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# The Impact of the Kanban Method on the Efficiency of Production Processes in an Automotive Company: A Case Study

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***Abstract:***

***Purpose:*** *The purpose of this article is to analyze and evaluate the effectiveness of the Kanban method in improving production processes within an automotive company, with a particular focus on production cycle time and the efficiency of seven production lines.*
***Design/Methodology/Approach:*** *The study employed a case study method and a quantitative analysis of real-world data from an automotive manufacturing company, covering the years 2023–2024. The effectiveness of the Kanban method was evaluated based on an analysis of production cycle times and the Overall Equipment Effectiveness (OEE) metric across seven production lines. The study accounted for the use of electronic Kanban cards, as well as ERP and T-card systems, which support the planning, visualization, and monitoring of production processes.*
***Findings:*** *The analysis conducted demonstrated that the Kanban method contributes to streamlining production processes, shortening production cycle times, and increasing the efficiency of production lines. Between 2023 and 2024, the OEE (Overall Equipment Effectiveness) metric improved across all seven lines analyzed. The average efficiency of all lines in December rose from 84.81% in 2023 to 85.74% in 2024. Furthermore, the implementation of Kanban helps to reduce overproduction and inventory levels, improve the flow of materials and information, and eliminate waste. However, certain limitations of the method were identified, relating to factors such as demand volatility, the need for frequent adjustments to production plans, and the risk of raw material shortages.*
***Practical Implications:*** *The research findings can serve as a basis for implementing and refining the Kanban method within manufacturing enterprises, particularly in the automotive industry. Adopting this approach enables better alignment of production with customer demand, a reduction in warehousing costs, more efficient management of material flow, and faster identification of bottlenecks and downtime. Successful implementation, however,*

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*requires effective coordination of supplies, continuous monitoring of demand, and the development of contingency measures to protect against disruptions in the availability of raw materials.*
***Originality/Value:*** *The originality of this article lies in its empirical assessment of the effectiveness of the Kanban method within an actual automotive company, based on data from 2023–2024. By simultaneously analyzing production cycle times and Overall Equipment Effectiveness (OEE) metrics across seven production lines, the study provides a multifaceted evaluation of the outcomes resulting from the implementation of this approach. The value of this work stems from its identification of the practical benefits and limitations of the Kanban method, as well as its confirmation of the method's significance for the continuous improvement of production processes and the enhancement of a company's competitiveness.*

***Keywords:*** *Organization of Production, Transport, Technology, Management.*

***JEL codes:*** *L23, N7, M11.*

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## 1. Introduction

The Kanban method, which originated from the Japanese Lean management philosophy, is one of its tools. It is widely used in many companies to streamline automated production and business processes (Chichanda *et al.,* 2024; Edgar *et al.,* 2025). At the core of this method lie the reduction of work in progress, work visualization, and continuous improvement (Csernoch *et al.,* 2024). Kanban helps minimize waste, streamline workflow management, and increases a company's competitiveness (Jizdan *et al.,* 2024).

Through process visualization and workflow management, Kanban helps reduce costs associated with electricity consumption. In the context of manufacturing processes, Lean means "streamlining" or "trimming down" production, reducing waste, and shortening production cycles. This is achieved by reducing inventories of finished goods and work-in-progress, managing material resources, and optimizing

the use of production floor space and machinery. "Lean" production uses fewer resources in the manufacturing process compared to traditional production methods.

The main benefit is a reduction in inventory levels, which limits the amount of storage space required and allows for an expansion of the product range (Kotani *et al.,* 2007). The fundamental principle of Lean Manufacturing is the elimination of all operations and activities that do not add value to the final product. Therefore, the starting point in lean manufacturing is to define the product's value from the perspective of a potential customer (the set of benefits the customer receives along with the product).

These benefits may include: order customization, total product costs, product specifications, a service system, and a loyalty program. Consequently, the product's added value is defined solely by the customer; manufacturers are responsible for creating it, and all other activities are viewed as waste (Stadnicka, 2021). In the production sector, companies implementing Lean are distinguished by a high level of integration and flexibility in their production processes, as well as short changeover and production cycle times. Technological processes are simplified and transparent, transport routes are short, and product batches are small.

In terms of procurement and distribution, companies maintain long-term relationships with a limited number of suppliers, ensuring regularity and short delivery times in accordance with Just-in-Time (Martins *et al.,* 2025). In contrast, the area of organization and management is characterized by a low level of formalization and centralization, a flat organizational structure, teamwork, and ongoing skill development (Neumann, 2023).

## 2. Literature Review

The use of the Kanban concept for the efficient transport of materials and raw materials from the warehouse to production and between individual workstations, as illustrated by an industrial company, is described in article (Pałęga et al., 2012). The significance and function of implementing Kanban in a manufacturing company were presented by the authors of article ( Galińska *et al.,* 2015) . They presented the theoretical characteristics of this method, discussed the implementation process, and made improvements in the areas of production and inventory management.

The analyses conducted showed a significant reduction in overproduction, which confirmed the effectiveness of the Kanban method used. Another example is an article that presents the key tasks, principles, functions, and differences between the Kanban method and its traditional counterparts in the area of ordering and moving materials (Kucharczyk, 2015). The main benefits of implementing the Kanban method were discussed, comparing them to other classic production planning and management systems. The authors, however, evaluated the Kanban method in a manufacturing company in publication (Dziekoński *et al.,* 2014).

According to the opinions of the surveyed employees, the implementation of Kanban had a positive impact on their work and the company's operations, contributing to: a reduction in inventory, the elimination of downtime, an increase in production flow, as well as improvements in the timeliness of orders.

