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# IDENTIFICATION OF KEY LEAN TOOLS IN THE AUTOMOTIVE INDUSTRY

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**Abstract:** This paper aims to emphasize the effective application of Lean philosophy as a strategic approach for achieving operational excellence, by presenting contemporary examples and best practices of Lean implementation within the modern automotive industry. The study focuses on identifying and analyzing Lean tools that significantly impact the improvement of business processes. The provided examples and analyses are intended to offer practical guidelines for organizations striving to improve their operations, as well as to contribute to a clearer understanding of Lean tool application in real-world settings.
**Key words:** Lean philosophy, automotive industry, production flexibility, production efficiency

## INTRODUCTION

The modern, dynamic market, rapid technological progress, and increasingly complex business requirements have forced organizations to constantly adapt to changes. In this context, flexibility becomes a key competitive advantage, and achieving it requires the adoption of modern tools and approaches to continuous improvement. For the successful implementation of the Lean philosophy in the organizations, improvement should not be viewed only as a technical task but primarily as a cultural and strategic process. Individuals, teams, and organizations need to embrace the philosophy as an integral part of their work approach and mindset in an increasingly demanding market. Continuous improvement is possible through rigorous and persistent reduction of common causes of variation around the desired performance level, within a stable process [1]. The high degree of prevalence and diverse applicability of the Lean philosophy underscore its universality and adaptability, highlighting the need for further scientific research across various contexts.
The motivation for conducting this study resulted from the increasing interest of organizations in improving their processes through minimal investments and maximizing the utilization of existing resources.

### Subject and aim of the research

The subject of this paper is the Lean philosophy and the practical application of Lean tools in the production processes of a company engaged in manufacturing parts for the automotive industry. The paper examines how specific Lean tools influence production processes and all related activities, including work organization, production time, and the quality of the final product. The main objectives of research are:

- identification of key Lean tools utilized in production systems within the automotive industry,
- demonstrate practical application of Lean tools through industry examples,
- evaluate, based on the given examples, the impact of these tools on key performance indicators (KPI) in production - cycle time, inventory, productivity and quality.

## STATE OF RESEARCH

The first significant scientific insight into the application of the Lean concept in manufacturing was provided by *Womack, Jones* and *Roos* in 1990, in their book „The Machine That

Changed the World“, where Toyota stands out as an example of highly efficient production [2]. Their studies later confirmed that the implementation of Lean tools such as 5S, Kaizen, JIT, Kanban, and TPM leads to:
- inventory reduction;
- cycle time reduction;
- improved product quality;
- increased customer satisfaction.

The essence of Lean philosophy is to reduce the time between the order and receipt of money by eliminating losses [3]. Numerous studies also emphasize the challenges in implementing the Lean philosophy. According to the *Bhasin* and *Burcher*, Lean implementation in practice often faces significant difficulties. Some of the common barriers are [4]:
- employee resistance to change;
- lack of education and understanding of Lean business culture;
- improper implementation due to insufficient expertise and lack of method knowledge (e.g., only visual changes without deeper analysis);
- poorly measured performance and misrepresentation of results;
- inadequate communication and lack of teamwork;
- the complexity and depth of changes required by Lean, which can cause fear and uncertainty among employees.

Recent literature has focused on the integration of Lean and digital technologies such as [4]:
- IoT and sensors for real-time scrap tracking;
- digital Kanban boards;
- usage of Big Data analytics for more efficient decision-making within the Lean framework.

Lean is no longer viewed only as an analog set of tools, but rather as a foundation for the digital transformation of production systems. Lean provides the philosophy and methodology, while digital tools enable faster and more precise implementation of these methods. Together, they create *Lean 4.0* - production model of the future [5]. Integration of Industry 4.0 within the Lean methodology can help overcome existing barriers to its implementation.
Serbian literature regards Lean as a strategic tool for improving competitiveness, but local authors also emphasize the challenges of implementation, such as lack of training, resistance to change, and formal application without true cultural transformation [6].

