) and significant (small group) adjustments for this. Large-scale modifications (innovations) come next.

The stages of Kaizen are as follows: reduce (simplify, centralize, synchronize, integrate, integrate), elimination (eliminate, stop, eliminate), and change (make alternative, modify, transform, divide). There are team leaders as well as participants who are chosen based on their suitability for the task in Kaizen collaboration (Shah and Ward, 2003; Pepper and Spedding, 2010; Ståhl et al., 2014; Arici, T. and Gök, 2016; Öksüz et al., 2017).

G. *Jidoka (Automation) Approach*

The Japanese term for jidoka, a lean manufacturing approach is *automation with a human touch.* The Toyota group's founder, Sakichi Toyoda, first proposed the idea when he created a textile loom that would automatically stop in the case of a malfunction. In the past, if a loom broke down, it would keep running and produce more shoddy textiles. To prevent this issue, an operator was paired with every machine at the same time. One operator could operate many machines using the Jidoka, and in the event of an error, the machine would shut down on its own and permission to halt the procedure in order to improve quality. Each team member in such a system is accountable for stopping the line when they notice an issue. This is due to the fact that assuring quality while the task is being done is far more effective than ensuring quality afterwards. One of the key tenets of lean management philosophy is doing things correctly the first time. One technique that aids in achieving this objective is jidoka. An andon visual warning system is employed throughout this exercise. Andon is a system that may alert machines and operators to any abnormalities, such missing components, defective tools, or goods that don't meet specifications (Shah and Ward, 2003; Shah and Ward, 2007; Ståhl et al., 2014; Arici and Gök, 2016; Zoroğlu, 2024).

H. *The Genchi Genbutsu Method*

It is insufficient to study a problem using information gathered at a desk in order to truly comprehend it. Going down to the problem's location (gembaya) and analyzing the conditions by firsthand observation are essential steps in a successful problem-solving process (Go and See). The successful implementation of lean management and the prompt and efficient resolution of issues require the ability to make the right decisions, gather information, examine problems immediately, look into potential causes, and reach goals by coming to a quick decision in unanimity. All organizational challenges should be solved using this concept. When a corporation produces for a market, it should never produce for that market without first visiting it in person and conducting a thorough analysis—that is, without just sitting at a desk and doing so. Determining the requirements and issues on the spot and adapting output accordingly is the healthiest course of action (Shah and Ward, 2003; Shah and Ward, 2007; Ståhl et al., 2014; Arici and Gök, 2016).

İ. *Poka Yoke Approach*

A Lean Manufacturing technique called Poka-Yoke keeps workers from making errors when performing physical labour. By using this technique, human mistakes may be identified and fixed before they happen. By employing a variety of error-preventing and auxiliary tools and strategies against human factor situations like forgetfulness, inattention, misunderstanding, lack of concentration, lack of standards, inexperience, negligence, sabotage, etc., Poka-Yoke seeks to achieve zero-defect production without requiring for extra oversight staff. With the help of apps for discontinuing switches, LED warnings, templates, guidance, sensors, adjusting pins, and other devices, Poka-Yoke helps operators avoid errors. Three primary tasks they perform are control, warning, and shutdown/stop. In this situation, existing automation systems must be combined with sensors and systems, which form the core of advanced technology for automation. In Poka-Yoke programs, the right Poka-Yoke instruments are chosen based on the product's features in order to detect deviations from the norms. In order to detect deviations from established protocols and benchmarks, devices are deployed (Shah and Ward, 2003; Shah and Ward, 2007; Ståhl et al., 2014; Arici and Gök, 2016).

J. *Total Productive Maintenance (TPM)*

The goal of total productive maintenance is to enhance equipment efficiency, minimize faults, and include all employees in daily production operations. It also imposes responsibility for maintaining the workstation and equipment used by the workers.