The literature contains numerous articles discussing the philosophies of Lean Management and Lean Manufacturing for the purpose of process improvement (including production logistics), such as publications (Baskiewicz *et al.,* 2017; Horzela *et al.,* 2021; Krawczyk, 2023; Leksono *et al.,* 2025; Luene *et al.,* 2025).

These works present an analysis of tools such as the Kaizen philosophy, the Kanban method, and Just-in-Time, the use of which helps optimize production processes. The author described Lean Manufacturing and its application practices in article (Chruściel, 2022). It discusses issues related to the tools used in the Lean Manufacturing concept and their effectiveness in eliminating waste. The positive and negative aspects of using the tools of this concept were compared with traditional practices.

The article encourages researchers to consider innovative applications of Lean Manufacturing tools and to further explore this topic. The application of Lean Management in intralogistics, on the other hand, is presented in the article (Piasecka-Głuszak, 2015). It presents the results of empirical research on the extent of lean tool application in the intralogistics of manufacturing companies on the Polish market.

## 3. Research Methodology

Currently, computer applications are used to manage the procurement process. In these programs, work is organized using Kanban boards, which are a fundamental element of the Kanban method (Mecalux, 2026). They are designed to visualize the workflow and manage orders.

A Kanban board contains columns such as "To Do," "In Progress," and "Done," which reflect the status of a given task. Tasks are represented by Kanban cards containing all relevant information about the task, including the individuals responsible for their completion. As work progresses, the cards move between columns (Pep, 2026).

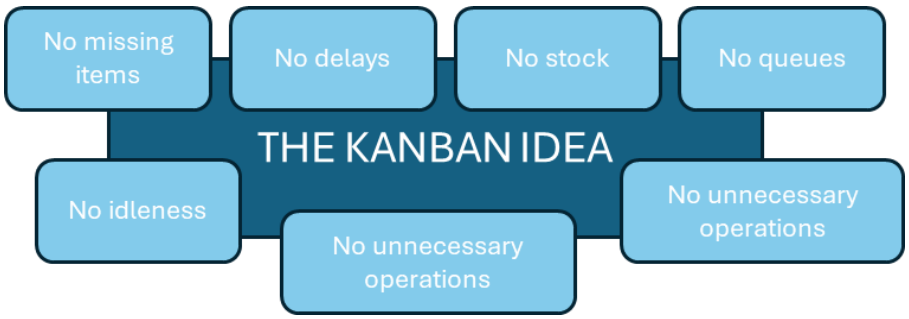
Advanced boards, used simultaneously by multiple teams, can contain dozens of columns and rows. Furthermore, modern boards available in software automatically generate reports and analyses, which enables the quick identification of any issues, bottlenecks, or opportunities for further process improvement (Kanbantool, 2026).

The Kanban philosophy is encapsulated in the slogan "7 Zeros" (Figure 1). The overall goal is to eliminate pre-production, in-process, and finished goods

inventories. The delivery schedule for finished goods to customers is planned down to the hour, and pickup orders are synchronized with customer orders. Thus, Kanban is a tool for continuous improvement that prevents overproduction and excessive material transport between individual production processes.

Using Kanban, it is possible to monitor and optimize material storage costs, increase the availability of raw materials, and synchronize production capacity with current demand, thereby eliminating unnecessary downtime and delays in production processes resulting from shortages of essential resources (Galińska, 2015).

***Figure 1**. The concept of the Kanban system*




***Source:** Galińska, 2015.*

There are two types of Kanban cards used to manage material flow: Kanban cards that serve as production orders and Kanban cards that serve as pick orders (Lean, 2026).

The success of Kanban implementation depends on adherence to six fundamental practices. Although mastering them is extremely important, this process is ongoing—about 40% of companies admit that their approach to Kanban practices is still evolving. The practices of the Kanban method are (Businessmap, 2026):

**1. Visualizing the workflow** – to visualize the process using the Kanban method, you need a Kanban board consisting of cards and individual columns. A crucial aspect is identifying what is necessary to ensure the proper flow of all goods from the moment an order is placed until the finished product is delivered. Identifying how work is carried out within the system will enable continuous improvement through the implementation of necessary and rational changes.

**2. Limiting work in progress** – one of the most important functions of Kanban is controlling the number of active work-in-progress (WIP) items. The absence of work-in-progress limits means Kanban is not being used. When a team shifts priorities to other tasks while a task is in progress, it usually has a negative impact on the process, and multitasking leads to overload, waste, and reduced efficiency. Limiting work in progress involves the introduction of a “pull” system.

Setting a maximum number of items at a given stage ensures that a card moves to the next phase only when the necessary resources are available for its completion. Such limits allow for the rapid identification and subsequent resolution of any issues in the flow.

**3. Flow management –** this practice relates to the organization of work, not to managing people. Flow is defined as the movement of work items through the production process in a predictable and balanced manner. Achieving smooth and efficient flow is one of the most important goals of Kanban implementation. Instead of focusing on micromanaging staff and keeping them constantly busy, it is better to optimize work processes by understanding how to move tasks through the system more quickly. As a result, Kanban accelerates value creation.

**4. Establishing clear and transparent process guidelines** – you can't improve something if you don't understand it. Therefore, the process should be clearly defined and widely communicated. People will be reluctant to get involved and participate in activities that they don't find useful. When the team is aware of a shared goal, it will collaborate effectively and make decisions that yield positive results. Operating principles—transparent, concise, properly defined, and flexible when necessary—have the potential to strengthen the team's self-organization.

**5. Establishing feedback mechanisms—**this is a fundamental element for teams and organizations striving to increase their agility. Such mechanisms ensure that organizations are able to respond appropriately to potential changes and facilitate the transfer of knowledge among stakeholders. The Kanban method recommends implementing stand-ups, both at the team level and in the context of services.

