APPLICATION OF SELECTED LEAN TOOLS IN AN AUTOMOTIVE SECTOR COMPANY

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Introduction/background: A special place in the development and improvement of the Lean concept is occupied by the automotive industry – the natural and primary environment of lean manufacturing. All manufacturers in the industry follow a pro-quality approach, regulated by the technical specification ISO/TS 16949, which points to Lean as the preferred form of production process management. Womack, Jones and Roos, in their book "The Machine That Changed the World", called the automotive industry an "industry of industries" pointing to the natural and primal environment for the creation, implementation and improvement of the Lean concept. Taking into account the operating conditions of modern production organizations, which force the design of production systems, and taking into account their flexibility, modularity and adaptation to specific customer needs, the application of the Lean Management concept should be stated, and especially Lean Manufacturing in relation to the current situation in the automotive industry. Lean Management is a management standard adopted in the automotive industry around the world. The essence of this concept boils down to increasing the quality of the product and raising the level of organizational culture, and individual tools are used to improve the production system. The result of the actions taken is the elimination of waste, which leads to lower production costs and improvement of the financial result.
Aim of the paper: The author of this paper has analysed a selected production line functioning in the automotive sector located in the Silesian region. In order to improve the flow of materials and information, as well as to enhance the production process, selected methods of the Lean Management concept were applied.
Materials and methods: The paper is an attempt to present the application of selected Lean tools (Kanban, Supermarket, Standard Operating Procedure) and it uses the observation and interview methods among company personnel.
Results and conclusions: It is assumed that satisfactory results can be achieved using this method, which would certify the improvement of work organization and increase the efficiency of individual tasks.

Keywords: Automotive sector, Lean Management, Kanban, supermarket, Standard operating procedure.

1. Introduction

In an age of economic development and growing competition, companies focus on providing high levels of customer service, short lead times, as well as the reduction of costs and stock. The latter aspect is important within the automotive sector, which is one of the most dynamically developing sectors in Poland. This is the second largest sector when it comes to turnover, just behind the food sector. Almost 10% of the Polish industrial production value and every sixth Polish Złoty in Polish exports comes from the automotive sector. According to estimates of the Polish Economic Institute, the value of Polish automotive exports in 2018 exceeded 31 billion EUR, i.e. about 14% of Polish cargo exports in total (https://www.money.pl/…).

Services performed based on Just in Time and Just in Sequence principles are key for the automotive sector. Correct performance of these services allows for reducing stock, meaning the reduction of warehousing costs. An important role is also played by shorter and stable lead times and increase of control over the procurement process on the recipient side. Continuous improvement of the key logistic processes leads to improvements in reliability and flexibility, and reduction of lead time (Kramarz, 2008).

Among many modern management concepts there are methods that contribute to solving logistical problems related both to physical and information flows. These are: Time Based Management and Lean Management (Liker, Franz, 2013; Liker, Morgan, 2011). Time Based Management is a concept that uses time as a factor in order to achieve a competitive edge as well as create and implement added value. Lean Management, in general, is a concept (philosophy) of company management that consists in adapting it to market conditions through its 'leaning' and eliminating various wasteful elements (Antosz, Stadnicka, 2017).

2. Literature analysis of selected terms related to Lean Management

Lean Management was created as a management concept focused on the elimination of all waste, and in relation to the production process it is called Lean Manufacturing. This term was first introduced to the literature in 1990 in the book "The Machine That Changed the World" (Janocha, 2016). Lean management is a method of company management that creates a working culture within an organization that makes all the organization's partners interested in striving for the continuous improvement of both the processes in which they work and themselves (Kiran, 2017; Protzman, C.W., Whiton, Protzman, D., 2018). Lean is the permanent, never-ending improvement of processes (Nor Azian, 2013) in order to enhance the level of products and services quality, reduce lead time and production cycles, and satisfy customer needs as far as possible through the elimination of waste. The Lean concept recommends understanding customer needs and identifying the factors representing value within a product (Vinarcik, 2009). The literature on the subject provides some principles that characterize the Lean concept and specify the procedures according to the concept (Womack, Jones, 2001; Bednarek, Buczacki, 2014). The principles are as follows:

- precise definition of value with reference to specific products or services,
- focus on the value flow, i.e. the composition of all operations necessary to lead a given product through all stages in order to provide a customer with a finished product (Malinowska, Kurkowska, 2017),
- Total Flow Concept,
- striving of all processes for perfection (Pérez, Sánchez, 2000).

The source of the Lean concept resides in the Toyota Production System (TPS) (Lee, Jo, 2007). The basis of this concept includes Just in Time (JIT), Total Quality Management (TQM), Kaizen, management based on values and management based on competencies (Żebrucki, Kruczek, 2018; Plenert, 2007). Selected Lean tools are briefly described for the purposes of the process analysed in the paper.

