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Enhancing Process Efficiency in Automotive Enterprises Through the Kanban Method

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Abstract:

Purpose: *The research objective of the article was to collect data from a real-life facility and demonstrate through analysis that the use of the Kanban method is a solution that streamlines processes in a selected manufacturing company in the automotive industry.*
Design/Methodology/Approach: *The study used the Kanban method, which is dedicated to process management in enterprises. The study assessed the advantages and disadvantages of implementing the Kanban method. The solution was analysed in terms of its impact on the improvement of production processes. To this end, the following were analysed: the number of stocks, the number of Kanban cards produced and the timeliness of order fulfilment.*
Findings: *The analysis showed that the Kanban method is effective in streamlining processes within the company.*
Practical Implications: *This solution contributed to a significant reduction in inventory and improved production flow, allowing production to be adjusted to actual demand. Thanks to the standardisation and visualisation of processes and the streamlining of material flow, production cycle times were shortened and waste was reduced. This also translated into increased and stabilised production. At the same time, a high and stable level of order fulfilment was observed, remaining at 99-100%, which demonstrates effective production flow management and minimisation of delivery delays.*
Originality/Value: *Considering the impact of Lean tools on the processes taking place in the company, it was found that these tools, including the Kanban method, were of great importance in increasing and stabilising the level of order timeliness. The analysed solution operates in accordance with the principle of continuous development, which translated into an increase in the overall competitiveness of the company, and this is crucial in the face of today's increasingly demanding market.*

Keywords: *Organization of production, transport, technology, management.*

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1. Introduction

The modern economic space is shaped by various organizations, including industrial, service, and trade enterprises. Their main goal is to provide customers with both tangible and intangible forms of a broadly understood product. The key aspect of the manufacturing enterprise is the process of production of specific products (Fam *et al.*, 2018). The process of production is closely connected with supplying production lines with the necessary materials and raw materials (Hawana *et al.,* 2019).

The flow of materials and information in the manufacturing process is organized by the production logistics (Pałęga *et al.*, 2012). Fundamental element of logistic systems is transport of goods (Neumann *et al.*, 2025; Neumann *et al.,* 2023).It also refers to internal transport, where all materials and raw materials are moved from the warehouse to production (Chłąd *et al.,* 2025; Ikatrinasari *et al.,* 2018; Jaqin *et al.,* 2023; Immanuel, 2025).

The main goal in the industrial enterprises is the continuous improvement of processes and, consequently, the implementation of effective tools and solutions to achieve a competitive advantage in an increasingly competitive market (Deja *et al.,* 2024; Deja *et al.,* 2023).

Under conditions, in which customer expectations are growing and changing demand requires the ability to adapt, effective management of the manufacturing processes is of particular importance. It enables to shorten order processing time, increase production efficiency, improve quality and reduce operating costs.

The dynamic development of technology allows for the application of many solutions, depending on the needs. One of the solutions that enables to improve the processes in the enterprise are Lean Manufacturing tools. It assumes implementation in the manufacturing system, among others, of Just-in-Time system, production control system (Kanban), reducing duration of production retooling or standardization of activities.

Lean concept requires a change in the philosophy of material flow in the area of production. Therefore, the implementation of „pull" production system and system of management of Kanban production is of fundamental importance (Dziekoński *et al.,* 2014)

2. Literature Review

The authors of this article analysed domestic and foreign literature on the Kanban method and the Lean Manufacturing philosophy that this method is derived from. This area is widely described in the literature in various aspects.

One of the important works on lean production is the book written by (Ohno) the creator of Toyota Production System (TPS). The author presented how the Lean rules may improve the efficiency of every manufacturing undertaking. It is a historical and philosophical description of Lean Manufacturing, Just in Time, or Kanban system. It focuses on production management and increasing process efficiency by eliminating waste.

The subject of management philosophy and rules applied by Toyota was addressed by (Liker, 2004) rules of Lean management that have made the company successful were discussed in this book. Kanban methodology was also described in (Hammarberg *et al.*, 2015), which presents the history of Kanban, its basic rules, and methods of implementation.