A team-level cadence involves a daily team meeting aimed at monitoring status and workflow. The meeting allows for an assessment of available resources and opportunities to increase the pace of task completion. It takes place at the Kanban board, where each team member presents information about their activities from the previous day and plans for the current day. Service-oriented cadences, which include meetings on service delivery, operational activities, and risks, are designed to coordinate and optimize service delivery.

The outcomes of these reviews, such as the identification of obstacles to effective service delivery, are a key factor in decision-making regarding the continuous improvement of the service network. Although regular meetings with a small number of participants have proven effective, the ideal duration of a session depends on the context, the nature of the issues, and the size of the team.

**6. Collaborative improvement –** one way to achieve continuous improvement and constant change within a company is to implement changes collectively, based on scientifically validated methods and feedback. Developing an organizational

culture where every hypothesis is evaluated in terms of its positive or negative effects plays a crucial role in fostering a mindset focused on improvement through incremental changes.

## 4. Research Results and Discussion

The subject of the research, analysis, and evaluation of the Kanban method's implementation is an automotive company belonging to an international conglomerate that specializes in the production of components for leading automotive brands. The analyzed company manufactures powertrain systems designed to reduce fuel consumption and exhaust emissions: air throttles, starters, exhaust gas recirculation (EGR) valves, and innovative electric compressors.

The company also specializes in the remanufacturing of components such as starters, alternators, automotive air conditioning compressors, and dual-mass flywheels. When examining the flow of materials throughout the entire production cycle, the following stages can be identified:

1. Receiving and storing raw materials.
2. Flow of raw materials through the production process.
3. Flow of semi-finished products and parts through the assembly process.
4. Receiving goods into the finished goods warehouse.

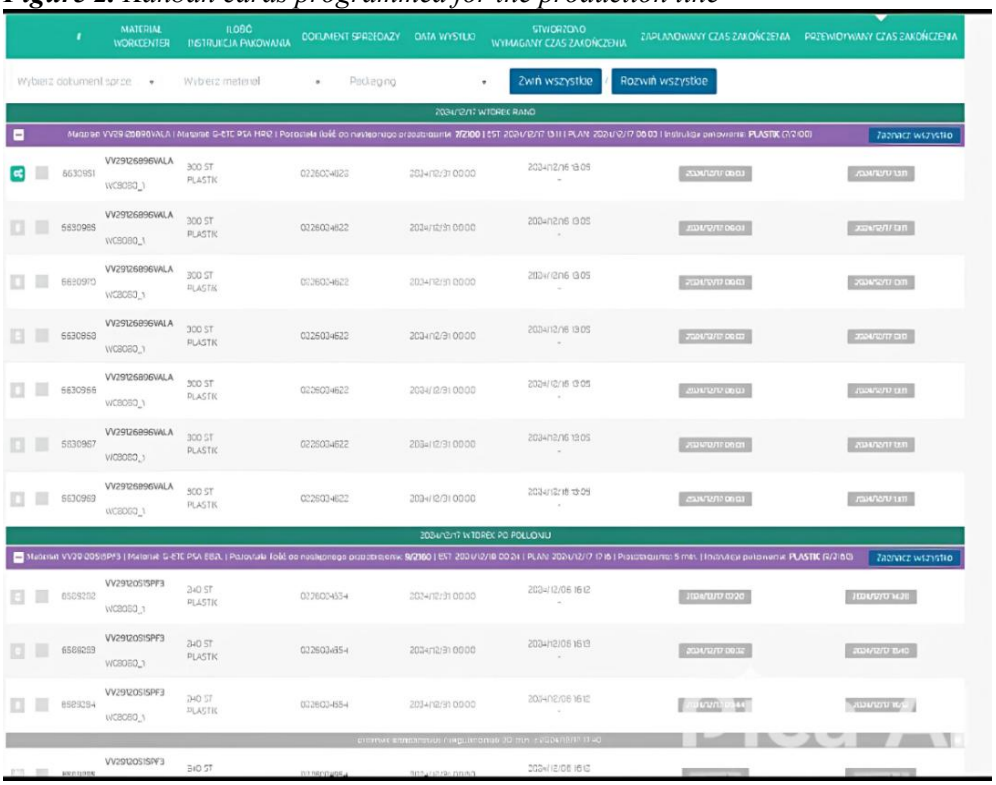
The Kanban method implemented at the company enables the smooth organization of the flow of materials and information between the various stages of the production process. To this end, the company relies on electronic Kanban cards, which are available in an in-house application. A Kanban card, which serves as a pick order, signals the need to retrieve specific components necessary for production from inventory (the retrieval simultaneously triggers replenishment) and deliver them to a specific workstation on the production line.

This is done using a "pull" system, limiting excess inventory and ensuring production proceeds according to the established schedule. In turn, a Kanban card serving as a production order signals the start of production. It automates production ordering and workflow processes. The content of a single Kanban card is one pallet of finished goods. For example: the production plan for a single line calls for the production of 2,400 units of item x and 900 units of item y. One pallet of finished product x contains 300 units, and one pallet of finished product y contains 180 units.

These are the customer's specifications, so the automotive company must adhere to them. Therefore, the production planner assigns 8 pallets of product X and 5 pallets of product Y to the line, resulting in a total of 13 kanban cards for that production line. After scanning the 300 units specified on the kanban card for item x, the card is automatically closed, a summary label is generated for the produced pallet, and the quantity of goods produced is reported.

If one shift ends and the product pallet has not been completed, the operators pause the kanban card at 120 units of the product, and exactly that amount is reported. The card is passed to the second shift; after the production of the given product pallet is completed, a summary label for 300 units is printed, and the remaining quantity of the product is declared.