## KEY LEAN TOOLS IN THE AUTOMOTIVE INDUSTRY – APPLICATION EXAMPLES

Application of modern Lean tools in practice helps organizations eliminate scrap in processes, improve efficiency, and enhance the final value of the service or product delivered to the customer. Below are examples of the implementation of some of the most important Lean tools in the industry. All examples are from a company engaged in the manufacturing of automotive parts.[1]

[1] Due to the business confidentiality and professional ethics, certain data in this paper have been partially modified or presented symbolically, and do not reflect actual numerical values. Key elements are intentionally hidden to preserve confidentiality and maintain professional standards.

### 5S

The 5S method refers to workplace organization and is widely applied in the automotive industry. Below is an example of the 5S principles implementation in a company that manufactures automotive parts. During the production line changeover from one production variant to another, the workplace was organized according to the following principles [7]:

- sort: excess materials and tools were removed, and only the necessary tools were placed next to or within the production line.
- set in order: each tool has a designated place, and tools are arranged in the order of use during production. Labels and color coding are used to identify tool positions.
- shine: daily routine cleaning schedule for the workplace has been implemented.
- standardize: Standard work instructions exist for every task or activity - cleaning, sorting, maintenance - and all employees follow the same standards.
- sustain: there is a department responsible for conducting 5S inspections, and 5S has been established as a criterion in the monthly team evaluations.

The primary advantages of implementing this approach include:

- accelerated tool retrieval,
- reduction in workplace accidents,
- enhanced worker productivity.

### Visual Management

Visual management is the practice of visualizing information or displaying requirements with a focus on improving the understanding of business processes [8]. Smart manufacturing systems, integrating the virtual and physical worlds, surpass traditional ways of working.
Figure 1 shows us a system for monitoring the operation of a production line. The system automatically receives signals from software and maps statuses (green - line operating smoothly; red - unplanned downtime; orange – planned downtime). The use of colors enables quick and intuitive identification of the production line's status, and any emerging issue is immediately made visible to all personnel via a large display screen in the production area. Detailed status indicators provide information on whether the cause of downtime is due to machine failure, material shortage, tool adjustment, or other factors. Additionally, the software enables the export of a comprehensive list of all events and issues for detailed analysis (e.g., using the 5Why method). This practical example of "visual management" effectively demonstrates how color functions as an information carrier, allowing everyone, from operators to managers, to quickly perceive and understand the production status without the need to read or analyze detailed reports.