Moreover, it was also shown how to determine WIP limits, map the flow of tasks and manage the flow of materials and information. Lean area and Kanban method were also described in (Anderson *et al.*, 2016) book, in which he discussed how to implement this method in technology organizations and in the article (Anderson *et al.*, 2016), where all concepts and guidelines regarding the Kanban method were presented.

Whereas, the comparison of the Kanban method with the Scrum methodology, showing the similarities and differences between the two methods, along with a case study of Kanban implementation, was presented by Kniberg and Skarin (2010).

In Śniegula (2020) article, the author focused on the application of Kanban method and examining its potential in management of operational processes in a multi-branch design office. The rudiments of Kanban method, including its connection with Lean Management and the application of Kanban cards were discussed.

Operational processes and project management were also analysed, introducing into the main issue. The empirical part of the article is based on an analysis of source materials and a survey questionnaire. The applicability of the Kanban method in project management was also demonstrated by (Krasiński, 2013) in his article. He presented the history of the adaptation of a Japanese IT project management tool.

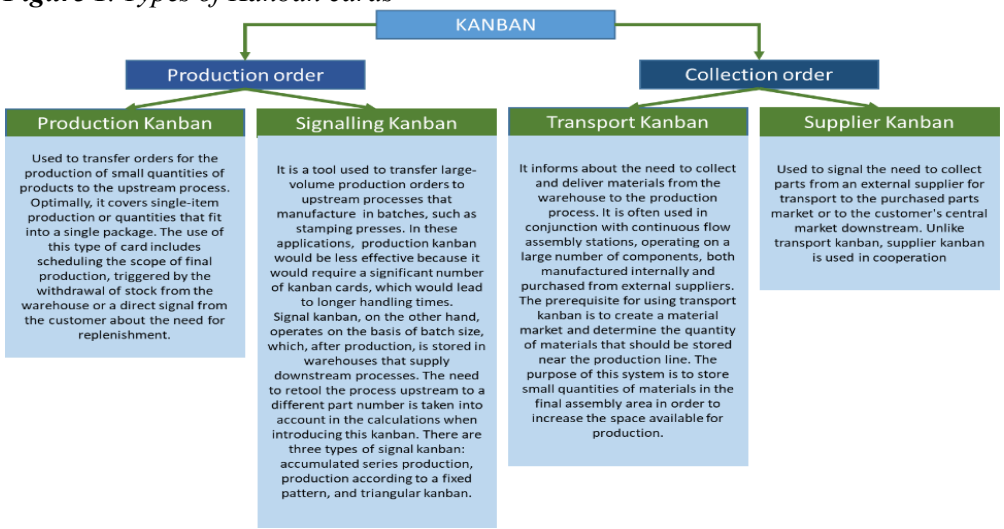
Based on an analysis of literature and personal experience, the author argues that the set of methodologies available to project managers can be enriched with Kanban. The authors of the article (Galińska *et al.*, 2015) presented the importance and function of the implementation of Kanban system in the manufacturing enterprise.

The theoretical characteristics of this method and the process of its implementation were discussed, and improvements were made in the area of production and inventory management. The analyses conducted showed a significant reduction in overproduction, confirming the effectiveness of the Kanban method applied.

3. Research Methodology

Kanban method, which is a tool for management of the processes in the enterprises, has gained wide recognition in the manufacturing enterprises all over the world. It is applied in internal logistics and production due to its effectiveness in the management of flow of work, inventory, or manufacturing processes. Kanban method is applied in the production logistics to determine the needs of production and movement of the materials in the pull system production, using Kanban cards for this purpose (Figure 1).

Figure 1. *Types of Kanban cards*



Source: *Own study.*

Important rules of the use of Kanban cards include:

- only one Kanban card can be assigned to the container at any given moment,
- a collecting person (next place) should determine the flow of elements from the previous place,
- Kanban cards move according to FIFO,
- when there is no card in the container, production is stopped,
- the number of elements assigned to Kanban card must correspond to the actual state in the container,
- the container must be delivered to the specified location, according to information in the card (Krasiński, 2013).

