# THE IMPORTANCE OF THE IMPLEMENTATION OF LEAN TOOLS IN THE AUTOMOTIVE INDUSTRY

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***Abstract:*** *Just in Time and Just in Case are essential Lean technologies that offer significant benefits in a variety of supply chain management scenarios. Those technologies are the mainstays of the Lean concept's tools that help to reduce costs, increase profitability, and meet consumer demands. They aim to reduce all waste by eliminating all actions that do not add value to the product. The paper also discusses the Poka-Yoke system and Kanban cards in addition to these tools. The benefits of applying this approach are demonstrated by Volkswagen, which has used these technologies to greatly improve production processes and the entire company.*

***Keywords****: LEAN, automotive industry, JIT, JIC.*

## 1. INTRODUCTION

In the past, mass production dictated the conditions in the market. Everything that was produced could be sold. Today, supply is formed according to customer requirements and their wishes, which requires additional market research, not just serial production, without information on demand. If this system of production were to continue, it would result in high costs of production, stocks, storage, etc., which would increase the price of an individual product without good reason. In response to the increase in these costs, Lean was created. Forming the concept of Lean, as a solution to the problems of overproduction, downtime, and waiting, it was concluded that it is necessary to eliminate all types of waste. From this concept, Just In Time (JIT) emerged. Due to the possibility of production downtime using the JIT concept, a new tool, Just In Case (JIC), was developed (Jayaram et al., 2008; Monden, 2011). The main goal of Lean is to meet customer requirements, and the prerequisite for this is timely and accurate communication between employees, which is regulated by the introduction of the next tool, Kanban cards. All this is regulated, according to the hierarchy by the highest system and one of the main

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tools of Lean, the Poka-Yoke system. These tools, as well as how they work in the Volkswagen factory, will be discussed in more detail further below (Ohno & Bodek, 2019).

## 2. LEAN TOOLS – GENERAL TERMS

The Lean concept originated at Toyota in the post-World War II period. It was created as a solution to improve production, following the example of the American company Ford. Lean is based on a philosophy that defines value from the customer's point of view and constantly improves the way value is created. Specifically, Lean is based on eliminating any use of resources that may cause the waste or that do not contribute to the end value for the client. This can be achieved through the proper functioning and work of each worker so that he realizes his full potential and contributes as much as possible (Ohno & Bodek, 2019).

Within Lean, there are seven types of waste: overproduction, scrap, transport, waiting, overprocessing, inventory, and unnecessary movements. Excessive production means the production of products that cannot be placed on the market with the excessive performance of operations, excessive documentation, etc. Wasting in the form of transport means unnecessary movement of material between processes due to, e.g., poorly conceived layout. Due to poorly planned production, there is a wait for the execution of operations, which creates additional costs (Monden, 2011; Ohno & Bodek, 2019). Waste as a consequence of excessive processing and excessive movements occurs due to poor product design, too many processes, unnecessary movements of workers, etc. Inventory, as tied-up capital in warehouses, certainly does not contribute to the final value of the product but increases costs, so this waste tends to be minimized. And the last type of waste is scrap, which occurs due to the interruption of the production process due to, for example, incomplete or inaccurate information, which stops the whole flow. The implementation of the Lean concept is done by standardizing all procedures and constant training and testing of employees' knowledge. Changes begin with defining the problem and then the target state. Until this goal is established, it is necessary to continuously monitor processes, manage them, and improve them in real-time (Dabić-Miletić & Božić, 2021; Jayaram et al., 2008, Lepadatu & Janoski, 2018).

## 3. LEAN TOOLS IN PRODUCTION

The company must be aware of its waste before implementing the Lean approach. If the wrong waste is defined, the wrong Lean tools will be used, providing no results. Some of the tools used are JIT, JIC, Kanban cards, Poka-Yoke system, 5S, Muda, etc. In the following paper, some of these tools will be presented as key in the implementation of the Lean concept in a company. These solutions may improve a company's profitability by up to 70%, increase productivity by up to 67 percent, and cut production costs by up to 65 percent (Leksic et al., 2021; Jayaram et al., 2008).

