



# Perspectives of Lean Management Using the Poka Yoke Method

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**Abstract.** The paper provides a theoretical perspective on Lean management, which is very often mentioned in connection with manufacturing companies. In the article, we present and offer an overview of Lean management used in the industry. Through this paper, we want to present the potential and advantages of the Poka-Yoke method for continuous improvement and modernization of pre-established and often outdated procedures in production processes. As an example, we describe the lean methodology and its elements. In conclusion, we focus on one method: the Poka-Yoke. It has advantages and disadvantages, but this paper points to selected parameters and possibilities for implementing this method in production as quickly and efficiently as possible. In conclusion, the advantages of implementing this method are highlighted. The research shows it is obvious how it is possible to contribute to increasing product quality, reducing costs associated with repairs and complaints, increasing productivity, and reducing loss of time caused by errors. By implementing lean management, we can also contribute to increasing the safety of the production process and reducing the risk of equipment failures. The research shows how lean production tools and the Poka-Yoke method can effectively develop intelligent manufacturing enterprises.

**Keywords:** Lean Management · Poka-Yoke · Process Innovation · Sustainable Manufacturing

## 1 Introduction

During World War II, Taichi Ohno, a production manager at a small Toyota plant, observed his employees and concluded that the workers at the waist had more knowledge than their foremen. He, therefore, chose a few of them and replaced them at the head of the workgroups instead of the aforementioned foremen. He assigned a part of the production line to individual groups and entrusted them with the task of jointly devising the best way to carry out the work entrusted to them. The Toyota company achieved unprecedented success with this system and enriched the world with a new term - Lean

management [1]. The priority of enterprises in a market economy is to ensure their commercial and economic success by producing competitive products and services. The identification, evaluation, and gradual improvement of the processes taking place in the company have become a common approach to the management of business agility oriented towards increasing performance in recent years. Insight into the organization's internal activities, reactions to the surrounding external environment, and concentration on process flows have become justified managerial disciplines to manage the company's internal activities. And that both in production processes and services and in the sphere of state administration [2]. In the past, attention was constantly paid to improving individual work activities or short-term process sequences. At the turn of the 90s of the 20th century, the first discussions about the possibility of process insight into the activities taking place in the company began. William Edwards Deming can be mentioned as an exception confirming the rule, who applied his process management methods in Japan, which remained unnoticed by the rest of the world for a long time [3]. At the beginning of the 20th century, several experts in managerial practice devoted their attention exclusively to production process improvement. As in the area of improving the quality of every single work operation, coordination of process operations, etc. Managers are currently oriented toward understanding business processes as complex process flows [4]. After the analysis, we try to point out the perspectives on applying poka-yoke as a management method in this paper.

## 2 Literature Review

The nineties marked a revolution in improving business processes by applying a new concept - reengineering, which seemed like a savior solution at the time. The authors of this term were American consultants James Champy and Mike Hammer. These promoters claimed that by identification, visibility, subsequent understanding, and reinvention, complex business processes could be almost redesigned and thus radically improved [5]. Applying the newly proposed measures was supposed to find the sources of inefficiency and eliminate unjustified or erroneous steps and everyday, harmful habits that were the legacy of labor division. From measuring the quality of individual acts, the focus shifted to complex values, such as efforts to acquire new customers, compliance with set deadlines, or providing high-quality services. The decisive factor in successfully applying this method was the innovative use of information technology, the correction of sequences of work actions, the introduction of business rules, and many other factors liberating processes [6].

Until the mid-1990s, it was a trend to discuss reengineering in connection with any managerial-business activity. This term appeared in most private, corporate, and public claims regarding minor changes. This sharp increase in the new way of managing business processes, often accompanied by great enthusiasm but without sufficient knowledge, was the cause of hysterical efforts to change everything in the company from the ground up [7]. Businesses have been forced to move to combinations of workflow systems, information software applications, and the Internet. It led to the creation of new business process management systems denoted by the abbreviation BPMS, the task of which was to coordinate the acts carried out inside the system with human work.

Creating business process architectures, determining the essence of success, and concentrating the forces of managers on achieving set goals were the first steps of large companies [8]. The trend in this period was using balanced indicators systems, denoted by the abbreviation BSC. It is a means of strategic management used to measure the company's performance [9]. The business process modeling of the nineties resurrected the practices of the Six Sigma method, which expanded its scope from mass production to practically all areas of industry [10]. Its popularity became radical, especially when it implemented the basics of the Lean method, which stabilized into the currently used approach called Lean Six Sigma [11].