It improves manufacturing processes, eliminating unnecessary stoppages and improving manufacturing efficiency. The implementation of the Kanban method is very common, especially in the enterprises that use Lean and Just-in-Time. It is a key method used in small and large enterprises from various manufacturing and logistics industries.

The research goal of the authors was to collect data from a real facility and demonstrate through analysis that the use of the Kanban method is a solution that improves the processes in a selected manufacturing enterprise from the automotive industry.

An analysis of Kanban method was conducted based on the manufacturing enterprise from the automotive industry. This enterprise is a part of an international corporation specializing in the production of components for leading automotive brands. The corporation has branches in 24 countries around the world, including Poland. Analysed manufacturing enterprise produces driving systems designed to reduce fuel consumption and exhaust emissions, including:

- stranglers,
- starters,
- exhaust gas recirculation valves (EGR),
- innovative electric compressors.

In addition, the enterprise specializes in the regeneration of components such as starters, alternators, car air conditioning compressors and dual-mass flywheels, giving them a new lease of life.

When describing the flow of materials throughout the entire manufacturing cycle, the following four stages can be distinguished:

1. Receipt and storage of raw materials.
2. The flow of raw materials through the production process.
3. The flow of semi-finished products and parts through the assembly process.
4. Receipt of goods into the finished goods warehouse.

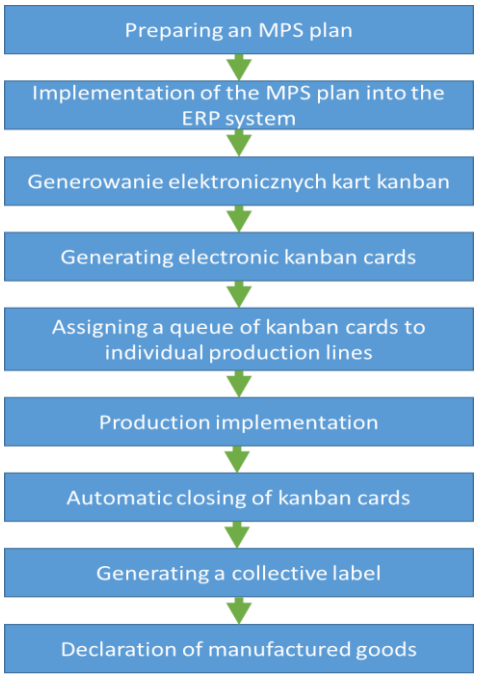
The Kanban method implemented in the examined enterprise allows for the simple and harmonious organization of the flow of materials and information between specific parts in the manufacturing process. For this purpose, the enterprise uses electronic Kanban cards, which are available in an in-house application.

Kanban card, which is a collection order signals the need to collect from the inventory (collection also activates completion) specific components necessary for production and delivering them to a specific workplace of a production line. It takes place in a „pull" system, reducing the excessive inventory and completing the production according to agreed schedule.

Whereas, the Kanban card, which acts as a manufacturing order, is a signal to start production. It automatizes the processes of ordering production and workflow.

The diagram showing the organization of the manufacturing process with the use of Kanban cards as a manufacturing order is presented in Figure 2. The manufacturing process is organized using ERP (Enterprise Resource Planning), which contains all the systems and tools necessary for the efficient functioning of the processes occurring in the enterprise.

Figure 2. *Organization of the intralogistics process with the use of Kanban cards*



Source: *Own study.*

It starts from creating the MPS (Master Production Schedule), that is, creating weekly manufacturing plans on particular references for a specific period of several weeks ahead. In the event of the analysed real facility, it is a period of 15 weeks. MPS is introduced to ERP, which is SAP in this case. Then, customer service automatically generates a Kanban card based on manufacturing plan assumed for the upcoming week.

It means that a specific number of Kanban cards are available in the system, making it possible to avoid excessive inventory and producing references that were assumed in the manufacturing plan. It means that the enterprise can only manufacture only as many products as the customer has ordered. The customer process orders the part in a number specified by Kanban, and delivery process manufactures the parts in a

number and sequences specified by Kanban. MPS is created once a week, so in the meantime, there may be changes in the orders from customers.