Establishing the system is necessary to achieve the goals of zeroing the entire production system by preventing losses, accidents, defects, and failures. Maintenance activities facilitate the development of a business culture that will maximize the efficiency of the production system. The major goals are to increase the lifespan of machinery and equipment and reduce labour, material, and time loss caused by malfunctions. Total productive maintenance is the most recent procedure to be added to the maintenance of systems, which has previously included breakdown, preventive, predictive, and efficient maintenance. The goals of total productive maintenance are to expand the equipment's lifespan, maintain it in optimal condition for service or production, boost return on investment, improve emergency response times, and guarantee worker safety. The whole workforce, from management to operators, participates in its creation. Total productive maintenance reduces process scrap rates, machine and line downtime, machine breakdowns, and work accidents while increasing overall equipment productivity, maximizing plant productivity worldwide, and installing maintenance systems needed for the duration of the machine or facility's life cycle.The following losses are included in the comparison of total productive maintenance: downtime losses from equipment performance (low tempo, idle and minor downtime, breakdowns, setup and adjustments, cutting tool and JIT replacement, commissioning), scrap losses (scrap and rework losses), shutdown losses, losses from production labour (management losses, motion financial losses), organization expenditures, shipping losses, measuring and modification losses, material losses, losses of energy, tool and die damages (Shah and Ward, 2003; Shah and Ward , 2007; Ståhl et al., 2014; Arici and Gök, 2016; Bilgin Sarı, 2018).

K. *The Single-Minute Mould Exchange/Single-Minute Exchange of Dies (SMED) approach*

This method, which was initially used by the well-known Japanese engineer Shigeo Shingo, reduces the amount of time needed for model changes, improving manufacturing efficiency and/or opening the door for small-batch production. Because it makes it simpler to adjust to unforeseen changes in production schedules, it also helps to minimize overstocking. The time interval between producing the final component, model turnaround time (MTT) of a batch and the first flawless component of the subsequent batch is known as the MTT. MTT is made up of components, tools, and equipment that are assembled, replaced, positioned, and adjusted. One lean production strategy that helps achieve JIT production—which allows for model modifications to be performed in the shortest amount of time—is shortening the MTT. There are a number of reasons why MTT is shortened, including shorter MTT, higher levels of competition, smaller batch sizes, shorter transition periods, and more frequent model turnaround. Model turnaround operations are divided into two categories: internal tasks that need to be completed while the machine is stopped and not manufacturing parts, and exterior tasks that can be completed while the machine is operating and producing. The list of tools needed for model rotation is created at the point where internal and exterior operations are separated. Every piece of equipment is examined to ensure that it is in good operating order. They are guaranteed to be accessible at every place of employment.

Prior to the model being returned, operational conditions, functional standardization, and the employment of intermediary apparatus are guaranteed at the stage of converting internal activities into external activities. During the time of cutting all activities, parallel operations, the creation of conservative mechanisms, the prohibition of adjustments, and the automation of tasks are guaranteed. Internal activities are upgraded and turned into external activities as part of the MTT development process, which begins and finishes with 5S. The model modification procedure is hampered by screws, so it's important to avoid panicking throughout the process, reduce post-change modifications, standardize the castings used in the machine, and standardize all setup tasks (Shah and Ward, 2003; Shah and Ward, 2007; Erkek, 2008; Ståhl et al., 2014; Arici and Gök, 2016).

III. The Application of this Concept

Computer-integrated manufacturing (CIM) and Automation in Lean Production: Lean production is a flexible production method that is sensitive to customer satisfaction. In order to respond to customer demands, it aims to reduce costs, shorten customer waiting time, reduce inventories and improve quality. The aim of lean production is to ensure on-time production, a seamless organization, teamwork and communication management. These are listed as below (Shah and Ward, 2003; Shah and Ward , 2007; Erkek, 2008; Ståhl et al., 2014; Arici and Gök, 2016);

- Issues such as transparency anytime, anywhere become possible only with automation and the use of Computer-integrated manufacturing (CIM) in production.

- Thanks to CIM, information exchanges, transportation and storage activities are accelerated. Accordingly, costs decrease and efficiency increases. As a result, customer satisfaction, which is the main goal of lean production, is achieved.