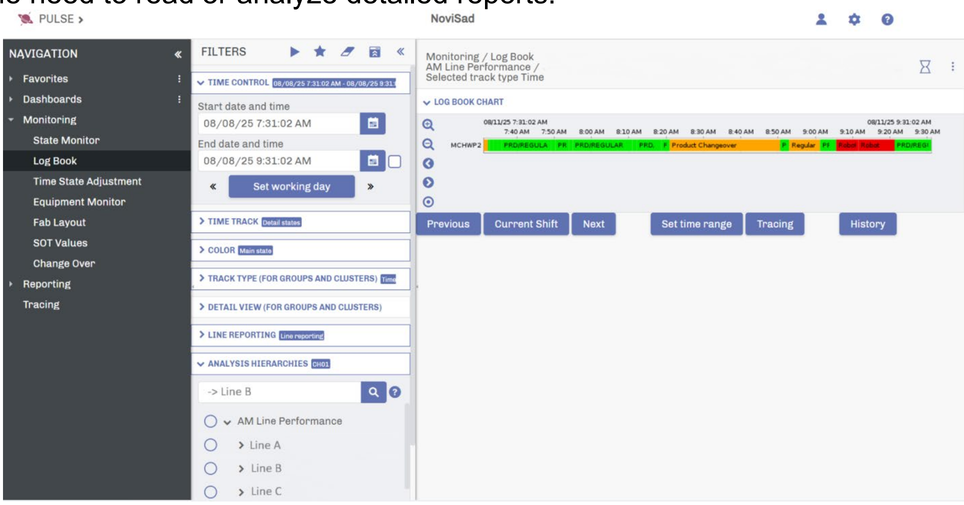


***Fig. 1.*** *System for monitoring and visualizing production line performance*

This example demonstrates how digitalized visual management facilitates transparency in production processes. The integration of clear color coding, time range filters, and detailed downtime classification enables faster detection, analysis, and elimination of losses—an essential aspect of Lean implementation in the automotive industry.
In addition to monitoring and improving equipment productivity and availability, monitoring and improving quality completes the Lean perspective in industry. Figure 2 presents a tool for tracking the total number of good and defective products, the percentage of scrap, main causes of scrap, and other related data.

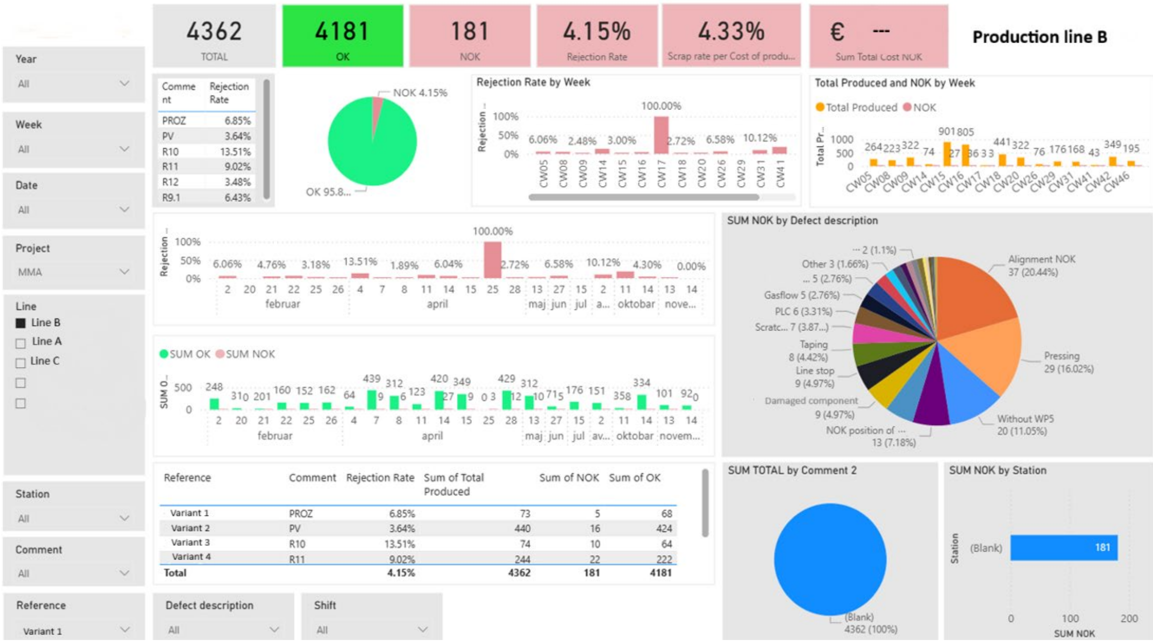


***Fig. 2.*** *System for monitoring quality and identifying primary scrap causes*

The presented example provides a visualization of quality-related data in the form of:

- Pareto chart of defects,
- Quality trends by shifts/days,
- The top 5 causes of scrap,
- The percentage of scrap in total production,
- The correlation of scrap with time, production line, or operator.