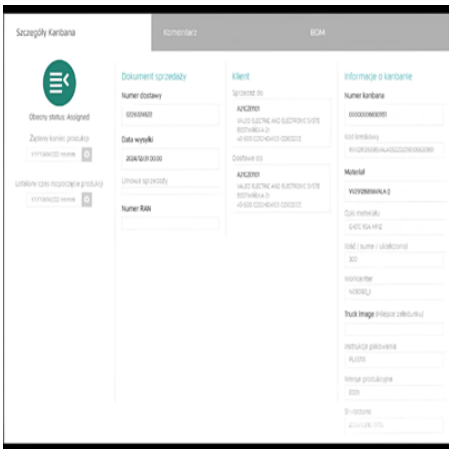
For this purpose, the Kanban cards can be created manually, however, it is only possible within the authorizations of the relevant customer service personnel who have access to the updated programmes from customers. When Kanban cards are available in ERP, production planner is responsible for creating the daily production plan.

The order of Kanban cards is assigned to production lines in an in-house application that every operator on the line has access to. It allows operators to see a detailed production plan, they know what index they need to generate, in what quantity, and when to retool the workplace. At this stage, the operators starts production by opening the Kanban card. They scan each individual piece.

Once all of them are scanned on the Kanban card, the card is automatically closed. A collective label is generated for the manufactured pallet of finished goods, and produced goods are automatically declared in ERP. The declaration is made collectively, after scanning the last piece of the product from the Kanban card.

T-card system allows people responsible for production planning to monitor the status of completion of individual tasks on an ongoing basis, while operators on production lines can see the detailed production plans on their operator desktops (Figure 3). They know what index they need to generate, in what quantity, and when to retool the machines.

Figure 3. *The content of the Kanban card*



Source: *Own study.*

4. Research Results and Discussion

To conduct an analysis of Kanban method implemented in the enterprise from the automotive industry, we used the elements and indicators of the manufacturing process, which are affected by the above method:

- inventory level in the years 2023-2024 (pieces),
- the number of Kanban cards produced (pieces),
- the punctuality of completion of orders – defined in the enterprise as customer service rate (expressed in %).

The department of production dealing with the production of stranglers was analysed. Table 1 shows the collected data concerning the inventory level in the years 2023-2024 with a division into specific months.

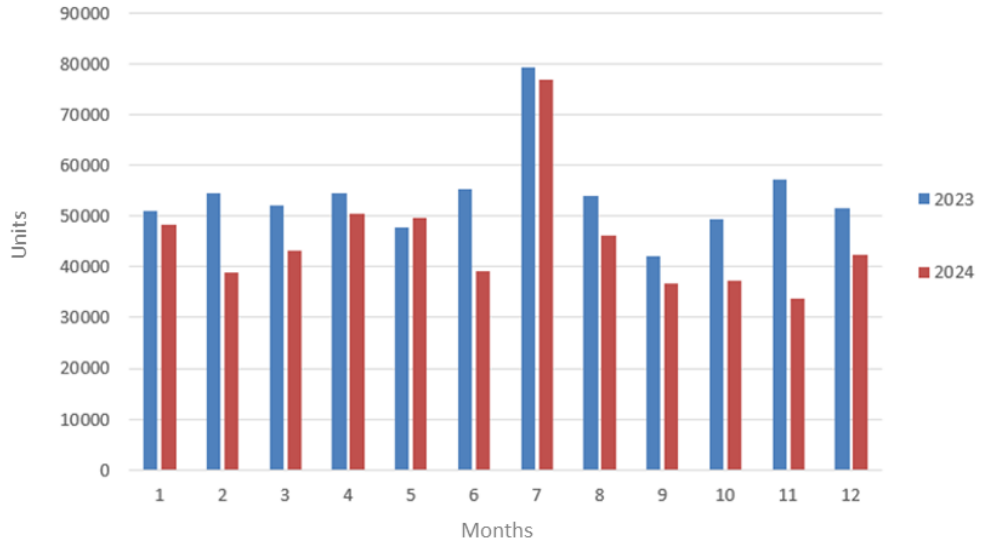
Table 1. *Inventory level in the years 2023-2024*

Number of stocks (units) in 2023–2024												
	Months											
Years	1	2	3	4	5	6	7	8	9	10	11	12
2023	51065	54565	52065	54415	47865	55435	79250	53870	41995	49255	57150	51550
2024	48280	38855	43295	50535	49580	39280	76840	46065	36855	37255	33635	42500

Source: *Own study.*

Data about inventory level in the years 2023-2024 with a division into specific months are presented in Figure 4.

