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Tools and methods of Lean Manufacturing - a literature review

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Abstract in English language: This article presents an overview of methods and tools of Lean Manufacturing, which are used in enterprises to improve production processes. Article aims to introduce the reader to both the most commonly used tools as well as those less known. A description of each method contains an overview of the assumptions, the main objectives and expected results. The article described tools such as VSM, 5S, SMED, Jidoka, standardization work, Poka-Yoke, Heijunka, TPM, Hoshin Kanri, Kamishibai, Kanban and the philosophy of Kaizen.

Keywords in English language: Lean Manufacturing, improvement, tools and methods

1. Introduction

The company's situation depends in large part from the a rapid response to changing customer requirements. Currently, the standard becomes to produce the products exactly on time, in the desired quantity and quality and with the lowest competitive price. All these activities, of course, must also generate a certain profit for the company.

Enterprise to achieve its objectives, and most of all to achieve a competitive advantage in the market must pay special attention to reducing production costs. During the implementation of subsequent operations arises value of manufactured products thus creating a value stream. It is important that the individual a value consisting of the price of the product was acceptable by klienów. That is why more and more importance to improvement of production processes. Improvement is to identify and eliminate losses occurring in production.

The concept, which allows the improvement of production processes is Lean Manufacturing (LM). It presumes the elimination of all waste occurring on the production (Japanese. Muda), which leads to a reduction in the transit time of the material by the process (in English. Lead time). Lean Manufacturing is derived from the production system TPS (Toyota Production System), whose creators are Japanese engineers: Sakichi Toyoda, Ki'ichirō Toyoda and Taiichi Ohno [7]. To achieve its goals manufacturing companies use a variety of tools and methods of Lean Manufacturing. These include: SMED (ang. Single Minute Exchange of Die), TPM (ang. Total productin Maintenance), 5S, Poka-Yoke, and other [11].

2. Types of waste

The essence of Lean Manufacturing is the elimination of all waste occurring in the enterprise. This shortens the time between ordering and sending the finished goods to the customer and increase productivity and reduce manufacturing costs. Taiichi Ohno in his work [11] dedicated to Lean Manufacturing listed seven types of waste: overproduction, inventory, mistakes and quality defects, waiting, over-processing, unnecessary transport and unnecessary movement. Currently, seven types of waste is enriched by yet another - untapped potential employee's [18].

Overproduction is understood as the production of products in advance and in greater quantities than required by the customer [15]. Overproduction is considered the most dangerous type of waste, because it translates into significant costs associated eg. Storage, and is the beginning of other waste. Inventories are keeping more materials, raw materials, work in progress and finished products than the required minimum. Wastage is the result of overproduction. Can lead to damage or destruction of products and generates significant transportation and storage costs. Mistakes and quality defects is understood as work that is not completed with positive results [14]. Waiting for a product is the time lost due to the expectations of people, material, information, or tool that does not add value in the manufacturing process. Excessive processing steps are necessary in terms of the value added, which however must be implemented in order to produce the product. This waste is understood as well as taking unnecessary time for the implementation of customer demand, as well as the use of sophisticated and costly technologies without justification. Excess transport unnecessary movement of materials, semi-finished or finished products within the company. This leads to increased production costs and increase the risk of destruction or damage to the product. Superfluous movement is not adding any value of physical employee. It results most often from inadequate organization of the work. The last type waste is underspending the potential employee. In this context, it is meant ignoring or underspending ideas, competence, talent and time employee [12].

3. Methods of Lean Manufacturing

In this review article such tools and methods of Lean Manufacturing as: VSM, 5S, SMED, Kanban, Jidoka, Hoshin Kanri, Heijunka, Standardized Work, Poka-Yoke, Kamishibai, Kanban and Kaizen philosophy will be presented.

VSM - Value Stream Mapping

A tool widely used in enterprises is VSM – Value Stream Mapping. VSM is a graphical way of presenting material and information flow in the production system. Map shows all the tasks undertaken in the process, from the purchase of raw materials and ending with the delivery of finished products to the customer. This analysis allows the identification of all kinds of waste and orientation for further action in order to eliminate them [2].