**Problem Solving Tools**

Problem-solving within Lean manufacturing constitutes a fundamental component of the Toyota Production System (TPS). Consequently, contemporary problem-solving tools represent essential techniques for minimizing waste and inefficiencies in production processes. Figure 3 illustrates the software tool "Problem Solving Tool," which is utilized within the Lean framework to systematically address production-related issues. This tool is part of an organizational system designed for standardized tracking and visualization of problem resolutions in manufacturing. User selects the production sector, project, production line, and station where the problem occurs. This primarily enables precise localization of the problem and its connection to the relevant teams and resources. The person responsible for the process inputs the problem solution into the system, making it visible to all individuals involved in the respective process and production line. In cases where the same issue reoccurs, responsible personnel can refer to the previously documented and implemented solution, thereby avoiding additional time loss. Problems are categorized by type (mechanical, electrical, software, etc.), which facilitates root cause analysis and supports prioritization in problem resolution.

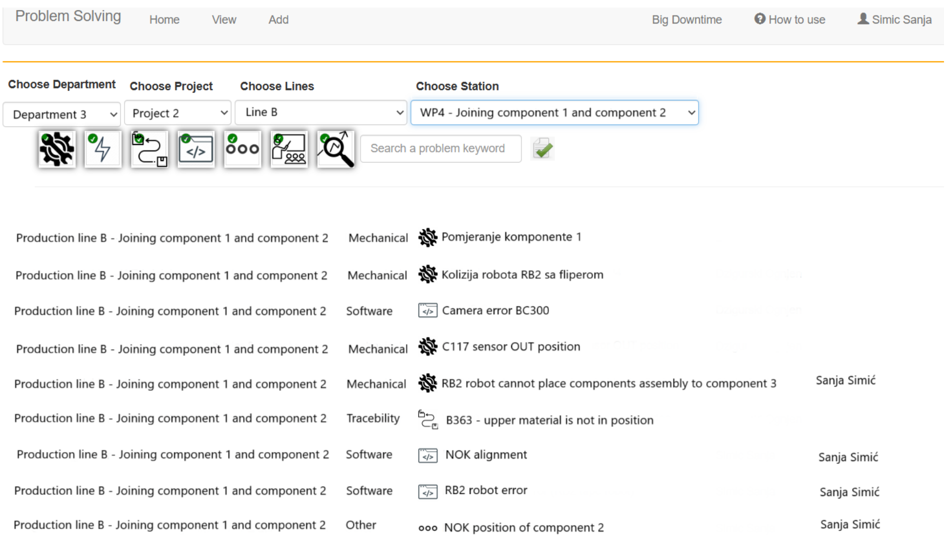


***Fig. 3.*** *Software tool for problem solving and solution strategy presentation*

## Single Minute Exchange of Dies - SMED

The ability of individualized and customized production has become a key success factor in today’s globalized and digital business environment. Customers strive to receive products customized to their specific needs. These high customer expectations have led to an increase in product variety and complexity. SMED (Single Minute Exchange of Dies) is used to reduce the time required for tool changes or machine adjustments during switching production from one product to another, in order to increase flexibility, productivity, and process efficiency. Generally, SMED aims to standardize and simplify the operations [9]. Figure 4 shows an automated changeover monitoring system, which monitors tool and material changes on the production line during the transition between production variants. This process is critical for efficiency, as improper or untimely execution can lead to delays, errors, and reduced overall productivity. The use of an automated system enables visual tracking of the changeover status and individual steps, reduces the time needed to perform all actions, minimizes human error, and increases quality and safety. System has enabled the reduction of changeover times to approximately 30 minutes for the most complex variants, while simpler changeovers can be completed in 10 minutes. Sections that indicate the product type, changeover steps, current status, and other relevant information are displayed on the HMI screen.