***Figure 2.*** *Kanban cards programmed for the production line*




***Source:*** *Own study.*

The T-card planning system oversees the organization of the production process and work scheduling. This system is used as part of the Lean Manufacturing philosophy to reduce losses associated with machine breakdowns and micro-downtime. It is a visual management tool that allows for tracking tasks at each stage of production. It is based on boards and cards where information about tasks and their deadlines is recorded. Each card is assigned to a specific production task, and moving it across the board helps visualize progress tracking. The key features of the T-card system are highlighted:

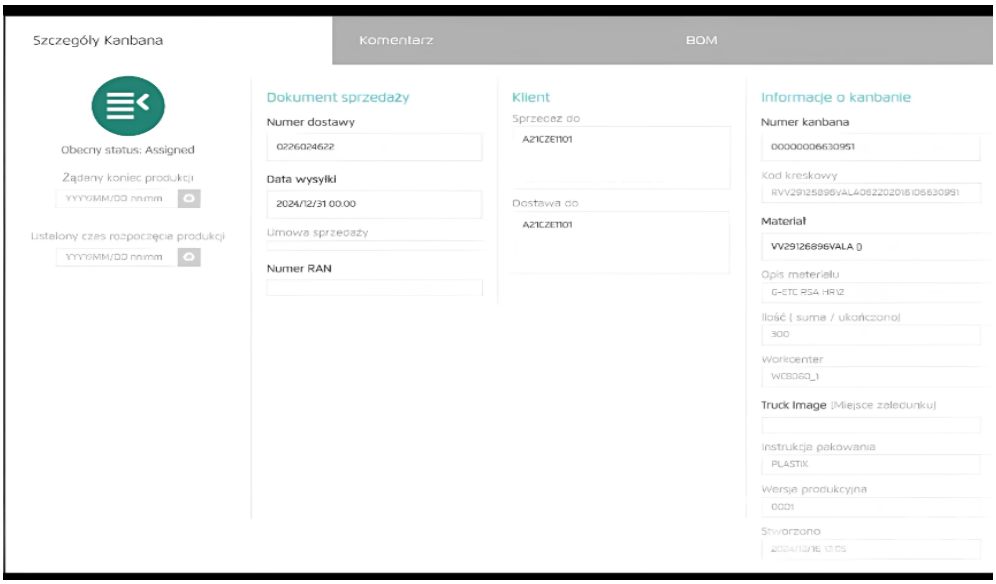
- process visualization – cards placed on the board allow for easy monitoring of the status of individual tasks,
- flexibility – the T-card system is easy to adapt to various environments, such as production and scheduling,

- card – each card contains information about a specific task, e.g., stage of completion, date, and operator number on a given production line,
- board – it is typically organized on a weekly and daily basis,
- layout and color scheme – cards are grouped by production line and color-coded, making it easier to distinguish between task types (e.g., by status or priority),
- transparency – it works by visually representing the schedule, making it easier to identify delays or necessary resources.

Thanks to the T-card, production planners can monitor the status of individual tasks in real time, while production line operators can view a detailed production plan on their operator consoles. They know which product to manufacture, in what quantities, and when to change over the machines. Figure 2 shows a queue of electronic kanban cards programmed for a single production line in the ERP system.

The contents of the electronic kanban card are shown in Figure 3.

***Figure 3**. Contents of a Kanban card*




***Source:** Own study.*

The Kanban method, one of the fundamental tools of Lean Manufacturing, has a significant impact on streamlining production processes, reducing costs, and eliminating waste. In the company under study, this method is used to organize, visualize, and optimize the production process, including the management of the flow of materials, parts, and components within the production process, as well as the automation of production orders in the form of electronic Kanban cards. Based on the analysis of the conducted research, the effectiveness of this method and its

impact on streamlining production processes in an automotive company were evaluated.

The analysis of the Kanban method implemented at the company under study was conducted in the following areas:

- production cycle time – the time elapsed from the start of production of a single unit to its completion [s],
- production line efficiency – OEE (Overall Equipment Effectiveness) index: a measure of machine efficiency that determines the percentage utilization rate of the machine park.

This is a composite indicator consisting of the product of the availability (percentage of operating time), performance (speed and productivity relative to ideal values), and quality (percentage of defect-free products) indicators.

Data on the production cycle time [expressed in seconds] for individual products (SKUs) manufactured on seven production lines are presented in Table 1. At the company, the production cycle time for a given product is standardized. This means that the process is organized in such a way as to fit within a specified target cycle time.

The goal is to meet the requirements of customer orders. Establishing standards in this area makes it possible to effectively identify time waste and implement measures to eliminate it. Standardization thus serves as a benchmark for measuring process efficiency, but also for implementing improvement measures. As a result, the system records how much of a product should be produced with the declared staffing levels on a given line.