Kanban

Kanban is a communication tool in the JIT system, used for batch-based production (Powell, 2018). The Kanban system focuses on reduction of stock in the production process. The Japanese term "kanban" can be translated as "information board" or "sheet, label", and in this case it means identifying a specified number of elements or products within a production line. It underlines the need to deliver a specified number of a given element. After depletion of all parts, Kanban returns to its source and then it becomes a new production order (acc. to the Kaizen Institute). Kanban is used to move the produced element from one processing station to another and is the carrier for the exchange of information included in it between individual production nests (Pałega, Staniewska, 2012). The basic assumptions of Kanban are as follows:

- high quality of offered parts, subassemblies and assemblies,
- preparation and production completion period as short as possible (e.g. machine retooling),
- optimum, standard size of a single production batch (Skowronek, Sarjusz-Wolski, 2008).

Therefore, Kanban is a continuous improvement tool that prevents overproduction (and excessive movement) of materials between the production processes (Penaa, 2020). Based on this, it is possible to control and reduce materials warehousing costs, increase raw material availability, and eliminate production downtime caused by missing goods (Galińska, Grądzki, 2015).

The literature on the subject provides the following Kanban types (figure 1) and an example of signalling (production) Kanban (figure 2).

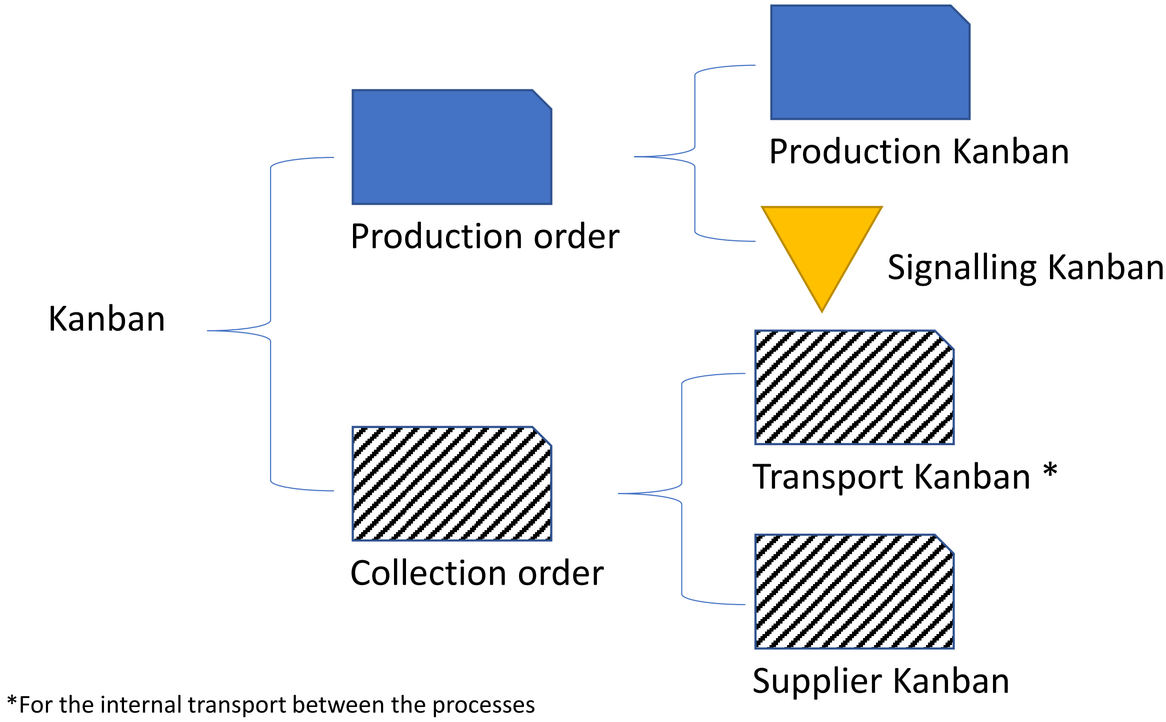

Figure 1. Kanban types Source: Developed based on Kaizen Institute training materials.