5S method

Another method used for the improvement of production processes is the 5S method. 5S is the basis for the implementation of Lean Manufacturing. The method name is derived from the first letters of the Japanese words: Seiri, Seiton, Seiso, Seiketsu, Shitsuke. They are also the names of the five stages of organization of the work [1]:

- Seiri – sorting, selection – the elimination of the workstation of all the items that are unnecessary to do the job. Step is carried primarily of decreased inventory, and better use of working space. In accordance with the principle of selection, all unnecessary items should be marked with a red label and placed in a designated area.
- Seiton – systematics – arrangement, designation and selecting a suitable place for all tools in the workstation at the selection stage. It can help in this instance. board of shadows or

color coding each tool. Step is performed to reduce unnecessary traffic employee performed when searching for tools and elimination of errors the quality of products resulting from mistakes by properly marking items.

- Seiso - cleaning – cleaning and maintenance of the workplace and sets out the standard of proper cleaning. Stage aims to: maintain positions in good condition, identify and eliminate the causes of pollution and care of machines.
- Seiketsu – standardize – determine the rules for the first three stages of 5S. In this stage, mainly defines the responsibilities of employees and creates instructions, supporting the execution of the previous steps. Stage provides a systematic procedure and repeatability previously entered changes.
- Shitsuke – discipline – ratcheting up at the habits of employees to comply with the previously introduced changes and act in accordance with the standards. It is a difficult and long stage, because it forces you to change the habits of both production workers and management.

5S method does not require large financial investment, it allows for the creation and maintenance of jobs in governance functions and cleanliness shapes and proper organization of the working environment. It is also the first step in strengthening the employees a sense of ownership in relation to the workplace.

SMED – Single Minute Exchange of Die

This method allows for shortening to a single minute changeover time is SMED. Developer methods Shingeo Singo has identified four stages of process improvement changeover equipment [13]:

- analysis of the current state workstation,
- separation operations changeover operations internal and external,
- transform internal operations in external,
- to improve all aspects of the changeover.

The action of bringing the greatest effect in minimizing changeover time is to transform the operations of internal external. Internal operations, are those whose performance takes place during the machine downtime. External, are activities that are performed before and after the stoppage. The more steps will have to move beyond the stop associated with the changeover, the more time can be spent on production [9].

Standardized work

Standardization work is a tool used Lean Manufacturing for the improvement of work and improves the sustainability of production processes [1]. Standardization means uniformly operations, or tasks by all operators. Standardized Work is the best method of operation. This allows the exercise of all steps in the same way, in the same order and time, at a fixed cost. Standardization also assumes continuous development of new, better standards, so as to adapt to the constantly changing customer requirements.

TPM – Total Productive Maintenance

TPM is a tool LM used to eliminate waste associated with technological machines in the enterprise. TPM is a way of management, integrating all employees to maintain of production continuity [8]. The main objective of this method is to increase the efficiency and productivity of machinery and equipment by: a marked decrease the number of failures, reducing the time retooling

and adjusting machines and short downtimes and idle (caused frequently absent employee, or waiting for the tools, material, information, etc.), reducing defects in product quality, decreased time spent on start-up of production [16].

Kanban

Kanban is a Japanese method of production control, which assumes control not based of the production schedule, and through events occurring directly on production. The use of Kanban allows for almost total elimination of pre-magazines (the stock is on the workstation), interoperable, and finished products. The raw materials are delivered from suppliers with hourly precision, , and thanks to reserves, production capacity and flexibility of the production process it is possible to produce almost any product at any time. In contrast, production orders are closely synchronized with orders received from customers [3].

Kaizen Philosophy

Kaizen philosophy is the concept of continuous improvement, which assumes constant search for ideas to improve all areas of the organization. It requires the involvement of all the company's employees, operators, up to the highest level of management. The aim of Kaizen is permanently replacing waste activities adding value. In practice Kaizen comes to collecting and implementing ideas of employees, which serve to improve the organization of work, or improving the production process [5].