***Table 1.*** *Production Cycle Time*

| Production cycle time [seconds] | | |
|---|---|---|
| Line 1 | Ref. 1 | 21.9 |
| | Ref. 2 | 21.9 |
| | Ref. 3 | 21.9 |
| | Ref. 4 | 21.9 |
| Line 2 | Ref. 5 | 25 |
| | Ref. 6 | 25 |
| | Ref. 7 | 23 |
| | Ref. 8 | 24 |
| | Ref. 9 | 27.8 |
| Line 3 | Ref. 10 | 17 |
| | Ref. 11 | 17 |
| | Ref. 12 | 17 |
| | Ref. 13 | 20 |
| | Ref. 14 | 17.5 |

| | | |
|---|---|---|
| Line 4 | Ref. 15 | 19 |
| | Ref. 16 | 19 |
| | Ref. 17 | 19 |
| | Ref. 18 | 18 |
| | Ref. 19 | 18 |
| | Ref. 20 | 18 |
| Line 5 | Ref. 21 | 17.5 |
| | Ref. 22 | 17.5 |
| | Ref. 23 | 17.5 |
| | Ref. 24 | 20,3 |
| Line 6 | Ref. 25 | 22 |
| Line 7 | Ref. 26 | 17.5 |
| | Ref. 27 | 18 |
| | Ref. 28 | 18 |
| | Ref. 29 | 18 |
| | Ref. 30 | 17.5 |

***Source:*** *Own study.*

Based on the data in Table 1, it can be concluded that cycle times for most lines are consistent and stable, indicating that the standards have been implemented correctly. This, in turn, contributes to the effective functioning of the Kanban method. The values fall within the range of 17–25 [s]. The only deviation occurs for item 9 and amounts to 27.8 [s], which may be due to the specific nature of this product.

Deviations from the established time can result, for example, in downtime at subsequent workstations when the cycle takes too long. Process standardization facilitates more effective management of material flow. Based on the production cycle time of individual SKUs, the average production cycle time for each production line was calculated, as shown in Figure 4.

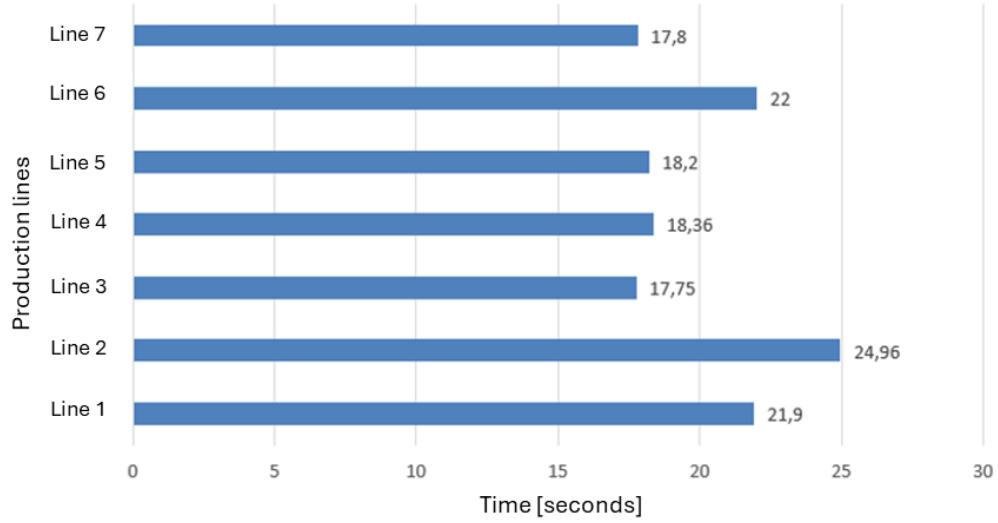
The average production cycle time for most production lines is approximately 18 [s], while the longest cycle time occurs on Line 2, at approximately 25 [s]. In the Kanban method, maintaining consistent cycle times is particularly important for a smooth workflow and contributes to the further development of a culture of continuous improvement (Kaizen) and operational stability.

The Kanban method directly impacts production cycle time through a more efficient workflow (elimination of bottlenecks and reduction of work in progress), reduction of inter-process inventory, and process visualization and transparency. It is estimated that the implementation of the Kanban method has reduced production cycle time by approximately 10–20%.

Data on the efficiency of individual production lines (OEE—Overall Equipment Effectiveness) in 2023 are presented in Table 2 and Figure 5. Efficiency targets for each month are set in the company's annual budget. The efficiency of production lines depends on many factors, including:

- the vacation season (productivity is generally lower in August than in other months),
- new line setups,
- the number of product variants produced on a given line (the more variants, the more changeovers, and consequently, lower productivity).

***Figure 4.*** *Average production cycle time*




***Source:*** *Own study.*

The data in Table 2 (Figure 5) show that in 2023, Line 1 was the most efficient—maintaining a very high level above 90% throughout the year—while the lowest efficiency was recorded on Line 7, where the rate did not exceed 76%. This is the average OEE value, considering that this line has one of the shortest cycle times at 17.8 [s].

This may be caused by various factors, such as quality issues, downtime, or a high number of changeovers due to high production variability. A decline in efficiency is visible on every line in August due to the vacation period.

Throughout the year, there is a slight upward trend on every production line, which is consistent with the philosophy of continuous improvement.

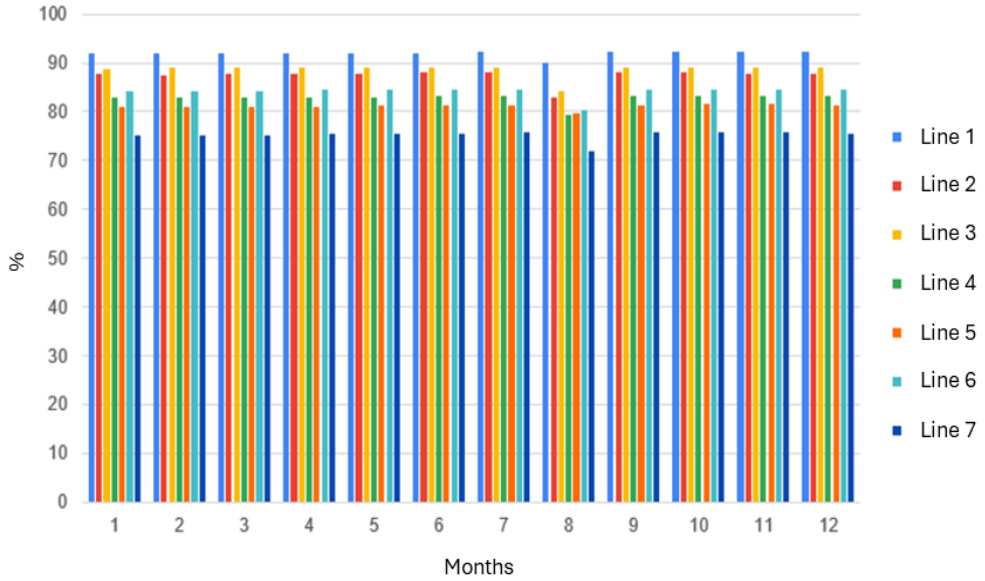
Looking at the number of SKUs produced on each line, it is evident that on Line 4, despite producing the highest number of SKUs (7), efficiency is not the lowest, which indicates a well-balanced process. In contrast, Line 6 produces only one SKU, yet its efficiency is at a relatively average level, which may indicate other types of losses.