Figure 4. *Inventory level in the years 2023-2024*



Source: *Own study.*

As a result of analysing the data obtained from the real facility (Table 1, Figure 4), the following conclusions were drawn:

- general decrease in inventory level in 2024 in almost every month in comparison with 2023 (the only exception is May, when inventory level increased by 3,6%). The highest decreases in inventory level occurred in November (by 23515 pieces - 41,1%), June (by 16155 pieces - 29,1%) and February (by 15710 pieces - 28,8%). The decrease in inventory level is probably caused by the real demand, which was lower in 2024;
- in both years, the highest inventory level is in July, which suggests the seasonality of inventory. It is connected with summer stoppages (CW31 and CW32) at the turn of July and August caused by summer leaves and increased demand after these leaves. The seasonal exception explains why, in the Kanban method, a temporary increase in inventory levels is permissible if specific needs are anticipated;
- pull system means initiating production when there is actual demand, rather than based on forecasts. Therefore, inventory level are maintained at a lower and more sustainable level, which can be seen in the above data, especially in 2023, which is characterized by relatively greater stability of inventory levels in the first half of the year. Generally, there are small fluctuations in most months throughout the entire examined period (except for July in both years and June in 2024);
- the lowest inventory level in the examined period was in the last four months of 2024. It can be the result of greater efficiency in planning and executing orders or reduced demand for products.

Kanban method directly affects the inventory level through reduction of warehouse inventory (materials and components) and work-in-process inventory. It is hard to determine exactly how much higher the inventory level would be without using the Kanban method. It is estimated that this method reduced the inventory level by about 30-50%.

Data about the number of Kanban cards produced in 2023 with a division into particular production lines are presented in Table 2 and Figure 5 The number of Kanban cards produced reflects the scale of production demand, as each card activates specific manufacturing order. Therefore, changing number of the cards shows fluctuations in demand, production load, and flexibility and efficiency of the manufacturing process.

As it results from the collected data (Table 2, Figure 5), 14026 Kanban cards in total were generated in 2023. The largest number of cards for the entire year was produced for lines 7, 6, and 5 (8506 pieces in total – 60,6% of all cards), which means that these lines are the main production units and are responsible for key products. Whereas, the lowest number of cards were created for lines 2 and 1 (1117 pieces in total – 8,0%).

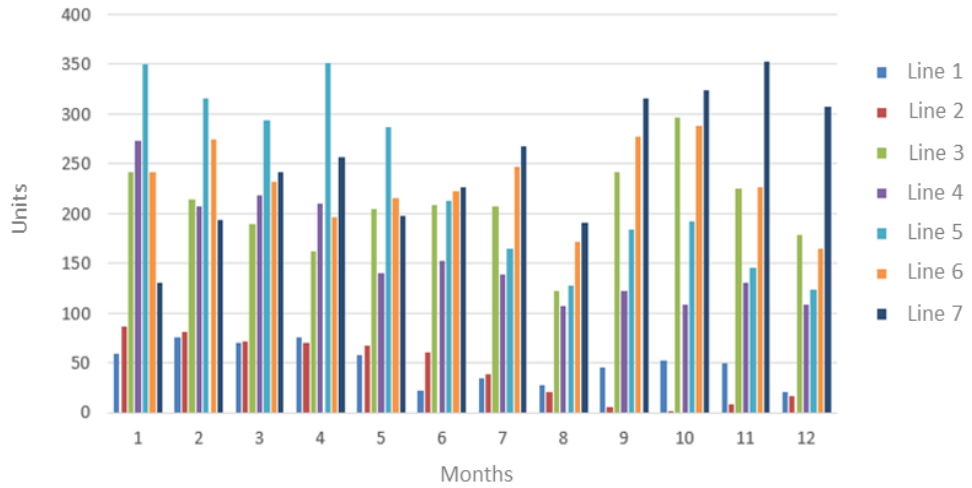
It shows low demand for the car parts produced on these lines or their supporting role in the manufacturing process. It is particularly visible on line 2 between August and December, which may indicate the completion of projects for products manufactured on this line.