IV. Lean Systems in Turkey and the World

Lean systems are mostly concentrated in the automotive sector in Turkey, perhaps because they are based on Toyota. However, lean production and management can be used in many sectors. Among these, the service sector, health sector and agriculture sector can also take their place. In fact, we can see that companies acting with the logic of sustainability evolve towards lean management. In our country, brands such as Temsa and Otoyol act with this system. In addition, Tofaş is also implementing the lean production system. In the textile sector, Sun Tekstil relies on lean systems to respond to consumer demand in the fastest way. Nike, a shoe and sportswear brand in the world, Intel, one of the popular technology companies, Caterpiller Inc., a construction material manufacturer known as Cat, and Porsche, which serves luxury consumption in the automotive sector, are also known lean production system brands. Porsche took a risk by switching to lean production in the 90s when it was making more losses than profits, but the result was much more positive than they expected. The brand, which shortened production times with the lean production system, made a profit in a few years. It is also a lean system to carry out all processes online in cases where documents or documents are required in public transactions. In agriculture, from time to time, in the name of regional inadequacy or conservation of natural resources, saving in irrigation activities to prevent water waste and irrigating with a drip system may also embody a lean philosophy. As a result, the lean system concept, which was developed to eliminate waste and activities that do not add value, is implemented in every field / sector where savings are tried to be made. The system, which was first known as the Toyota Production System (TPS) and then continued to develop as Lean Systems, is summarized in general terms. In today's world where there are local and global health crises, wars, climate problems, natural resource problems and economic bottlenecks, lean philosophy is an understanding that can be applied and made sustainable in many sectors. It is believed that if the details, functioning, purpose and processes of this system are well understood and put into practice, the absolute end will be positive and successful. Transitions to online processes that are widely used in Turkey, e-government document acquisition applications in the public sector, many systems that prevent paper waste can be called a lean System (Shah and Ward, 2003; Shah and Ward, 2007; Erkek, 2008; Türkan, 2010; Ståhl et al., 2014; Derin and Ilkım, 2016).

V. EVALUATION

Applying lean concepts is now critical for firms to achieve the flexibility needed to manage crises resulting from uncertainty, react quickly to changing situations, and continue to exist. Companies that wish to adjust to the new environment have reorganized their production and service systems in this way by conducting lean transformation studies. Determining what *value* is is the first and most crucial stage in the

Lean Production methodology. After defining value for businesses, the following stage is to get rid of wastes that don't provide value. Acceptance of waste removal concepts is necessary for this. In real life, the shift to a lean mindset starts with visual control and 5S. The next step would be to create standards for ongoing advancements. Workers need to be included in the standards' development Process. Putting lean manufacturing approach into practice entails more than just using lean tools. It also calls for a shift in the industry and business cultures. This is a gradual process that requires oversight and management. It's an iterative process that must be carried out consistently and persistently throughout time. When considering other concepts, lean manufacturing is still relatively new. Companies are hesitant to alter their procedures when they are not under enough pressure from competitors and consumers. Furthermore, the majority of firms are resistant to this shift since they believe it would cost them more money to do the necessary tasks. But since the proposed adjustments will stop waste, the goal is to increase firm profits rather than incur more expenses. The foundation for inspiration for constant enhancement is comprised of clearly defined objectives and actively involved leadership.

However, it requires a long-term view and a fundamental comprehension of people's innate drive for pursuit of objectives or achievement. The role of management is to encourage and promote this approach and concentrate the attainment of goals in line with the business's overall strategy.

When the contribution of Lean production activities to the productivity of the enterprises is examined; the positive effects of the system applied are seen in the elimination of errors, increase in continuous improvement efforts and decrease in occupational accidents. The most important benefit of the Total Productive Maintenance (TPM) system is the increase in overall equipment efficiency. In addition, since the applications provide benefits at many points in terms of reducing losses and malfunctions, they also play a major role in reducing costs. Since the TPM understanding includes the philosophy of continuous improvement, it is seen that the errors and malfunctions within the scope of total productive maintenance in the enterprises will be detected and eliminated, and thus the system will become an increasingly effective and advantageous structure day by day (Shah and Ward, 2003; Shah and Ward, 2007; Ståhl et al., 2014).

It is clear that the Lean production system, which is applied within the scope of preventing the occurrence of failures, planned maintenance and autonomous work of operators beyond the understanding of repairing the failures that occur, is a strategic tool for the effective use of machines and reducing costs, especially in manufacturing enterprises. Organizations that realize the advantages of the system and want to implement it should first test the system with the identified pilot applications and see its advantages