***Table 2.*** *Production Line Efficiency in 2023 – Author's own analysis*

| Production line efficiency [%] in 2023 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Production Lines | **Months** | | | | | | | | | | | |
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| Line 1 | 91.8 | 91.9 | 91.8 | 92 | 92.1 | 92.1 | 92.2 | 90 | 92.2 | 92.2 | 92.2 | 92.2 |
| Line 2 | 87.6 | 87.5 | 87.7 | 87.9 | 87.9 | 88 | 88 | 83 | 88 | 88 | 87.9 | 87.9 |
| Line 3 | 88.7 | 88.9 | 88.9 | 88.9 | 89.1 | 89.2 | 89.2 | 84.3 | 89.2 | 89.2 | 89.2 | 89.1 |
| Line 4 | 82.8 | 82.8 | 82.9 | 82.9 | 83 | 83.2 | 83.2 | 79.4 | 83.2 | 83.2 | 83.1 | 83.1 |
| Line 5 | 80.9 | 81 | 81.1 | 81.1 | 81.2 | 81.3 | 81.4 | 79.8 | 81.4 | 81.5 | 81.5 | 81.4 |
| Line 6 | 84.2 | 84.2 | 84.3 | 84.4 | 84.5 | 84.5 | 84.6 | 80.2 | 84.5 | 84.6 | 84.5 | 84.4 |
| Line 7 | 75.1 | 75.1 | 75.3 | 75.4 | 75.4 | 75.6 | 75.7 | 71.9 | 75.7 | 75.7 | 75.7 | 75.6 |

***Source:*** *Own study.*

***Figure 5.*** *Production line efficiency in 2023*




***Source:*** *Own study.*

Data on the efficiency of individual production lines (OEE) in 2024 are presented in Table 3 and Figure 6.

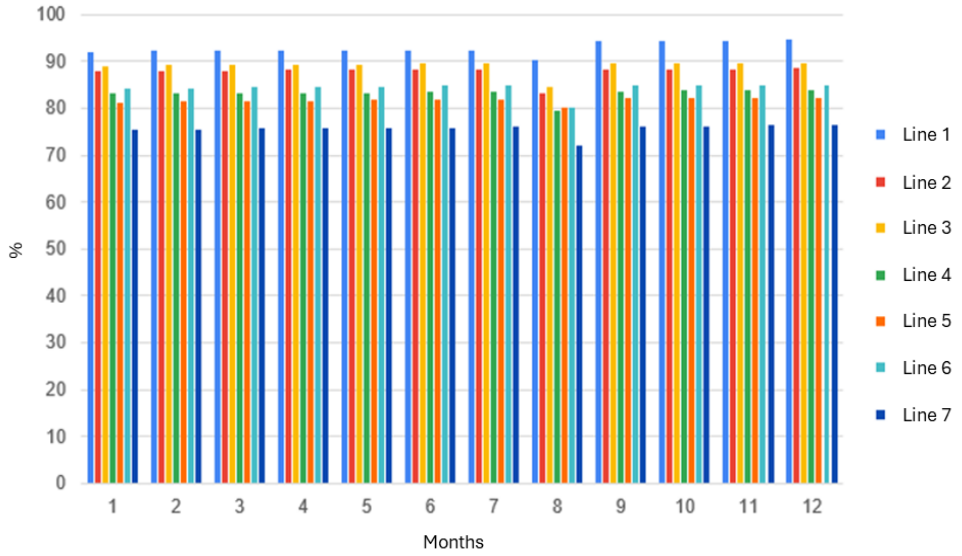
***Table 3****. Production Line Efficiency in 2024*

| Production line efficiency [%] in 2024 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Production Lines | **Months** | | | | | | | | | | | |
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| Line 1 | 92 | 92.2 | 92.2 | 92.2 | 92.3 | 92.3 | 92.4 | 90.1 | 94.4 | 94.4 | 94.4 | 94.5 |
| Line 2 | 87.8 | 87.9 | 88 | 88.1 | 88.1 | 88.2 | 88.2 | 83.2 | 88.2 | 88.2 | 88.3 | 88.4 |
| Line 3 | 89 | 89.2 | 89.3 | 89.3 | 89.4 | 89.5 | 89.5 | 84.5 | 89.6 | 89.6 | 89.7 | 89.7 |
| Line 4 | 83 | 83 | 83.1 | 83.1 | 83.2 | 83.5 | 83.6 | 79.5 | 83.6 | 83.7 | 83.9 | 83.9 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Line 5 | 81.2 | 81.4 | 81.5 | 81.6 | 81.7 | 81.8 | 81.9 | 80 | 82.1 | 82.2 | 82.3 | 82.3 |
| Line 6 | 84.3 | 84.3 | 84.4 | 84.6 | 84.6 | 84.7 | 84.8 | 80.2 | 84.9 | 84.9 | 85 | 85 |
| Line 7 | 75.4 | 75.5 | 75.7 | 75.8 | 75.8 | 75.9 | 76 | 72 | 76.2 | 76.2 | 76.3 | 76.4 |