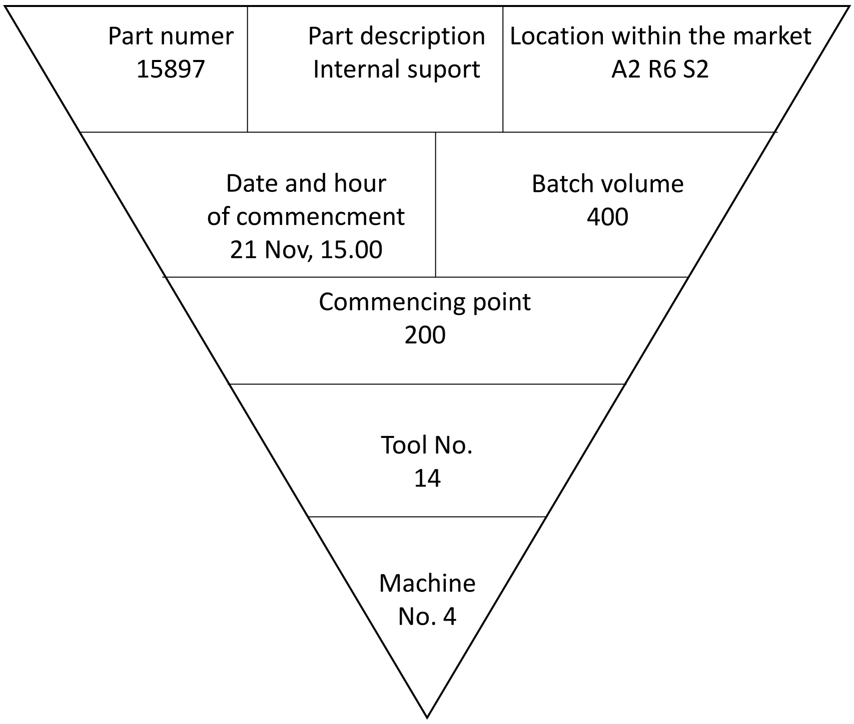

Figure 2. Example of signalling (production) Kanban. Source: Developed based on Kaizen Institute training materials.

Lean-Manufacturing supermarkets (http://www.leancenter.pl/…)

The term was introduced into the Toyota Production System, inspired by the organization of the American supermarkets ordering those products that had been purchased and searched for by customers (Rewers, 2016). In factories or offices, these are locations for the temporary storage of products, and documents used within the next processes. Supermarkets are used between processes that differ with cycle times or where other problems are present that preclude continuous flow. The feature of supermarkets is also the ability to self-control the production. Production should commence and stop when the stock within the supermarket exceeds the determined minimum and maximum levels. Another feature is the application of FIFO queues that represent the orders and products storage queuing system identification. FIFO means First In, First Out, meaning that the first order entered into the system is completed first. A similar thing concerns production – an element that came from the previous process first is used as the first one (Lewczuk, 2012).

3. Analysis of the production process in an automotive sector company

The analysed company is part of an American concern that has many divisions around the world, including two in Poland. The production plant is located in the Special Economic Zone in Tychy. The plant is oriented at the production of steering columns and gears for the following automotive customers: Opel, Fiat Group, BMW and PSA. The mission of the company is to become a world leader in automotive systems and derivative products. In order to achieve this, the company must cooperate with the personnel, suppliers and owners to provide the customers with the best solutions with simultaneous maintenance of profitability. The vision of the company is to be perceived as the best supplier by the customers.

Figure 3 presents the company layout, showing the production line identified in the red area. The line will be analysed in detail in order to present the materials flow.