Table 2. *The number of Kanban cards produced in 2023*

Number of kanban cards produced (units) in 2023													
Production lines	Months												
	1	2	3	4	5	6	7	8	9	10	11	12	Total
Line 1	59	76	70	75	58	22	34	27	45	52	50	21	589
Line 2	86	81	71	70	67	60	39	21	6	2	8	17	528
Line 3	241	214	189	162	204	208	207	122	242	296	225	179	2489
Line 4	273	207	218	210	140	152	139	107	122	108	130	108	1914
Line 5	350	316	294	351	287	212	165	127	184	192	146	124	2748
Line 6	242	274	232	196	216	222	247	171	277	288	226	165	2756
Line 7	130	193	241	257	198	226	267	191	316	324	352	307	3002

Source: *Own study.*

Figure 5. *The number of Kanban cards produced in 2023*



Source: *Own study.*

An analysis of the data obtained shows highly varied and dynamic demand for products manufactured on specific production lines. Until May, most parts were manufactured on line 5, in June production was more balanced, while in the subsequent months, we could see growing production on line 7.

Therefore, the Kanban method effectively reacts to fluctuations in demand – a decrease in the number of cards does not mean stoppage, but rather a conscious adaptation of production to current market needs, and changing number of produced Kanban cards allows to avoid excessive inventory.

Data about the number of Kanban cards produced in 2024 with a division into particular production lines are presented in Table 3 and Figure 6. In 2024, 11766 Kanban cards in total were generated. The highest level of production occurred on line 5, and the lowest on line 1.

The production was focused mainly on four lines: 5,6,3 and 4 (9498 cards in total – 80,7%) and they were the central element of manufacturing process in this year. Whereas the lines number 1,2 and 7 were used the least (2268 cards in total – 19,3%).

Until March, the largest number of production orders was created for line 5, and in the subsequent months, production was balanced, with a predominance in some months on line 6. Seasonality in production is visible in August (summer vacations) and December. It is worth noting that in 2023, line 7 produced the most (21.4% of cards), and a year later, only 6.9% of cards were created in the same line. It shows how dynamically demand for car parts can change in the examined enterprise and how important the Kanban method is for maintaining an efficient manufacturing process.

Table 3. *The number of Kanban cards produced in 2024*

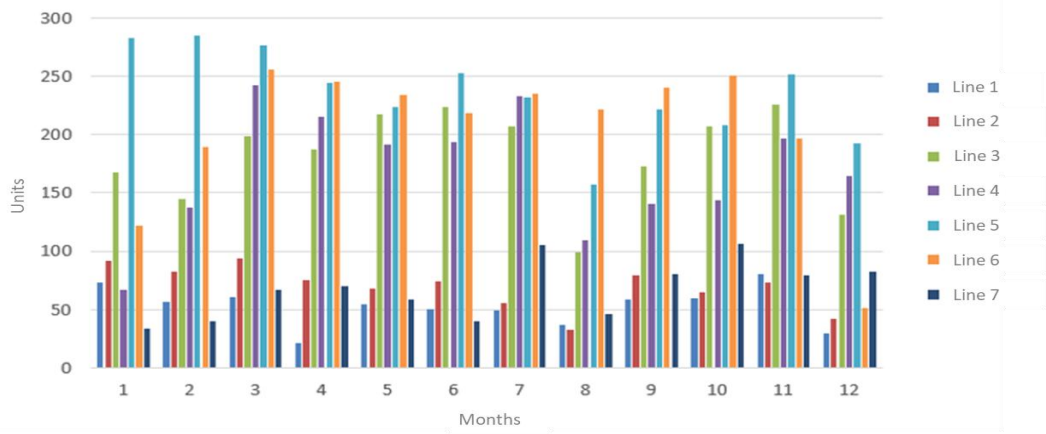
Number of kanban cards produced (units) in 2024													
Production lines	Months												
	1	2	3	4	5	6	7	8	9	10	11	12	Total
Line 1	73	56	61	21	54	50	49	37	58	60	80	29	628
Line 2	92	82	94	75	68	74	55	33	79	65	73	42	832
Line 3	167	145	199	187	217	224	207	99	173	207	226	131	2182
Line 4	67	137	242	215	191	193	233	109	140	144	197	164	2032
Line 5	283	285	276	244	224	253	232	157	221	208	252	192	2827
Line 6	122	189	256	245	234	218	235	221	240	250	196	51	2457
Line 7	34	40	67	70	59	40	105	46	80	106	79	82	808