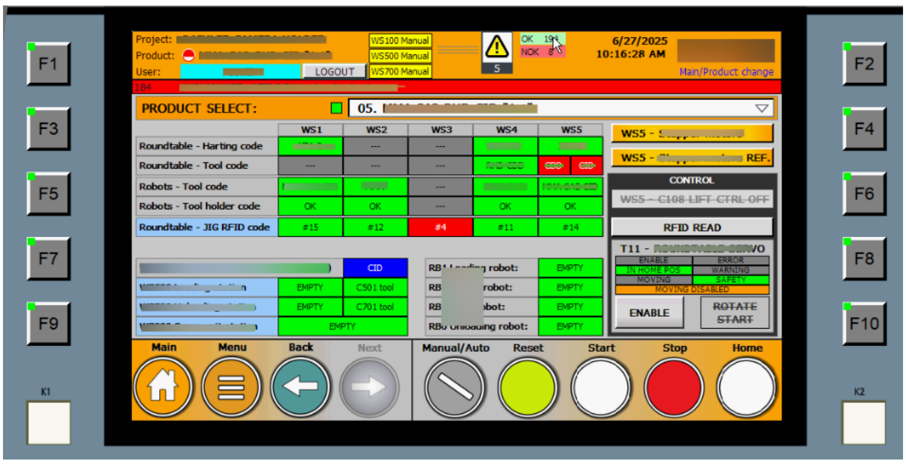


***Fig. 4.*** *Automatic changeover tracking system*

Implementation of such solutions in modern manufacturing is part of the broader concept of Lean philosophy and Industry 4.0, both of which aim to optimize resource usage, support digitalization, and improve efficiency through smart systems.

**Poka-Yoke**

The Poka-Yoke tool ensures that a component can only be placed in the correct way, thereby eliminating the possibility of operator error. If the component is not properly positioned, system automatically stops the process and gives a warning signal. This is a fundamental principle in Lean manufacturing - detecting problems in real time and automatically stopping the system. Figure 5 shows the method of positioning the tray with components inside a drawer. The highlighted element displays "Poka-Yoke corner" which ensures correct tray placement and prevents errors. There are four corners for positioning: one fixed (4) and three adjustable (3). The fixed corner guarantees that tray can only be placed in a specific orientation.

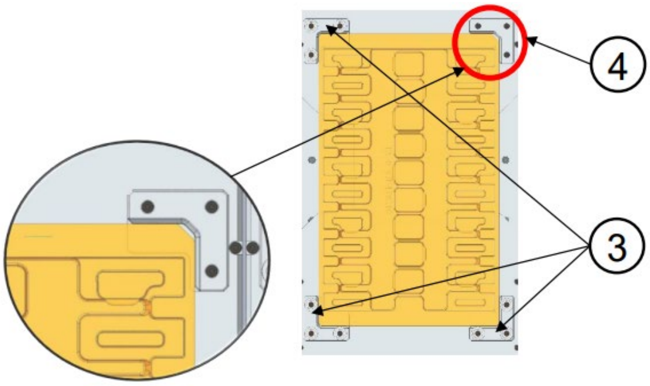


***Fig. 5.*** *Application of the Poka-Yoke system for ensuring correct tray positioning in a drawer*

This method of guiding and positioning allows each tray to be placed correctly and consistently, without the need for additional operator checks or training. As a result, work quality is improved, and potential errors are eliminated. The core philosophy of Poka-Yoke method is respect for human capability and intelligence. During repetitive operations which depend on vigilance or memory, poka-yoke may save time and release the mind of worker for operations more creative and increase their value [10].

**Jidoka**

The Jidoka principle in manufacturing is typically triggered by quality issues in products and implies stopping the production line until the problem is effectively resolved. A common example of Jidoka application in modern production lines is the automatic stop of the process after three defective products are detected consecutively. The production line is equipped with an automatic inspection system that sends good products to the output station and defective products to the scrap station. When the first defective product passes through the system, error is recorded, but production does not stop immediately. However, if three defective products are detected consecutively, the system automatically:

- stops the production line;
- activates the light and sound signal;
- displays a notification message to the responsible person.

This approach enables quick response to potential problems in the process (e.g., worn tools, incorrect materials, errors in machine parameters) and prevents further scrap parts production.