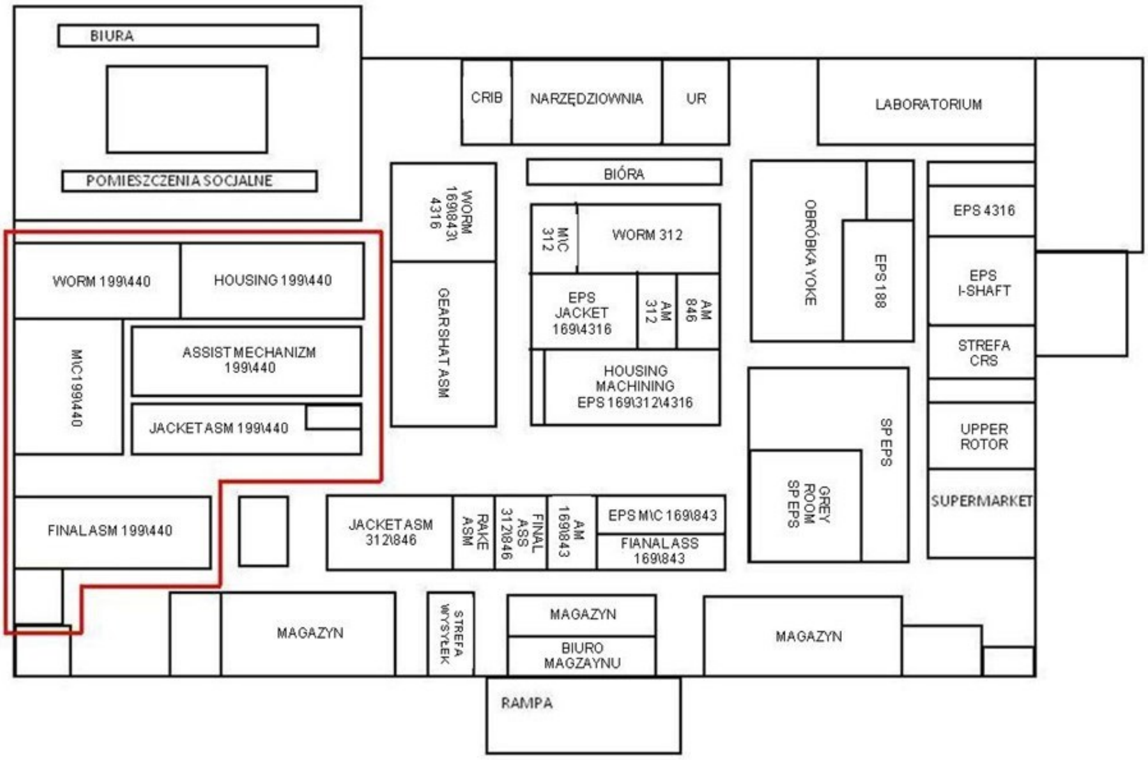

Figure 3. Production hall and warehouse layout. Source: Developed based on materials.

The production line used for the production process of steering columns has been analysed because there was a problem with the smoothness of work on this line. There was a shortage of materials needed for the production of columns in due time. Therefore, the aim of this paper is to propose Lean tools that could solve this problem. The line consists of 6 assembly areas and 1 area of temporary storage of finished products before their transfer to the warehouse. Blue arrows in figure 4 show the materials flow between subsequent assembly stations.

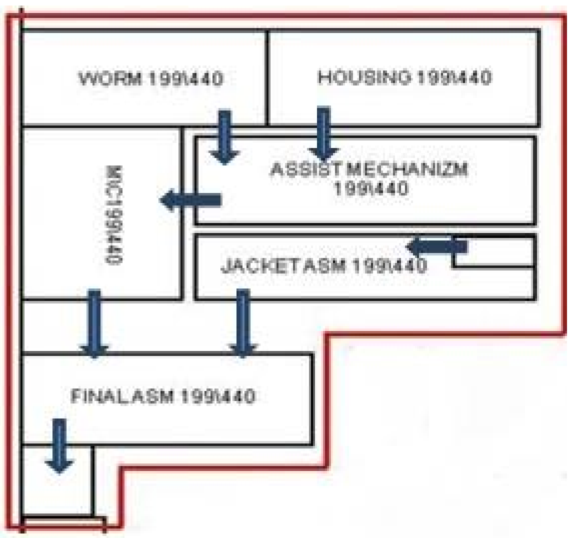

Figure 4. Materials flow on the selected production line. Source: Developed based on materials.

The production line is divided into three sections that assemble, make or connect elements composing the steering column. Notice that each station is a client for the previous one and a supplier for the next one. That is why keeping regular and continuous supplies at each stage of production is so important. Faulty delivery of materials for production causes downtime on the line, and thus extension of the production process and delay in order completion for customers.

Many different models of steering columns that are similar in external appearance are assembled on the line but they differ in terms of components. Subassemblies composing the column may be divided into common for all types, common for selected types, and characteristic for a single type. An example model of the steering column is shown in figure 5.

Figure 5. Example model of a steering column. Source: https://imged.pl/ford-focus-mk1-kolumna-kierownicza-15187391.html.

The warehousing system in the company is based on the internal warehouse with subassemblies in a quantity that suffices to cover the 12-hour production of each of the given models. The warehouse takes about 1/5 of the production hall area.

Parts for the internal warehouse are delivered from the external warehouse located within the logistic park in Chorzów. Paper FIFO labels are generated and printed from the system at the moment of accepting the goods from the supplier in the external warehouse. The number of printed paper FIFO labels is 1 label per pallet (regardless of the number of packages on the pallet). Then, the whole pallets are transported to the internal warehouse.

In the internal warehouse, according to the "supermarket" needs, reported by persons responsible for Kanban cards collection from the "Kanban" mail, collection of material from the "supermarket" and distribution of parts to suitable containers to the warehouse keeper, they are repacked/unpacked from the pallet to final packages. The sizes and weight of these packages allow for the safe transport and placement of parts on slides located at the production lines. Another step is the transport of the parts from the "supermarket" to the production line, according to the Kanban order. The situation allows for tracing the material from its delivery to the internal warehouse. At the moment of pallet unpacking, missing markings on individual boxes hinders, or in most cases precludes, further correct tracing of the material flow and keeping the FIFO principle.

The process of material flow in the company is shown in figure 6.