***Source:*** *Own study.*

***Figure 6.*** *Production line efficiency in 2024*




***Source:*** *Own study.*

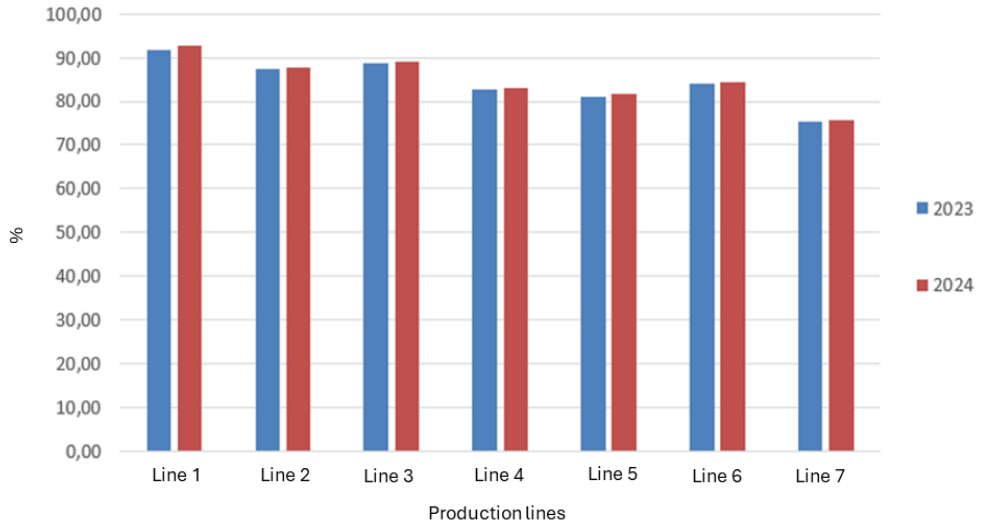
As in 2023, the highest efficiency was achieved on Line 1. This is a very high level, particularly in the last four months, reaching 94.5%. Line 7 was once again the least efficient, exceeding 76% in recent months. Overall, 2024 also saw small but steady increases in efficiency, with significantly higher figures following the August vacation period. Based on the efficiency of individual production lines, the average efficiency of each production line for the years 2023–2024 was calculated, as shown in Table 4 (Figure 7).

***Table 4.*** *Average production line efficiency for 2023–2024*

| Production line efficiency [%] in 2023–2024 | | |
|---|---|---|
| Production Lines | **Years** | |
| | **2023** | **2024** |
| Line 1 | 91.89 | 92.78 |
| Line 2 | 87.45 | 87.72 |
| Line 3 | 88.66 | 89.03 |
| Line 4 | 82.73 | 89.09 |
| Line 5 | 81.13 | 81.67 |
| Line 6 | 84.08 | 84.31 |
| Line 7 | 75.18 | 75.60 |

***Source:*** *Own study.*

***Figure 7.*** *Average production line efficiency in 2023–2024*




***Source:*** *Own study.*

An analysis of the data in Table 4 (Figure 7) revealed that the OEE rate increased on every production line in 2024 compared to 2023. These increases are consistent, although their magnitude varies by line. Line 1 achieved the highest efficiency (92.78%—an increase of 0.89 percentage points), while Line 7 achieved the lowest (75.6%—an increase of 0.42 percentage points).

Production efficiency increased steadily across all lines during the period under review. This demonstrates that the production process operates according to the principle of continuous improvement, where high levels of efficiency are constantly being raised.

Based on the efficiency of individual production lines, the average efficiency of all production lines for the given months in 2023–2024 was also calculated, as shown in Table 5 (Figure 8) In 2023, average efficiency started at 84.44% in January, rose steadily in subsequent months, and ended at 84.81% in December.

In contrast, in 2024, average efficiency stood at 84.67% in January and rose steadily, reaching 85.74% in December. An increase in average efficiency is evident in every month compared to the same month in 2023.

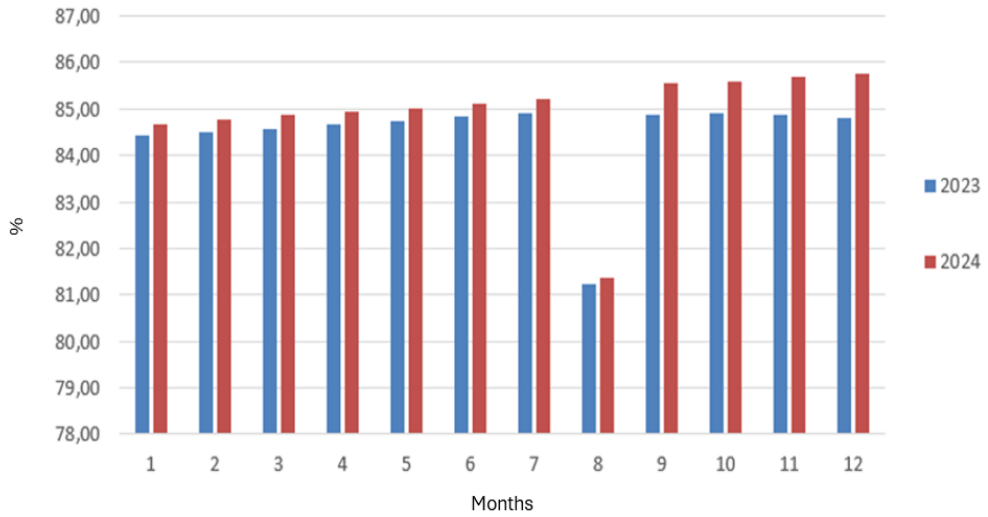
The seasonal decline in August is a normal occurrence, but it is worth noting the greater acceleration in efficiency growth during the last four months of 2024 (above 85.5%), whereas the figures for 2023 rose slightly during those months, only to fall again and not exceed 85%.