### 5Why

This Lean method requires employees to identify the root cause of a problem, preventing the company’s engineering team from settling for superficial solutions and forcing them to address issues permanently. It is a very simple analytical method that can be used without any statistical analysis. Below is an example of applying the 5 Why method to the case of bad alignment between two components at the one station within the production line.
Problem description: In the process at the WP4 station (Joining Component 1 and Component 2), bad alignment between Component 1 and Component 2 was observed. This led to a defective output product, activation of Jidoka, and stoppage of the production line. The problem-solving analysis and its results are presented in Table 1.
In this case, although the initial conclusion after the appearance of defective parts was that there was a problem with the offset, the analysis showed that the real cause was the lack of proper work procedures. Additionally, during the design and implementation of this change on the production line, it was not considered that the new gripper, due to a more complex manufacturing process, would behave differently in the production environment. Despite having the same tool dimensions and design, the gripper reacted differently to working conditions, and after a short period, a micro-shift in the tool’s coordinate system occurred, resulting in an incorrect offset.

***Table 1.*** *Root cause analysis of bad alignment using the 5Why technique*

| No. | Question | Answer |
|---|---|---|
| 1 | Why did bad alignment occur between Component 1 and Component 2? | Because the offset in the X direction was incorrectly set. |
| 2 | Why was the offset in the X direction incorrectly set? | Because a new gripper was implemented, of the same design, but it proved to be less stable than the previous one. |
| 3 | Why did the new gripper cause the offset problem? | Because after installing the new gripper, the position was not checked and adjusted. |
| 4 | Why was the position not checked and adjusted after installation? | Because there was no defined standard procedure for position verification after modifications. |
| 5 | Why was there no such standard procedure? | Because current procedures do not require manual measurement, inspection, and adjustment as a mandatory step after changes on the production line, unless there are mechanical modifications to the tool. |

### Total Productive Maintenance

In modern manufacturing organizations, the development of a strong maintenance culture is essential for improving production efficiency and operational success. A prime example is the implementation of Total Productive Maintenance (TPM), a key concept rooted in Japanese manufacturing philosophy that promotes comprehensive maintenance and equipment management. TPM objective is to maximize efficiency and productivity by involving all employees, from operators to planners, engineers, supervisors, and top management, in proactive activities. Practical industrial application of TPM is through the SAP PM (Plant Maintenance) module. This module supports the planning, execution, and monitoring of all maintenance activities in a digitalized and automated manner. By enabling the creation of maintenance plans, work orders, and detailed recording of interventions, SAP PM helps organizations simplify maintenance workflows and reduce equipment downtime. Integration of SAP PM with inventory management ensures efficient spare parts handling, which minimizes delays and enhances production reliability. In an industrial setting, SAP PM allows maintenance teams and managers to quickly access maintenance schedules, avoid overlapping activities, and assess technician’s workloads. Preventive maintenance routines managed through SAP contribute directly to reducing unplanned failures, extending life of equipment, and lowering overall maintenance costs. SAP can be integrated with quality control, production, and energy management systems, allowing a holistic approach to maintenance and manufacturing processes. This integration improves communication between different departments and supports faster response to potential issues.

## CONCLUSION

The presented case studies illustrate how Lean tools support continuous improvement in real industrial settings. At its core, Lean methodology emphasizes the creation of greater value through the efficient use of fewer resources. The basic Lean framework involves methodical cost reduction and scrap elimination across entire value streams, rather than just isolated points, creating processes that require less human effort, space, capital, and time to produce goods and services at significantly lower costs and with far fewer defects compared to traditional business systems. In modern manufacturing systems, Lean has emerged as one of the most effective concepts for improving and increasing the competitiveness of organizations. This article, in addition to reviewing existing literature, presents practical applications of some of the most important Lean tools used in the contemporary automotive industry. Through concrete examples, the application of tools, approaches, deeper understanding, and problem-solving methods in modern industry are explained. It is important to note that insufficient or incorrect understanding of Lean, resistance to change, and lack of a long-term strategy significantly affect the efficiency of its implementation. Therefore, successful implementation and sustainable application require not only technical knowledge and tool introduction but also cultural transformation, involvement, and discipline of all employees.

## ACKNOWLEDGEMENT

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