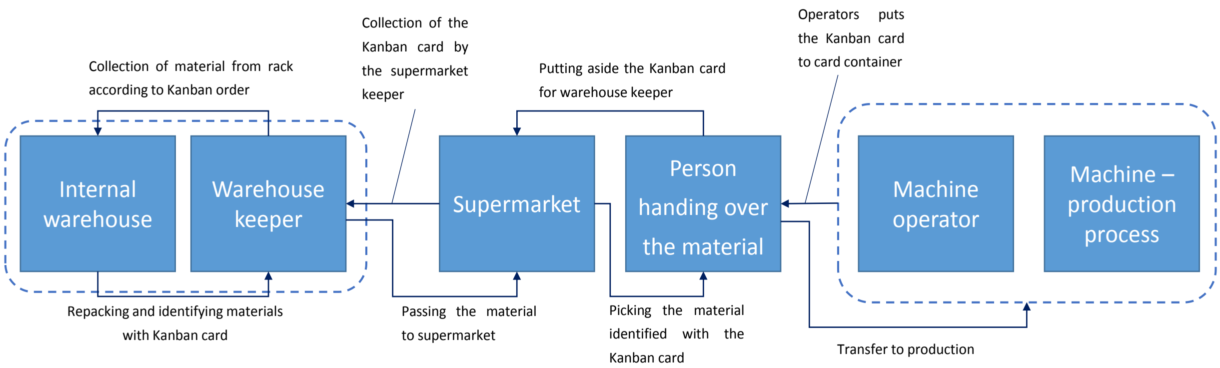

Figure 6. Materials flow on the selected production line. Source: author's own work.

Taking the parts for production is initiated by the machine operator. Having collected material necessary for the production from the slide, he or she puts the Kanban card delivered together with the material in a dedicated container. The person providing the products, when supplying previously ordered goods, collects the Kanban cards put aside by operators and then returns them to the "supermarket" and collects the products ordered by the Kanban cards. The external warehouse employee who has handed over the prepared goods according to the "supermarket" order collects the put aside cards from the so called "Kanban mail". According to their content, he or she takes the parts necessary for production from the racks. After repacking the ordered material, the material is identified with a proper Kanban card and sent to the "supermarket".

Figure 7 presents examples of the "supermarket" and Kanban card.

Figure 7. "Supermarket" and Kanban card examples. Source: Developed based on materials from the company.

Based on the analysis of product flow and Kanban cards in the company, as well as on my own observations and interviews, it can be stated that:

The materials are accompanied by paper FIFO labels and Kanban cards. There are situations when the card is "lost", which might lead to nonconformity of the goods ordered with the actual needs of the line.

However, the information on the number of parts (elements) in the production process is missing. This results from the fact that until the ready product leaves the line, the parts composing the steering column are visible as parts waiting in the supermarket. In turn, this results from the situation that Kanban cards are not registered, and information on the number of parts in the company is kept in the SAP system. The number of parts is updated only in the system when the labels of the column type are scanned on the final station. Therefore, any part between the "supermarket" and the final station is identified as located in the external warehouse (missing differentiation of parts in the system between the internal warehouse and the "supermarket"). This situation means that the internal warehouse stores high buffers of stock. As mentioned, the warehouse is 1/5 of the production hall area.

The Company has an external warehouse located 30 km away. The distance means that the time of waiting for the delivery to the internal warehouse may significantly extend. Missing data on the number of parts actually needed for the production and generation of analyses make it difficult to maintain the policy of continuous improvement of the transport processes. When it becomes necessary to retool the production line (production of another column model), and in the case of out-dated stock status, the lead time extends, too.

Proposed changes

At the moment, the Kanban production organization method is based on plastic cards. Losing or damaging such cards is not only a cost for the company, but also contributes to delays in production. In turn, missing communication between the production and warehouse leads to delays and situations where the operator gets products he or she did not order. Therefore, it is proposed to use an electronic Kanban system on the production line. The main benefit of e-Kanban is the option to easily calculate when to add and remove cards used in the system, and to find lost cards (Czerska, 2014). This type of improvement should contribute to a faster (compared to the current solution) flow of materials and information inside the company and to its partners. The Electronic Kanban system significantly increases the accuracy and precision of the placed orders and lists, the manual generation of which would take much more time and in practice would be impossible with such accuracy. Using the electronic Kanban system makes it possible to control the materials flow in the production process using different identification technologies. E-Kanban differs form the traditional Kanban system in that the conventional elements such as Kanban cards have been replaced by barcode readers or RFID tags. Electronic Kanban is easier to reconfigure and it is easier to introduce the priority Kanban queue (e.g. heijunka principle) with the option of so-called "expropriation" – temporary cancelling of the current Kanban, if the situation necessitates that, and its placement on the top of the kanbans awaiting implementation with simultaneous collection and implementation of another kanban in the queue (http://metz.leancenter.pl/…).