### 3.1 Just in Time

Many researchers believe that the source of inefficiency is overstocking and the accumulation of finished products. The tool most commonly used in such situations is JIT. JIT implies an approach/strategy that focuses on producing the required amount of required products at the required time. The JIT strategy coordinates raw material orders

from suppliers directly with the production plan and program. The application of JIT in production refers to increasing the ability of workers to operate a larger number of machines and devices, as well as helping other workers in the event of interruptions and failures on the production line. JIT manufacturing systems reduce inventory costs because manufacturers receive materials and parts as needed for production and do not have to pay storage costs. Manufacturers are not left with unwanted inventory if the order is canceled or not fulfilled. One example of applying the JIT system is described by Toyota, a low-inventory automobile manufacturer that relies heavily on its supply chain to supply the parts needed to make automobile as needed. As a result, after receiving the order, the manufacturer orders the parts needed to assemble the automobile. For JIT production to succeed, companies must have continuous quality production, no equipment failures in machinery and equipment, and reliable suppliers (Lepadatu & Janoski, 2018; Ohno & Bodek, 2019).

### 3.2 Kanban

The Kanban system is used to improve the communication of all production lines. The system employees are as follows: Data on the type and quantity of units needed for production are entered on a card in the form of a label called "Kanban" and sent by workers of one process to employees of the previous process. In that way, the accuracy of the production process is achieved because there is information about where, how many, and which units are needed. The result of the application is that many processes in the plant are interconnected. This linking of factory processes enables better control and management of the required quantities of materials for different products. Sending information to the employees of previous processes gives them a clear picture in advance of the required quantities and time of production of individual parts. The following figure 1 illustrates the Kanban card (Thürer et al., 2022; Monden, 2011).


Figure 1. Kanban card (Thürer et al., 2022)

In the previous figure, it can see that the kanban card consists of several labels. The M4 mark indicates the route within the manufacturing process. A special mark on Kanban cards is WMI and VDS, which are parts of the vehicle identification number and consist of numbers and letters. On the card in Figure 2, the letter J in the WMI number indicates the geographical area of the manufacturer in this example, Japan. Other letters and numbers indicate engine types, models, and similar terms, and each manufacturer, for these and all other symbols on the card, has an internal list of unique markings (Thürer et al., 2022).

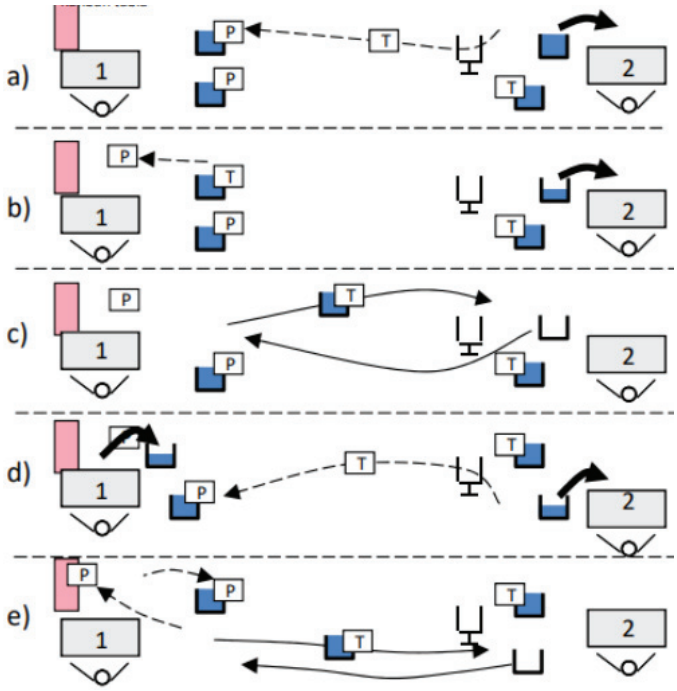


Figure 2. Two-card flow of Kanban system (Simeunović & Tomašević, 2022)

Figure 2 shows the two-card flow of Kanban. In the part of Figure a), the employees at Station 2 take the parts from one box. The transport card is placed in the Kanban card box and sent to Station 1 (transport signal), where the parts from the box are used. The employees at Station 1 take the production card (production signal) from the full box and add the transport card to that box, as seen in part of Figure b). In part of Figure c), it is shown that the employees at Station 1 send a box with a transport card to Station 2 (empty boxes from Station 2 are sent to Station 1). When one or more production cards are assembled at Station 1, production begins, as seen in segment d). Finally, he puts a production card in each full box, which indicates the beginning of the production of these parts (segment e) (Simeunović & Tomašević, 2022).