Source: *Own study.*

Data about the number of Kanban cards produced in the years 2023-2024 are presented in Table 4 and Figure 7. In comparison with 2023, the number of Kanban cards produced in 2024 decreased from 14026 pieces to 11766 pieces (decrease by 2260 pieces - 16,1%). It refers to nearly every month, apart from July, when 18 manufacturing orders more were created (increase by 1,6%).

The highest decrease occurred in January, February, and April. In 2023, the largest number of cards were created in January, whereas, in 2024 – in March. The lowest number of manufacturing orders was created in August, which is connected with manufacturing stoppages as a result of planned summer vacations. Similar situation occurs in December, where, apart from the reduction in orders, there were stoppages during the holiday season. However, the level of orders is quite stable, with no significant fluctuations between months.

Figure 6. *The number of Kanban cards produced in 2024*



Source: *Own study.*

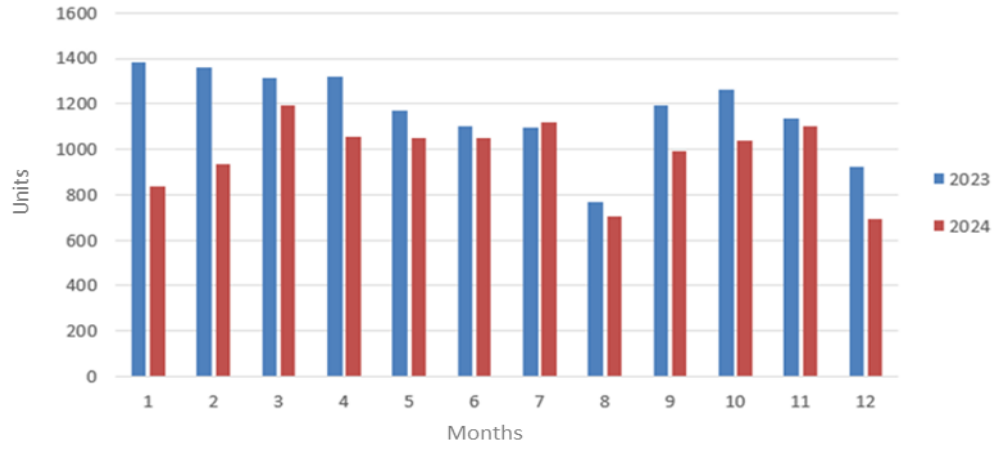
Changing number of generated manufacturing orders shows that the manufacturing process works according to Lean Manufacturing rules. Production is flexible and adjusted to changing market demand. No sudden changes or overproduction means effective synchronization between demand and production, which minimizes the inventory level and losses.

Table 4. *The number of Kanban cards produced in the years 2023-2024*

Number of kanban cards produced (units) in 2023–2024												
	Months											
Years	1	2	3	4	5	6	7	8	9	10	11	12
2023	1381	1361	1315	1321	1170	1102	1098	766	1192	1262	1137	921
2024	838	934	1195	1057	1047	1052	1116	702	991	1040	1103	691