***Table 5.*** *Average efficiency of all production lines in 2023–2024*

| Production line efficiency [%] in 2023–2024 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Years | **Months** | | | | | | | | | | | |
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| 2023 | 84.44 | 84.49 | 84.57 | 84.66 | 84.74 | 84.84 | 84.90 | 81.23 | 84.89 | 84.91 | 84.87 | 84.81 |
| 2024 | 84.67 | 84.79 | 84.89 | 84.96 | 85.01 | 85.13 | 85.20 | 81.36 | 85.57 | 85.60 | 85.70 | 85.74 |

***Source:*** *Own study.*

***Figure 8.*** *Average efficiency of all production lines in 2023–2024 – author's own analysis*




***Source:*** *Own study.*

An OEE rate of 85% or higher is considered very high, and on key production lines in the automotive industry, the goal is to achieve a rate of over 90%. With this in mind, it can be concluded that the production line efficiency of the company under review is at a very high level, close to the global standard. The Kanban method had a direct impact on increasing production efficiency through a smoother flow of materials, fewer downtimes, rapid response to changes and disruptions, and improved product quality.

## 5. Conclusions, Proposals, Recommendations

Based on the research conducted and the analysis of the actual facility, the implementation of the Kanban method yielded a number of benefits that improved the efficiency and quality of processes at the automotive manufacturing plant, although certain drawbacks could not be entirely avoided. The benefits of implementing the Kanban method include:

- **reduction of excess inventory and overproduction –** eliminating overproduction and excess inventory is one of the most important goals of this method. The Kanban method is based on a pull system, which means that production is initiated precisely when there is a demand for the product, i.e., when an order is received from a customer. This leads to a significant reduction in excess component inventory, work-in-progress inventory, and finished goods inventory, which simultaneously reduces storage costs. It also eliminates further consequences resulting from overproduction, such as reselling goods at a price lower than the production cost or scrapping products,

- **increased production efficiency –** the Kanban method enables the optimization of production processes, thereby boosting productivity. Visualizing the workflow allows for the quick identification of any issues or bottlenecks, enabling an immediate response and the implementation of corrective actions using the appropriate tools,

- **improved production quality** – the Kanban method is based on continuous process improvement, which leads to a reduction in the number of missing items and product defects. Customers notice this, as they receive high-quality products that comply with all standards,

- **increased process transparency –** one of the main advantages is process transparency. Kanban serves as an information hub where all ongoing tasks are monitored. Managers have a constant overview of the production process across all production lines. If a problem arises in production, managers immediately see where it occurred and what it involves. This allows them to respond quickly to unexpected situations and assess whether the process is proceeding according to the established production plan. Visualizing the process flow ensures data clarity, which facilitates employees' daily work,

- **shortening the production cycle time** – by monitoring production progress, it is possible to identify bottlenecks, allowing for immediate corrective action. Reducing work in progress (WIP) and eliminating inefficient activities also contribute to cycle time optimization,

- **cost reduction** – production is limited to the exact quantity ordered, with no excess. Consequently, costs are reduced by limiting overproduction, lowering storage costs, and minimizing downtime,

- **aligning production with demand** – the Kanban method enables a company to adapt to changing market and customer needs. It allows for immediate responses to changes and real-time adjustments to priorities, which helps maintain operational continuity,

- **better communication and collaboration** – the method promotes transparency and openness within the team. By visualizing processes, everyone on the team (e.g., line operators, production managers, planners) has access to the same information regarding the status of the process, which facilitates communication and coordination of activities,

- **automated and efficient information flow –** Kanban efficiently automates the process of ordering and replenishing production as well as the workflow, allowing the team to focus on completing tasks and increasing productivity.

In addition to its many benefits, the Kanban method also has certain drawbacks, including:

- **frequent plan modifications** – when changes occur in customer orders, it is necessary to add new Kanban cards to the ERP system and assign them to the appropriate production lines. This results in frequent modifications to production plans and a higher number of changeovers, leading to a slight decrease in production efficiency,

- **less flexibility in response to demand fluctuations** – the Kanban method exhibits limited flexibility in the face of dynamic changes in demand, making it difficult to adapt to changing customer requirements. Such situations occur quite frequently, so it is necessary to make changes to production plans,

- **no safety stock –** Kanban relies on production without safety stock, so there is a risk that production interruptions may occur in the event of a breakdown or a shortage of raw materials,

- **high demands on suppliers –** Kanban requires a high degree of flexibility from suppliers, which entails the need for deliveries even several times a day. Suppliers must therefore operate on a Just-in-Time basis,

- **limited technological flexibility –** the Kanban method is not flexible enough to handle significant technological changes and innovations, which prolongs the time needed to adapt to new conditions.

These factors mean that implementing the Kanban method in conditions of fluctuating demand requires additional management strategies to minimize the risk of these problems occurring.

However, the benefits presented far outweigh the drawbacks and contribute to the smooth and efficient operation of processes within the company in question. This is crucial for the company's competitiveness in a market as demanding as the automotive industry.

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