VI. CONCLUSION

Employee classification and reward schemes: It's critical that workers receive the appropriate incentives in a lean manufacturing system with a flexible workforce and job rotation. It is recommended to turn on various forms of rewards systems in order to boost worker productivity and motivation. A worker who is content and receives fair compensation for their efforts will strive for excellence and take the required care in their work in proportion. Employees are required to be their own quality inspectors in a lean system. As stated by the employment agreement, clauses that forbid work rotation may occasionally be included in contracts. A mutual trust agreement might resolve issues if workers are unionized. Depending on the employment agreement, contracts may occasionally have provisions that forbid job rotation. In the event that workers are unionized, a mutual trust arrangement might solve issues. Because of this, relationships with the union should likewise be formed and grown inside a trusting environment. Lean manufacturing is seen as a suitable strategy to achieve a new extensive vision of sustainability for businesses that want to achieve superiority in an environment that participants rapid advancement and change, so that numerous industrial businesses that employ it are predicted to be able to achieve sustainability in very soon. As a significant factor in establishing the top priorities for developing product designs and for manufacturing procedures and equipment that should be tailored to the environmental, economic, social, and technological sustainable development in all types of industries, sustainability is going to participate in a significant and growing role in the development and production of products and process techniques. Considering procedures, it was previously stated that workstations in lean systems should be organized in a specific order. A company that wishes to transition to this method may need to relocate the station or migrate to a new work space in order to transform the equipment more usable. Of course, this could prove worthwhile on its own. Entrepreneurs or administrators ought to embrace these risks and follow a plan.

ACKNOWLEDGMENT

I would like to appreciate the executives, the employees of this organization in this sector, and specialists who gave vital expertise and conversations.

REFERENCES

[1] Arici, T., and Gök, M. Ş. (2016). Yalin Üretim Sistemleri Ve Çevresel Yönetimde Yenilikçi Yaklaşim: Teknolojik Yönelim. Turkish Studies (Elektronik) , 11(21), 113 - 124.

[2] Balcıoğlu, Y. S. and Gözel, A. (2019). Alternatif Yönetim Yaklaşımlarından: Yalın Altı Sigma. GBRC, PressAcademia Procedia, 9(1), 105-108

[3] Bilgin Sarı, E. (2018). Yalın Üretim Uygulamaları Ve Kazanımları. Uluslararası İktisadi Ve İdari İncelemeler Dergisi, 585-600.

[4] Bordean, O., Borza, A., Razvan, N. and Crisan-Mitra, C. (2010). The Use of Michael Porter's Generic Strategies in the Romanian Hotel Industry. International Journal of Trade, Economics and Finance, 1, 173-178.

[5] Cooke, P. (1994). The experiences of german engineering firms in applying lean production methods, Lean Production and Beyond: Labour Aspects of a New Production Concept, International Institute for Labour Studies, 77-93, Geneva.

[6] Derin, N. and Ilkım, N.Ş. (2016). Dünyadan ve Türkiye'den Örneklerle Sağlık Hizmetlerinde Yalın Yönetim. Hacettepe Sağlık İdaresi Dergisi, 19(4), 481-502

[7] Erkek, S. (2008). Yalın Üretim Anlayışı, Konya Ticaret Odası Etüt Araştırma Servisi Araştırma Raporu, 2008/36/465

[8] Hopp, W.J. and Spearman, M.L. (2004). To pull or not to pull: what is the question? Manufacturing and Service Operations Management 6(2), 133–148.

[9] Holtskog, H. (2013). Continuous Improvement beyond The Lean Understanding. Procedia CIRP, 7, 575-579.

[10] Demeter, K. and Matyusz, Z. (2011). The impact of lean practices on inventory turnover. International Journal of Production Economics, 133(1), 154–163.

[11] Iranmanesh, M., Zailani, S., Hyun, S.S., Ali, M.H. and Kim, K. (2019). Impact of lean manufacturing practices on firms sustainable performance: Lean culture as a moderator. Sustainability, 11(4), 1-20.

[12] Jon, C. Y., Detty, R. B. and Sottile, J. (2000). Lean Manufacturing Principles And Their Applicability To The Mining Industry. Mineral Resources Engineering, 09 (02), 215–238.

[13] Klippel, A., Petter, C., and Antunes Jr., J. (2008a). Lean management implementation in mining industries. DYNA, 75(154), 81-89.

[14] Krajewski, L.J., Ritzman, L.P. and Malhotra, M.K. (2020). Üretim Yönetimi/Süreçler ve Tedarik Zincirleri (9.basım), Nobel Yayıncılık, Çeviri Editörü: Semra Birgün.