The term "Lean Management" includes several management methods aimed at identifying and eliminating activities that do not represent any benefit in creating products and services. However, it can be most briefly presented as a philosophy that the company cannot apply to a specific process but must implement in its entire operation. We can discover the roots of Lean in the relatively early stages of modern management. Already in 1910, Henry Ford promoted the groundbreaking theories of Frederick Taylor, Frank Gilbreth, or the founder of the Gantt chart, Henry Gantt. The common feature of these giants was the effort to maximize the production process in the shortest possible time. Other representatives of the Lean philosophy include James Womack, the author of the term lean production, or Taiichi Ohno, the author of the rapid rebuilding method, also known as the SMED method [12]. The industrial world gradually adopted Lean as a universal tool designed to improve processes in the company, which also found its further application in the service sector, healthcare, and banking [13].

The methodology is based on a cyclical approach aimed at improving business processes - work teams concentrate their attention on smaller improvement measures, and the resulting improvement is achieved in successive iterations. At the same time, they help to eliminate possible adverse consequences of the experimental solutions implementation. Lean management assumes the standardization of the processes themselves. It means documenting them and verifying that they work in harmony with the processed description before proceeding with their improvement [14].

### 3 Research Methodology

The methodology of Lean management represents a summary of principles and methods aimed at identifying and eliminating activities that do not represent any benefit in creating products and services intended to serve the customers of the process. Based on this claim, these activities represent unnecessary waste in production. Originally, this "production lean" technique was intended to improve business processes in industrial production. Over time, however, it found its application in other fields, especially in services and administration. The essence of thinking in the Lean management style is to think simply, directly, or simply put, to use "peasant common sense", and all this in a systematic arrangement and methodical application to specific aspects of the process [6].

The basic principles of Lean management are [2]:

- Determining the customer-friendly process value. Value is the intended product or service satisfying the customer's needs, provided at a time and a price corresponding to his ideas;

- Identification of activities involved in the subsequent value creation. The process is defined by the sequence of steps that occur during the creation of value, from the creation of the product design to its presentation to the customer, from the order receipt to its dispatch, and from the used material to the finished product;
- Setting processes in motion. Ongoing processes destroy the idea of dividing the company into separate departments. They pass through the company without respecting the rules of previous hierarchical structures. Many times, they even cross the company's boundaries with a serious connection to selecting subcontractors or customers. Thus, they enable each participant in the process to contribute to the creation of value with their activity;
- Management of customer needs. Processes are conditioned by the need to deliver a specific product or service. In other words, what the customer wants and when suits him is produced. This approach replaces the classic make-to-stock method, continuing to try to sell what is currently in stock;
- Striving for perfection. It represents an endless effort to reduce time, cost, effort, space, errors, and failures, all under the same conditions under which the goods are produced, or the service provided simultaneously.

As mentioned in the previous section, Lean management is based on a cyclical approach to process improvement. Individual company members will focus on smaller improvement tasks. The organization's overall improvement will be achieved in successive iterations, which also help eliminate possible negative consequences caused by applying experimental solutions. To achieve the desired process improvement, it is necessary that the idea of Lean management grows deep into the thinking of employees and thus becomes an integral part of the corporate culture. The concept of Lean management methodology is [15, 16]:

- Long-term philosophical approach promoted by management through long-term strategic plans.
- Orientation to the process as the bearer of the produced object quality or the service provided, as well as the mediator of the performance capacity of key business functions, which thus transforms considerations closer to the specific characteristics and conditions of the process with subsequent assumptions:
  - If the process is properly designed, then the products will achieve the required quality.
  - If the process is balanced and smooth, then the costs of covering peaks or holding stock will be eliminated.
  - If the company produces what the customer requires, and when he needs it, he will not have to fight for every piece sold, and the stock level will tell, with its volume and structure, what the market is interested in.
  - If the process focuses on the quality of each operation, it will be relieved the costs resulting from repairs and complaints.

- Intentional search for individuals through whom it is possible to implement the company's intentions in the quality improvement area or cost reduction and to support their personal development.
- Long-term support of self-educational processes and the prosperity of the company without exception:
  - About process control and a thorough understanding of addressing situations.
  - About a precise discussion with consideration of all eventualities before a solution is chosen and then their rapid implementation.
  - About constant efforts for organizational self-reflection and a systematic improvement program.

Lean management methodology finds its application mainly where attention is paid to increasing process performance while simultaneously reducing operating costs. It manifests itself when reducing the amount of inventory, reducing the size of the production space, or saving the work spent on a specific performance. It is popular where it is necessary to simplify the processes and shorten the time of entering the material into the process and handing it over as an output to the next stage of the process or directly to the customer. Another important feature of this methodology is the division of activities taking place in the process into those that add value to the product through their activity and those that are not directly related to the added value, or do not contribute to its creation or, on the contrary, burden it [17]. If we are considering the use of the Lean management methodology, the following assumptions should be used in our analysis [18]:

- Waste appears in many different forms in processes;
- The speed of making a change in an active process is critical;
- Processes are not kept in motion;
- Process changes must be systemic in nature, committed, and adapted to a balanced complex of small changes affecting all related areas, such as personnel, technology, and process systems.