The currently applied material economy organization system requires using two independent labels at the same time (one disposable FIFO label and another multiple use Kanban label). Therefore, one can use labels containing information from both aforementioned cards. Figures 8 and 9 show a combination of FIFO and Kanban labels.

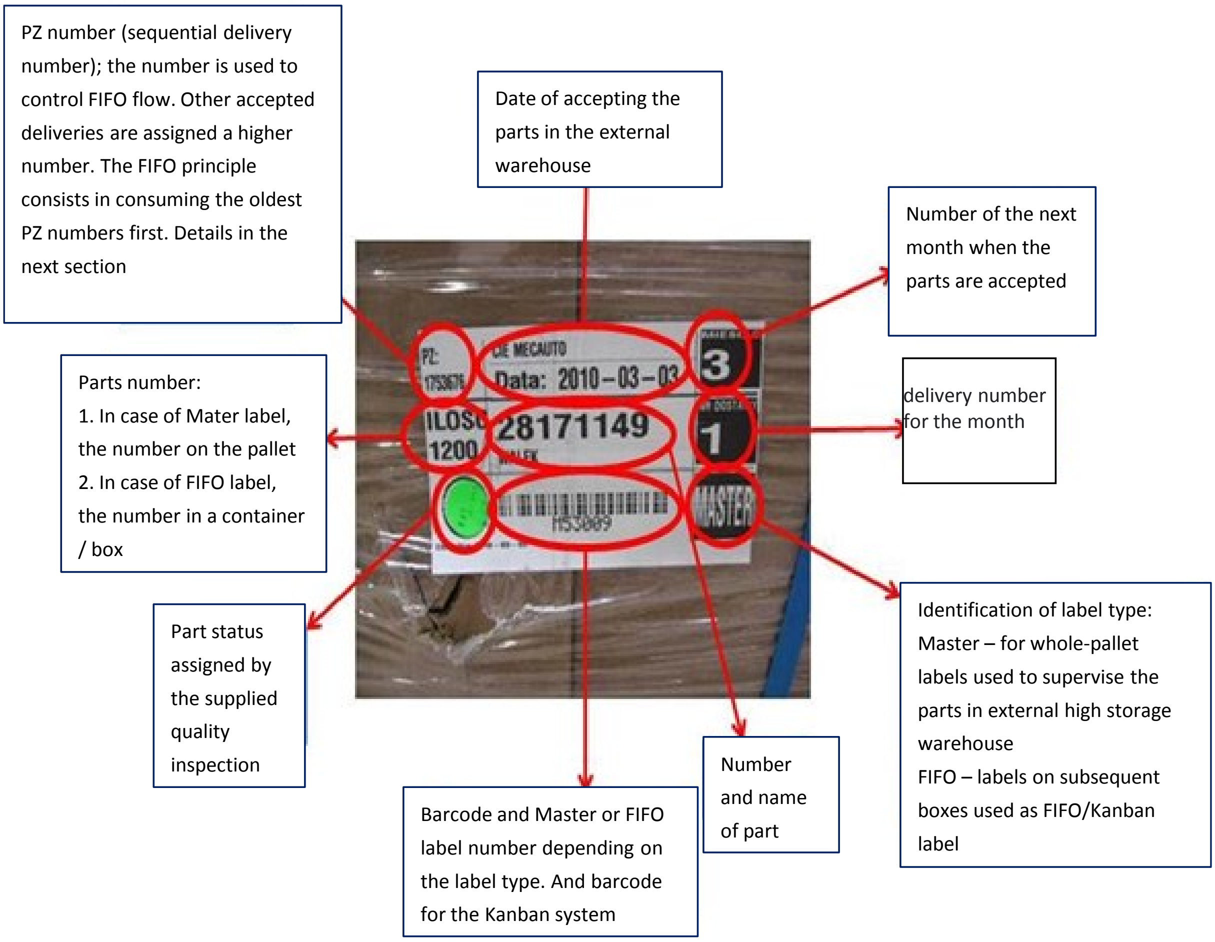

Figure 8. Combination of FIFO and Kanban labels Source: Developed based on materials from the company.

The introduced new label can be divided into: Master and FIFO/Kanban. The Master label dedicated to stocktaking of parts in the external warehouse will be generated at the moment of accepting the goods at the warehouse. In turn, the FIFO/Kanban generated in the QAD system (ERP software) will be related to the Master label. They are printed at the moment a given pallet is collected from the rack to the pallet unpacking zone where the warehouse keeper identifies all boxes on a given pallet with FIFO labels. After scanning, each label will be entered into the system in order to enable verification as to whether all labels/items from the previous FIFO have been used/scanned or possibly locked by the quality inspection.