[15] Krisztina, D. and Zsolt, M. (2011). The Impact of Lean Practices on Inventory Turnover. International Journal of Production Economics, 133(1), 154-163.

[16] Liker, J. (2015). Toyota Tarzı. İstanbul: Optimist.

[17] Moyano-Fuentes, J. and Sacristan-Diaz, M. (2012). Learning on Lean: A Review of Thinking and Research. International Journal of Operations and Production Management, 32(5), 551- 582.

[18] Pepper, M.P.J. and Spedding, T.A. (2010) The Evolution of lean Six Sigma. International Journal of Quality & Reliability Management, 27, 138-155.

[19] Pettersen, J. (2009). Defining lean production: some conceptual and practical issues, The TQM Journal, 21(2), 127–142.

[20] Rosen, M.A. and Kishawy, H.A. (2012). Sustainable manufacturing and design: Concepts, Practices and Needs, Sustainability, 4, 154-174.

[21] Selim Balcioglu, Y. and Gozel, A. (2019). Alternatif Yönetim Yaklaşımlarından: Yalın Altı Sigma. PressAcademia Procedia, 9(1), 105-108.

[22] Sengenberger W (1994). Lean production-the way of working and producing in the future?, Lean Production and Beyond: Labour Aspects of a New Production Concept, International Institute For Labour Studies, 1-22, Geneva.

[23] Ståhl, ACF., Gustavsson, M., Karlsson, N., Johansson, G and Ekberg K. (2014) Lean production tools and decision latitude enable conditions for innovative learning in organizations: a multilevel analysis, Applied Ergonomics, 47, 285-291.

[24] Shah, R. and Ward P.T, (2007) Defining and developing measures of lean production, Journal of Operations Management, 25, 785-805.

[25] Spiegel, D.V., Linke, B.S., Stauder, J. and Buchholz, S. (2015). Sustainability strategies of manufacturing companies on corporate, business and operational level. International Journal of Strategic Engineering Asset Management, 2(3), 1-20.

[26] Tăucean, I.M., Tămăsilă, M., Ivascu, L., Miclea, S. and Negrut, M. (2019). Integrating sustainability and lean: SLIM method and enterprise game proposed. Sustainability, 1-28.

[27] Türkan, Ö. U. (2010). Üretimde Yalın Dönüşümün Temel Performans Kriterleri. Balıkesir Üniversitesi Fen Bilimleri Enstitüsü Dergisi, 12(2), 28-41.

[28] Öksüz, M. K., Öner, M. and Öner, S.C. (2017). Yalın Üretim Tekniklerinin Endüstri 4.0 Perspektifinden Değerlendirilmesi, 4th International Regional Development Conference, Tunceli, Turkey, 758-766
[29] Öztürk, İ. (2017). Altı Sigma, Yalın Üretim ve Yalın Altı Sigma Metodolojisinin Tarımsal İşletmelerde Verimlilik ve Kalite Üzerine Etkisi. KSÜ Doğa Bilimleri Dergisi, 20(3), 201-208.
[30] Rüttimann, B.G. and Stöckli, M.T. (2016) Lean and Industry 4.0—Twins, Partners, or Contenders? A Due Clarification Regarding the Supposed Clash of Two Production Systems. Journal of Service Science and Management, 9, 485-500.
[31] Vastag, G.Y. and Whybark, D.C. (2005). Inventory management: is there a knock-on effect? International Journal of Production Economics 93-94, 129–138.
[32] Wijaya, A., Kumar, R. and Kumar, U. (2009). Implementing lean principle into mining industry issues and challenges. International Symposium on Mine Planning and Equipment Selection, 1-9, Banff, Kanada.
[33] Womack, P. J. and Jones D.T. (1998), Yalın düşünce, Sistem Yayıncılık, Yayın No,163, 120-124, İstanbul.
[34] Yingling, J. C., Detty, R. B. and Sottile Jr., J. (2000). Lean manufacturing principles and their applicability to the mining industry. Mineral Resources Engineering, 9(2), 215-238.
[35] Zoroğlu, B.(2024). Toyota Kültürü ve Toyota'nın 14 İlkesi. https://bariszoroglu.wordpress.com/2013/01/17/toyota-kulturu-ve-toyotanin-14-ilkesi/