In practice, the Lean management methodology is applied primarily where [18]:

- If favorable market conditions require an increase in the performance of processes or a reduction in the time of order cycles;
- The competition is characterized by its aggressive policy in the area of price and quality of services;
- Customers demand lower prices;
- Businesses try to minimize inventory;
- Owners demand a higher return on capital;
- The company sees the possibility of improving its position in the market by improving the quality of its products.

Lean management methodology can be applied in two ways. The first method is Kaizen-style team meetings, which Japanese improvers successfully used, especially in

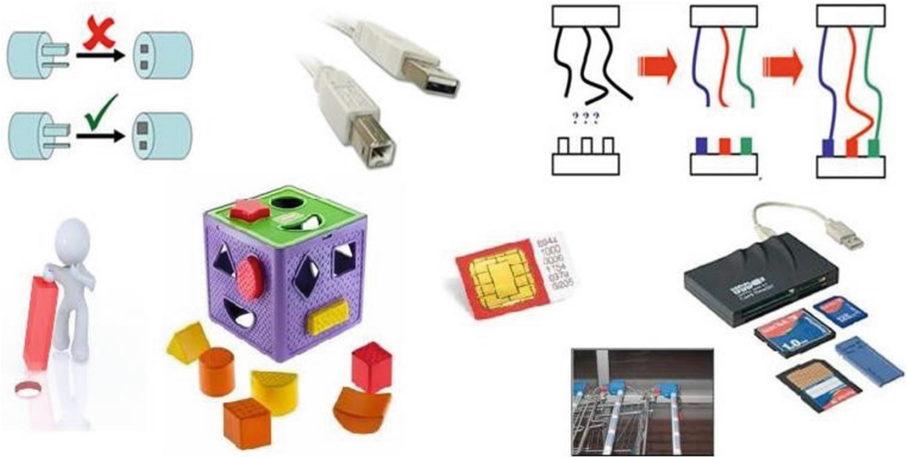
earlier periods. The principles of Kaizen are mainly based on the assumption that the implementation of any small changes carried out at regular intervals and with long-term active maintenance can ultimately bring fruit in the form of a significant improvement in the performance of the process. Kaizen activities often referred to as lightning or accelerated process improvement, aim to eliminate waste in specific areas of the process, increasing performance and maintaining it. Most often, they gather people into a short-term cooperative group in the range of 2 to 5 days. While value chain mapping projects typically focus on conceptual analysis and future prospects, Kaizen focuses on identifying unnecessary activities and sources of waste and planning turnarounds to correct identified problems [4]. The second method of application is classic project incentives using the traditional Deming PDAC cycle – i.e., Plan – Do – Check – Act. This method is successfully used in more extensive improvement programs or the planning and managing of changes occurring in more complicated processes and where the project scope and necessary preparations exceed the implementation possibilities within a few days [7]. A fundamental contribution of the lean manufacturing methodology to the corporate philosophy is the constant pursuit of perfection and the periodic improvement application. Lean management is based on the condition that there is no level of perfection with which the company should be satisfied and which cannot be further developed. After the values of one improvement cycle are designed, applied, and verified, it is necessary to reassess additional, new needs and customer requirements [19]. It is also necessary to pay attention to further improvement, whether it is changing in the area of increasing the processes' capacity or removing everything undesirable and unnecessarily burdening processes [6].

For the correct implementation of Lean management, several principles, methods, and approaches are applicable in improvement projects. From a large number of methods, it is good to mention at least a few of them [9]:

- Value stream mapping;
- Process flow analysis;
- Principles of push and pull;
- 5S Method;
- Accelerated transformation of activities;
- Poka-Yoke Method.

## 4 Results and Discussion

A typical error prevention example is a warning that pops up on the screen of every personal computer. A box will appear asking if you want to save the open file before shutting the computer down completely. Other examples are safety caps on medicines that prevent children from opening them independently, safety barriers on slopes, or protective barriers in parking areas or areas with restricted movement. This technique is also used in industry. For example, using color coding, barcodes for recognizing specific products in production lines, different types of sensors or color-marked areas to ensure transport, or ordinary circuit breakers protecting the electrical network. For more examples, see Fig. 1 [5].



**Fig. 1.** Typical examples of the Poka-Yoke method application [5].

The main mission of the Poka-Yoke method is to identify and prevent errors. If they do occur, the defective product mustn't reach the customer.