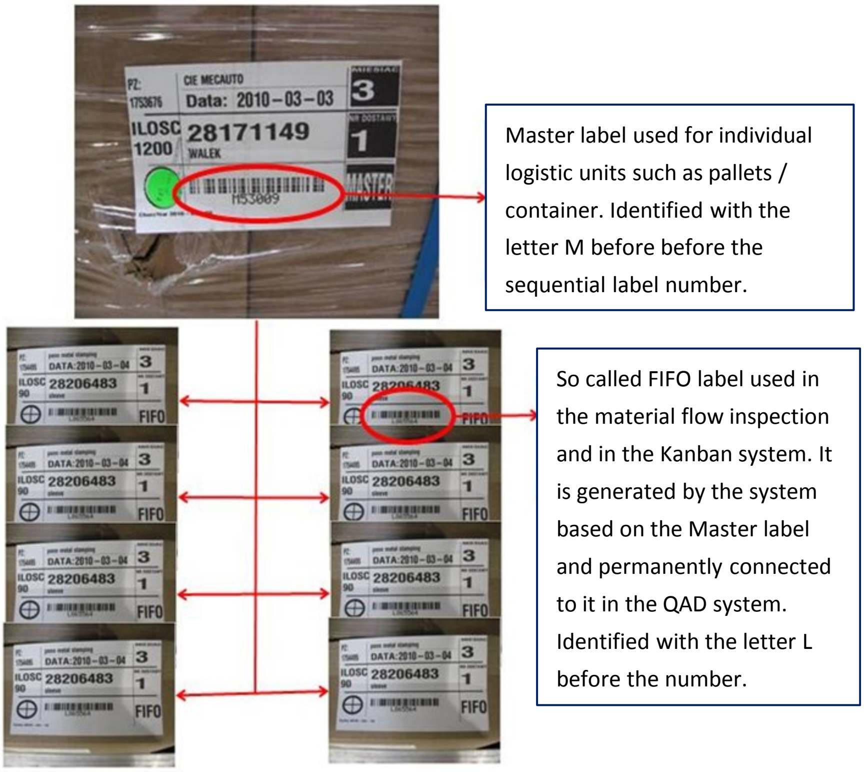

Figure 9. Combination of FIFO and Kanban labels. Source: Developed based on materials from the company.

Another proposal concerns improvement of warehouse stock control so that all parts taken for production are visible in the information system with the option to trace where they are currently located on the production line. This proposal will be ready for implementation after the introduction of barcode readers.

The change of external warehouse location from Chorzów to Tychy also seems necessary. This would reduce the time for the transportation of parts necessary for production.

Elimination of the internal warehouse, taking up 1/5 of the production hall area, and introduction of the principle of supplying necessary parts based on the JIT system are other change proposals. Elimination of the internal warehouse in the company does not mean the necessity to increase the area of the external warehouse because of the precise management of information concerning the volume of owned and necessary parts. At this moment, it is necessary to perform the Make or Buy analysis in order to make sure that such a solution would be beneficial. However, warehouse outsourcing may help in avoiding, e.g. costs related to keeping an empty warehouse area, or reduce employee-related costs.

After implementing the proposed changes, the process of materials flow and Kanban cards is shown in figure 10.

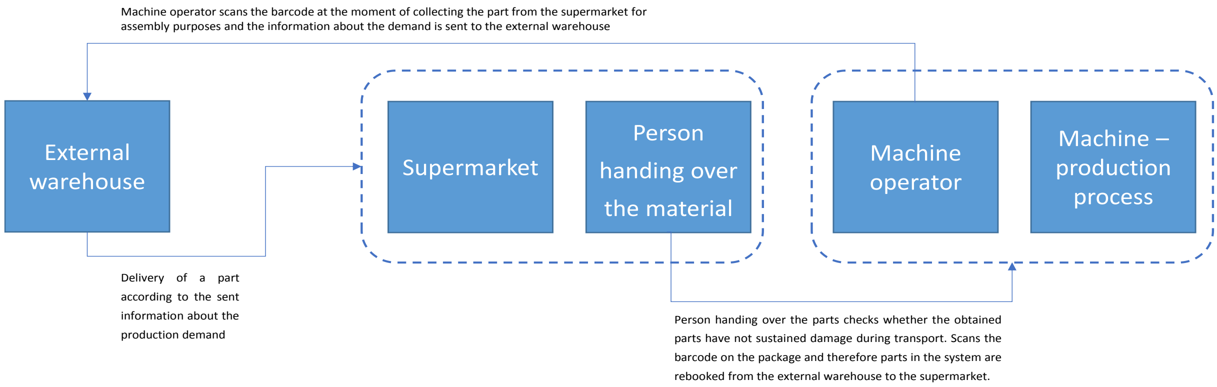

Figure 10. Materials flow in the line after implementing the changes. Source: author's own work.