### 3.3 Just in Case

Another tool that will be described in this paper is JIC. The essence and significance of the JIC concept will be explained through a comparison with the JIT strategy. The JIC strategy is to maintain a minimum level of inventory with the goal of never running out. In essence, it can be costly if inventory is wasted, but the global nature of supply chains sometimes makes JIC a more appropriate approach than JIT. The goal of JIT is not to keep stocks low, but to improve efficiency and reduce costs and storage space. The parts are delivered to the mounting strips a few moments before they need to be installed, which allows the products to be made to order. This works well if the parts are manufactured in-house or by local suppliers who can guarantee delivery on a daily basis. While JIT requires suppliers to be able to provide parts on time, JIC only functions if companies continuously predict part demand and transmit information to suppliers in real time. This can ensure

that suppliers optimize production to meet demand and prevent companies from holding too much or too little inventory. Table 1 shows the basic differences between the JIT and JIC strategies (Lepadatu & Janoski, 2018; Jiang et al., 2022).

Table 1. Differences between JIT and JIC (Jiang et al., 2022; Monden, 2011)

| | **Just in Case** | **Just in Time** |
|---|---|---|
| Main goal | efficiency for end-users | efficiency for all entities |
| Production | MRP (material requirement planning) | centralized forecast |
| Planning and control | optimization of the existing system | demand planning |
| Quality | error detection | error prevention |
| Focus on performance | production plant efficiency | system efficiency |
| Suppliers | multiple, remote, independent | one or two sources; within the production system |
| Stocks | part of the system | strives for elimination |

### 3.4 Poka-Yoke system

Toyota Production System introduced the Poka-Yoke system in the 1960s to prevent human error. The goal of Poka-Yoke is to detect errors and take corrective action. It is hierarchically above the previously mentioned systems, which means that it controls all production processes. This system helps all employees avoid mistakes. Regardless of the type of technology used, the goal is to detect and eliminate abnormal conditions that lead to the prevention of product defects. This system stops the whole flow by detecting an error. With the development of Industry 4.0 and the application of its solutions, such as Cloud, Big Data, Blockchain, Digital Twin, Artificial Intelligence, etc., everyone is making Poka-Yoke's work easier (Lv et al., 2022; Lepadatu & Janoski, 2018).

The Poka Yoka system can also be used to prevent the causes of errors and control, which decides whether to adopt or reject the product. So, her task is to detect the error as soon as possible. By analyzing all processes and their continuous improvement, a "zero defect" is achieved. Detecting errors before defects in a product that has already reached the user is the main goal of this system. Errors should be detected as soon as possible and eliminated as much as possible, i.e., eliminate the cause of the same so that mistakes do not recur. The basics of implementing the Poka-Yoke system are preventive controls and warnings (Widjajanto et al., 2020; Lv et al., 2022).

By introducing the technique, the company is guided by the following principles: Defects are most often the result of human error. It should be pointed out that these mistakes happen without the worker even being aware of them. The causes are mostly poor communication or identification, poor training, etc. The solution to poor communication and incomplete information is certainly Kanban cards, which in themselves improve the exchange of information between employees. All errors made in the company are recorded and then analyzed. Most of them can be prevented by using Poka-Yoke

techniques (mistakes are answered quickly and in the short term, which reduces their frequency). The techniques used are simple, do not require the intervention of an engineer, and are cheap and efficient (Lv et al., 2022; Monden, 2011).

## 4. SOME BENEFITS OF IMPLEMENTATION OF LEAN TOOLS IN THE AUTOMOTIVE INDUSTRY

The goal of this paper is to look at specific Lean tools and analyzing of their using in practice. An example of the use of Lean tools in the automotive industry is provided for the purpose of this research. The following is an example of how Volkswagen employed Lean techniques to minimize waste, boost productivity, and reduce the time it takes to produce a unit of production.