#### 4.1 The Most Common Ways of Applying the Poka-Yoke Method

By correctly implementing the Poka-Yoke method, it is possible to detect deviations in the installed product from the basic caliber or the characters programmed in the machine. We know [19]:

- Guide pins of different sizes
  - The pins located in the lower part of the mold exactly fit the holes in the upper part of the mold.
  - Pins placed in the foundation preparations' storage surfaces ensure the desired object's precise and correct foundation.
- End sensors
  - They detect the exact part position and then start the work process.
  - They detect the movement of the tool and its displacement. The tool returns to its initial position when the boundary surface is reached.
- Optical sensors
  - They detect the presence and position of the part after the assembly operation. If the sensor registers a missing part of part, it sends a signal to the machine's control system, which blocks the object in the fixture or alerts the operator with light and sound signals.

- Counters

- Counters record the exact number of operations or the number of assembled pieces. A light and sound signal is triggered in the event of a difference between the actual number and the reference number.

## 4.2 Procedure for Implementing the Poka-Yoke Method

Among the generally recognized guidelines applied when implementing the Poka- Yoke method in a company, we recommend the following activities [20]:

1. Identification of input parts based on their parameters:
  - Part weight - determination of weight standards, use scales to identify individual parts.
  - Part dimensions – determination of the standard for length, width, diameter, etc., identification of deviations utilizing mechanical stops, limit switches, etc.
  - Part shape – determination of standards for specific shape features, such as angles, contours, bends, hole positions, etc.
2. Detection of deviations from previous processes or detection of operation skipping:
  - Method of monitoring operations - the next cycle cannot be carried out if the employee or the machine does not perform the sequence of actions required by the standard during the work cycle.
  - The method of passing from process to process - we cannot carry out the cycle if one of the steps is skipped; therefore, the standard procedure was not followed.
3. Detection of deviations from fixed values:
  - Control via counter
  - Redundancy method – a specific number of parts is stored in a batch. If it happens that the batch contains a larger number of units, an error is signaled.
4. Measuring critical indicators–detecting critical production parameters, such as pressure, current, time, and temperature. The cycle is suspended until the monitored value returns to the prescribed tolerances.

For the Poka-Yoke method to be successful in a business, it needs to have these qualities [21]:

1. Timeliness - the success of the method depends mainly on the time when it was implemented in the process. The sooner it is applied, the sooner its impact will be felt – help detect and remove unwanted errors.



2. Accuracy – it should be a precise solution that easily diagnoses and identifies what caused the given problem.
3. Simplicity – The Poka-Yoke solution should be as simple and straightforward as possible. It is an important characteristic, as the employee does not have enough time and effort to take special care of a specific solution. The more complex the given solution is, the greater the chance of an error occurring.
4. Transparency – the Poka-Yoke solution must be unobtrusive and direct. If it becomes a burden on the process, the employee will start looking for ways to bypass such a solution.

## 5 Conclusions

In conclusion, we want to evaluate that Poka-Yoke is a technique often used in lean management. This management approach aims to maximize value and minimize waste in all aspects of an organization. Lean management aims to create a continuous flow of value to customers while eliminating waste, defects, and delays. Poka-Yoke techniques can support this goal by helping eliminate errors and defects, streamline processes, and improve efficiency and productivity.

One of the main potential benefits of using Poka-Yoke in a lean management context is that it can help to reduce or eliminate waste in the form of defects, rework, and other issues that result from errors. By detecting and correcting errors as they occur, Poka-Yoke can help minimize the need for rework and other corrective actions, saving time and resources. In addition, Poka-Yoke can help to improve the flow of value to customers by reducing delays and increasing efficiency, which can lead to increased customer satisfaction and loyalty. Overall, using Poka-Yoke as a mistake-proofing technique can be a powerful tool for achieving the goals of lean management and maximizing customer value.

Some of the potential benefits of Poka-Yoke include:

- Improving quality: By reducing or eliminating errors, Poka-Yoke can help improve the overall quality of products or services. It can lead to fewer complaints and returns from customers, as well as fewer defects and repairs.
- Increase efficiency: By streamlining processes and eliminating the need for manual error checking, Poka-Yoke can help increase efficiency and productivity. It can lead to cost savings and faster completion.
- Increasing competitiveness: Poka-Yoke can help organizations become more competitive in their markets by improving quality and efficiency. It can lead to increased sales and market share.
- Increased customer satisfaction: By providing higher products and services quality, Poka-Yoke can help organizations better meet customer needs and expectations, which can lead to increased customer satisfaction and loyalty.
- Improving employee satisfaction: By reducing errors and simplifying processes, Poka-Yoke can help improve the work environment and increase employee satisfaction and morale.

All these advantages point to the necessity of designing workplaces so that the work surface is adapted to the employee as much as possible and serves to simplify work. It can be achieved using poka-yoke principles. Our further research will focus on combining ergonomics with the use of a pick-to-light system and testing it in laboratory conditions.

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