During observation of the production line flow, a situation related to the problem of battery replacement in a forklift was noticed. Lack of operator knowledge about the battery replacement extended the process of parts delivery to the line (even by 15 minutes). These, however, were sporadic cases but they occurred among newly employed persons, the rotation of whom was mostly too frequent. The Standard Operating Procedure tool has been proposed. In general, SOP is a detailed description of specific steps leading to required and expected results, i.e. nothing more but standardization of some processes. Standardization of work is one of the basic tools in the Lean Manufacturing concept within the scope of improving the work, stability and repeatability of processes. An example SOP concerning the replacement of a battery in a forklift truck is given in figure 11.

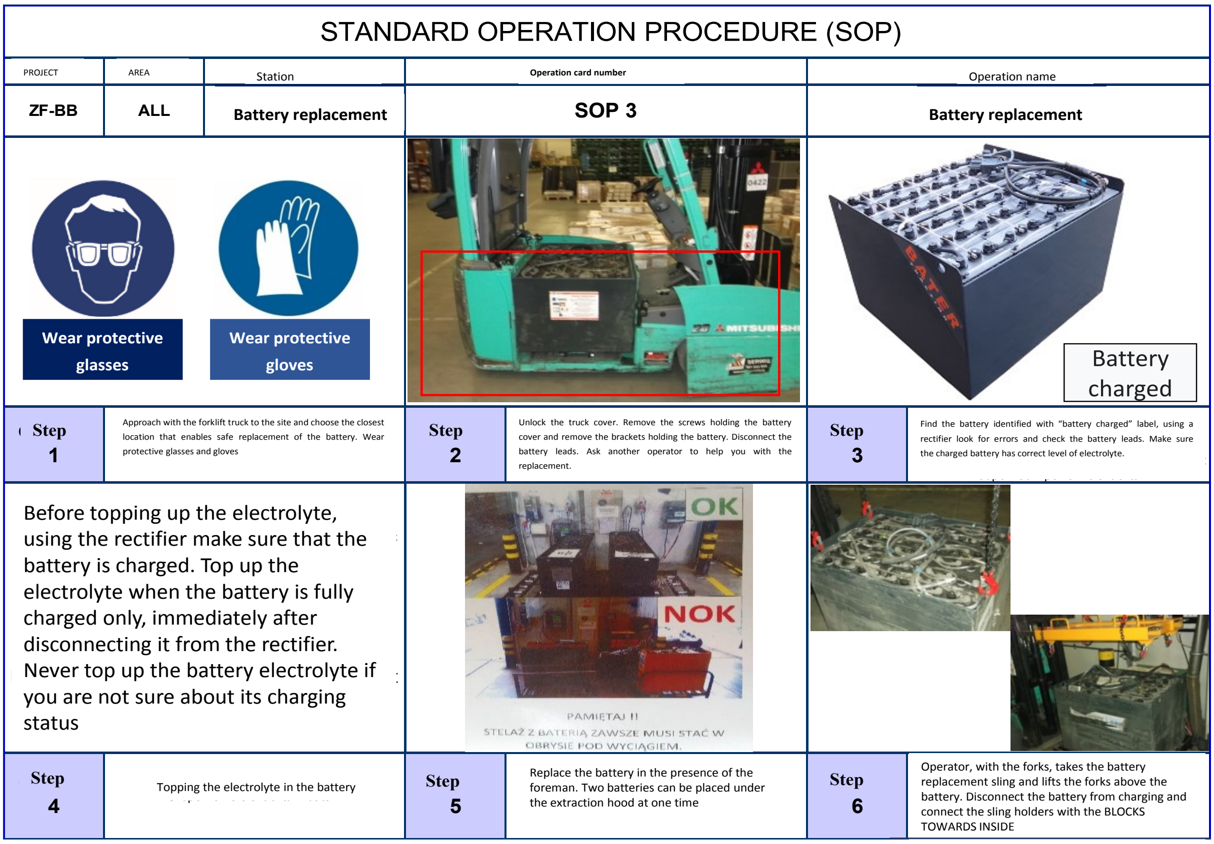

Figure 11. Example SOP concerning the replacement of a battery in a forklift truck. Source: author's own study.

Conclusion

The results of the performed literature studies and the author's own work (observations and interviews with employees) show the ability to use the selected Lean tools to improve the production flow in a company from the automotive sector. These studies should also include some numerical results in order to show how the proposed changes affected the reduction of time and costs, and increase in production. This issue will be the subject of other studies. The proposed changes improved the general functioning of the examined company and provided an impulse for further changes and introduction of other Lean tools. Undoubtedly, only the companies that are able to eliminate waste from their processes and satisfy even greater expectations of their customers have a chance to succeed and develop in the future. It is worth mentioning that almost all the processes implemented in the companies depend on standardization. Because of that, it is easier to observe the processes, measure them, notice discrepancies, disclose problems and eliminate waste.

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