Source: *Own study.*

Figure 7. *The number of Kanban cards produced in the years 2023-2024*



Source: *Own study.*

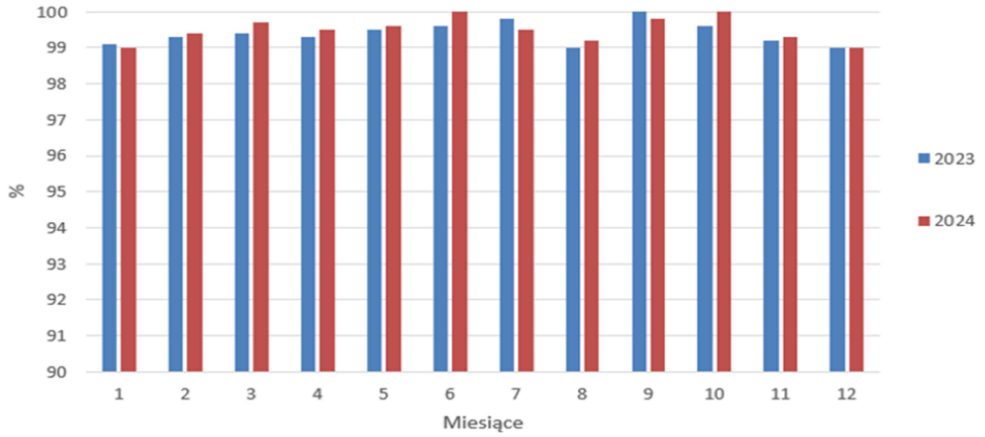
Data about customer service rate in the years 2023-2024 are presented in Table 5 and Figure 8.

Table 5. *The punctuality of completion of orders in the years 2023-2024*

Timeliness of order fulfilment (%) in 2023–2024												
Years	Months											
	1	2	3	4	5	6	7	8	9	10	11	12
2023	99,1	99,3	99,4	99,3	99,5	99,6	99,8	99	100	99,6	99,2	99
2024	99	99,4	99,7	99,5	99,6	100	99,5	99,2	99,8	100	99,3	99

Source: *Own study.*

Figure 8. *The punctuality of completion of orders in the years 2023-2024*



Source: *Own study.*

Data in Table 5 and Figure 8 show high level of punctuality of completion of orders, as all values are between 99 and 100%. Taking into account completion of orders in Just-in-Time system, no drops below 99% is a very good result, showing that logistic processes are advanced. Average annual punctuality of completion of orders in 2023 was 99,4%, and 99,5% year later.

The lowest values were observed in January and December. No fluctuations in the punctuality of completion of orders means that the system of production and delivery is stable, even in the face of increased efficiency, seasonality or inventory level restrictions.

This indicator allows to assess efficiency of the suppliers, internal logistic and manufacturing processes. The punctuality of completion of orders is between 99 and 100%, which shows effective time management and delivery of orders according to customer demands. These are values that do not require any improvements; they just need to be maintained. Taking into account the impact of Lean tools on the processes occurring in the enterprise, it can be concluded that these tools, including

Kanban method, largely affected the stabilization of the level of punctuality of completion of orders.

5. Conclusions, Proposals, Recommendations

Kanban method was analysed in the article, illustrated with an example of the selected manufacturing enterprise from the automotive industry. The functioning of the Kanban method in the real manufacturing environment was analysed, as well as different tools supporting production logistics, among others, T-card planning system.

Attention was also paid to IT system, integrating the use of tools, that is, ERP. The advantages and disadvantages of implementation of Kanban method were analysed. The solution was analysed in terms of its impact on improvement of the manufacturing processes. For this purpose, inventory level, the number of Kanban cards produced and punctuality of completion of orders were analysed.

The analysis conducted showed that Kanban method is efficient in the improvement of the processes occurring in the enterprise. This solution allowed to largely reduce the inventory level and improve production fluidity, allowing production to be adjusted to actual demand, and the standardization and visualization of the processes and the improvement of material flow shortened manufacturing cycle periods and reduced waste.

It also resulted in increased and stabilized production. High and stable level of punctuality of completion of orders, at the level between 99 and 100% was also observed, which shows efficient management of flow of production and minimization of delivery delays.

The analysed solution works according to the principle of continuous development, which has increased the competitiveness of the enterprise, and it is crucial in the face of increasingly demanding market.

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