Many organizations have worked to optimize production processes after understanding that global market demands, particularly increasingly complicated client expectations, are setting new production flexibility criteria. Volkswagen, one of Europe's largest automobile manufacturers, has implemented a Lean manufacturing approach. However, the organization continues to experience issues as a result of the lack of preventive control systems (Lepadatu & Janoski, 2018; Lepadatu & Janoski, 2018).

The company's management saw problems in the functioning of the production process due to the occasional downtime of the manufacturing process. The reason for this is the decentralized storage system, which is the physical distance between the storage of components and the manufacturing process. Namely, the layout of the Volkswagen complex is organized as follows. At the production plant in Emden (Germany), the inventory of materials needed for production is located in the complex itself, because the dimensions of the production plant allow keeping the inventory in the same place where the manufacturing is. In other cities, storage facilities with inventory are located at a distance of about 30 minutes from the factory. In the production facilities themselves, there is a certain amount of inventory. However, when that quantity is not enough, delivery is made from the storage. This type of filling can cause downtime on production lines (Jiang et al., 2022; Thürer et al., 2022).

As it was concluded, a small amount of material is kept in the production plants for certain manufacturing processes that require a certain level of inventory at a given moment, and about 2 hours are needed to fill the hall with new components, assemblies, etc., for the next cycle. In such conditions, the system does not allow the production process to stop and the requirements for inventory of materials to accumulate. The company's management has applied the JIC concept to solve problems when a certain level of inventory is required in the production plant itself. This prevents the manufacturing line from stopping due to a lack of materials. However, this concept requires additional space. When that is not possible, the managers of the companies choose JIT, in case the problem of the distance between the storage and itself is solved. Since delivery alone requires less cost than downtime due to lack of inventory, this concept is effective for factories whose warehouses are far away (Jiang et al., 2022; Thürer et al., 2022).

The implementation of JIT and JIC strategies maintains the level of inventory so that the required components are at the right time, in the right place, and in the right quantity. In addition, without the use of the Kanban method, all production systems would be unable to coordinate and synergize.

The Kanban system provides information such as the exact time at which a particular product part will arrive at a given production line. However, if an error occurs during the installation of a part of the automobile that is not intended for that model, quality control finds errors only at the end of the process, which includes the possibility of several consecutive errors. As a solution to this type of problem, the implementation of the Poka-Yoke system is proposed. In this way, the company would take full advantage of Lean production and establish a balance between quality and timely customer satisfaction (Jayaram et al., 2008; Lepadatu & Janoski, 2018; Thürer et al., 2022).

## 5. CONCLUSION

The implementation of the Lean concept contributed to an increase of efficiency in Volkswagen's car industry. The manufacturing facilities are organized so that communication is done via Kanban cards. In this way, the information is timely and accurate, which prevents human error in the initial stages of production. Volkswagen's production system has its own storage within the production plants, which enables the application of the JIT business concept. However, if there are no conditions for this type of supply of inventory, the same effect is achieved by organizing production so that the storage is up to 30 minutes away from the manufacturing halls. In this case, the JIC concept is applied, which means that the optimal amount of stock is held, obtained by continuous research of market demand. Above all production processes, there is the Poka-Yoke system, as a tool to control and correct any defects that may occur.

The goal of this system is to stop the flow of the process immediately after detecting the error since it has been established that the occurrence of a defect at the beginning affects all further processes until the end of a given series. Before the introduction of the Poka-Yoke system, bugs "accumulated" and were noticed only at the end of the series, which increased costs as well as production time. With the introduction of Lean, Volkswagen has increased profits while satisfying customers, improving business, and reducing costs. The contribution of the Lean concept can be seen in the production systems of the automotive industry, but it can also be applied to all manufacturing companies that strive to be leaders in the market. Implementation requires initial investment and standardization of all processes and methods of work, but it significantly contributes to the improvement of business and the reputation of the company from the very beginning of the application of this concept.

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