Jidoka

The notion of Jidoka refers to the ability to stop the production line or machine by the operator at the time of the appearance of a malfunction or problems during manufacture. Problems may be related to the quality of products and delays the manufacturing process due to a lack of material, tool information. Equipment operators the ability to detect emerging anomalies and immediately stop the operation, it allows for a more efficient production process. Tools that enable the implementation of the rules Jidoka are: Poka-Yoke and Andon [19].

Poka-Yoke

Poka-Yoke (jap. Show - any error, Japanese. Yoke - prevention) is a method of preventing errors coming from mistakes. The main principle in the system Poka- Yoke is that the errors are to blame processes, not the employees. Poka- Yoke solution is characterized to prevent any errors in the process. With Poka-Yoke is also possible to obtain reduced time required for training employees, eliminating many quality control operations (or its total elimination), reducing the amount of defects and a 100% control of the process. An example of a Poka-Yoke solution is a SIM card, which can be put on the phone only one way through the angled corner [4].

Heijunka

Heijunka, or leveling production is mainly aimed at eliminating jumps in production. Leveling production is known as a method of sequencing products in order to balance the production, increase productivity and flexibility by eliminating waste and minimizing differences in load workstations [6]. Balancing production is understood as to avoid sudden jumps in the amount of manufactured products in the schedule [20]. Production leveling consists in determination of the sequence and the amount of flow from the process, so that current demand was realized from the warehouse / supermarket and did not cause sudden changes in the production schedule. Production schedule should be in a given period of time constant (time largely depends on the seasonality of products). The aim is to ensure that the products were produced in a particular sequence in batches of as few pieces. In other words, production leveling is a way of ensuring the availability of products for customers through a repeatable and uniform flow of products and supplies in the warehouse. Repeatable flow of products from production also contributes to load balancing workstations.

Hoshin Kanri

Hoshin Kanri is a method that allows to focus all the company's ability to improve its performance through the development of a unified policy and annual management plans based on the basic concept of the company's management [17]. Hoshin Kanri can have various applications in the enterprise, starting with strategic planning methods and tools to manage complex projects, the quality management system (new products are manufactured in the company as a response to customer demand) up to the operating system, ensuring stable earnings growth. The actions of this method are carried out in the following stages:

- to define the mission and vision in the context of an overall strategy;
- defining strategic objectives (3 - 5 years);
- defining annual targets;
- transferring targets at lower levels;
- implementation of the objectives;
- inspections objectives;
- annual evaluation of the realization of the objectives.

Kamishibai

Kamishibai is a set of simple audits, which are designed to control the work, use of methods LM, as well as to teach the person controlling find possible improvements to the process or position. A key element of this system is an array Kamishibai, which is placed directly on the production line. For the layout prepared a layout line schedule for conducting audits and documentation for the auditor. Application Kamishibai makes that auditor can be any person working in the company , for example bodyguards, the production staff, the accounting, personnel and head office. This is possible thanks to a very simple design of the sheet audit. The sheet contains the most common check list of areas to check in the form of pictures and images along with the location of the place on the map layout [10].

Conclusion

In the literature, there are different views and descriptions of the various tools of Lean Manufacturing. This paper aims to bring all the tools and methods LM, starting from the general 5S, and ending with the less well-known: Hoshin kanri, leveling production.

Each of the methods of Lean Manufacturing is designed to support the company the elimination of waste occurring on the production and in achieving the objectives of improving production. Table 1 is presented a summary of eight types of waste, and sample tools to help eliminate them.

Table 1. Summary of types of waste and methods of Lean Manufacturing, which help eliminate them, source: own

Waste	Methods of Lean Manufacturing
Overproduction	Kanban, Heijunka, VSM
Excessive stocks	Kanban, Heijunka, VSM
Mistakes and defects in the quality of products	Poka-Yoke, Jidoka, Kamishibai
Unnecessary movement	5S, Standardized work
Unnecessary transport	Kanban
Waiting	TPM, SMED
Excessive processing	Standardized work, Kanban
Untapped potential employee	Kaizen

The article tools and methods of Lean Manufacturing is only a small fraction of all the available literature on methods of improving production. The Polish companies have only recently started to use the basic tools, such as. 5S or SMED. However, over time the company will begin to implement newer methods LM.

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