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Research paper
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IMPACT OF PART QUALITY ON INTRALOGISTICS EFFICIENCY IN AUTOMOTIVE MANUFACTURING: KPI-BASED OPTIMIZATION

Abstract: *This paper examines the role of performance metrics in logistics systems, focusing on production logistics in the automotive industry. Key performance indicators (KPIs) such as Scheduled Sequence Achievement Ratio (SSAR), Scheduled Time Achievement Ratio (STAR), and Standard Production Lead Times Ratio (SPLTR) are analyzed to evaluate efficiency and reliability. The study highlights the negative impact of poor-quality parts on intralogistics,. The findings emphasize the importance of high-quality production processes and rigorous quality control to optimize logistics operations and customer satisfaction.*

Keywords: *logistics performance, KPIs, SSAR, STAR, Automotive industry, quality management*

1. Introduction

Intralogistics, or production logistics, is vital for efficient automotive manufacturing, ensuring seamless material flow and adherence to production schedules (Davidović, 2005). Key performance indicators (KPIs) such as Scheduled Sequence Achievement Ratio (SSAR), Scheduled Time Achievement Ratio (STAR), and Standard Production Lead Times Ratio (SPLTR) monitor process efficiency and schedule compliance (Đorđević et al., 2020b; Đorđević et al., 2025). However, poor-quality parts disrupt these processes, causing production delays, increased costs, and inventory management challenges. This paper examines the impact of part quality on intralogistics in the automotive industry and proposes KPIs to optimize production processes, enhancing reliability and efficiency.

2. Logistics Fields

Logistics can be split into five types by field: procurement logistics, production logistics, sales logistics, recovery logistics, and recycling logistics (Figure 1).

Lean Manufacturing is a business system for organizing and managing product development, operations, suppliers, and customer relations that requires less human effort, less space, less capital, less material, and less time to make products with fewer defects to precise customer desires, compared with the previous system of mass production (Lean Enterprise Institute, 2008).

In this scientific paper, we will focus on production logistics (Intralogistics) and propose key performance indicators (KPIs) used to monitor performance, analyzing how the quality of production processes and the quality of raw materials influence logistics processes.

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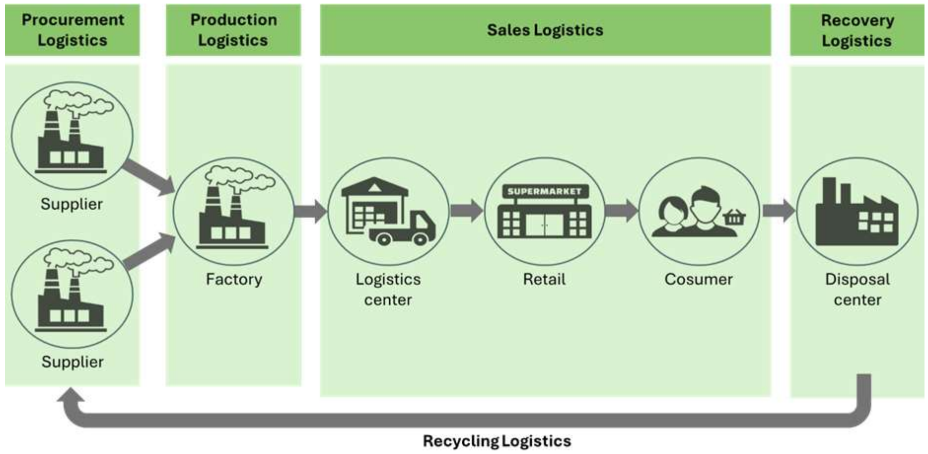

Figure 1. Logistics fields

3. Standard production lead times

The car manufacturing process in the factory begins in the Press Shop (PS), where sheet metal parts are stamped (Vujanac et al., 2017a, 2017b). These stamped parts are then sent to Body in White Subgroups (BiW1), where subassemblies are created. Afterward, the subassemblies from BiW1, along with parts from the Press Shop, are transferred to the Body in White Main Line (BiW2), where the assembly of the car body begins. The manufacturer follows the progress of each sequence through several checkpoints (Table 1), and the data is recorded in a central system (Picture 2). Key measurement points include the entry and exit times for the following areas: Body in White Main Line (BiW2): Point A (entry) and Point B (exit), Paint Shop: Point K (entry) and Point C (exit), Assembly Line: Point D (entry) and Point E (exit). These points are detailed in Figure 2. Based on the entry and exit times for each area, the lead time is calculated, which represents the time a vehicle spends in that specific area. This data is used to monitor the efficiency of the production process and identify potential bottlenecks. For every car body there is a tag of the customer who ordered the car (Figure 3).

Table 1. Checkpoints by Plants

Plant	Point	Status
BodyShop	**A**	**Entering Body Shop**
	L	Body Completion
	B	**Body Shop Deliberation**
Paint Shop	**K**	**Entering Color Branches**
	W	E_Coat_Sanding
	I	Status I
	C	**Paint Shop Deliberation**
Assembly Shop	**D**	**Entering Assembly Shop**
	U	Entering TRIM Line
	O	Homologative Plate Emission
	Q	Transit in Chassis 3
	Y	End Of Line
	E	**Assembly Shop Deliberation**

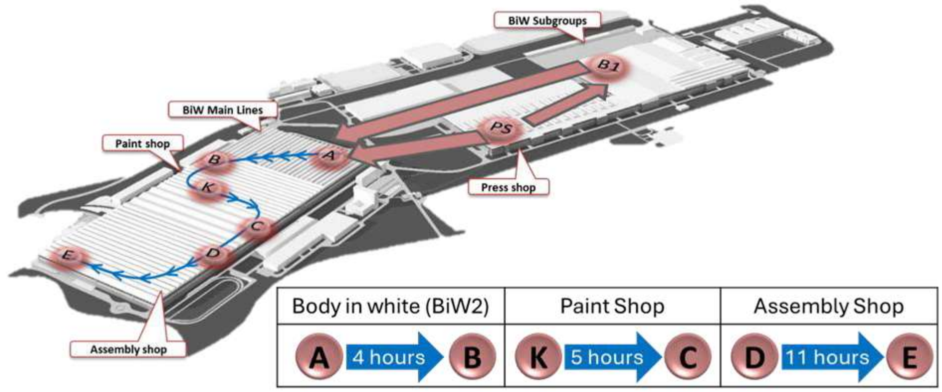

Figure 2. Lead times and checkpoints

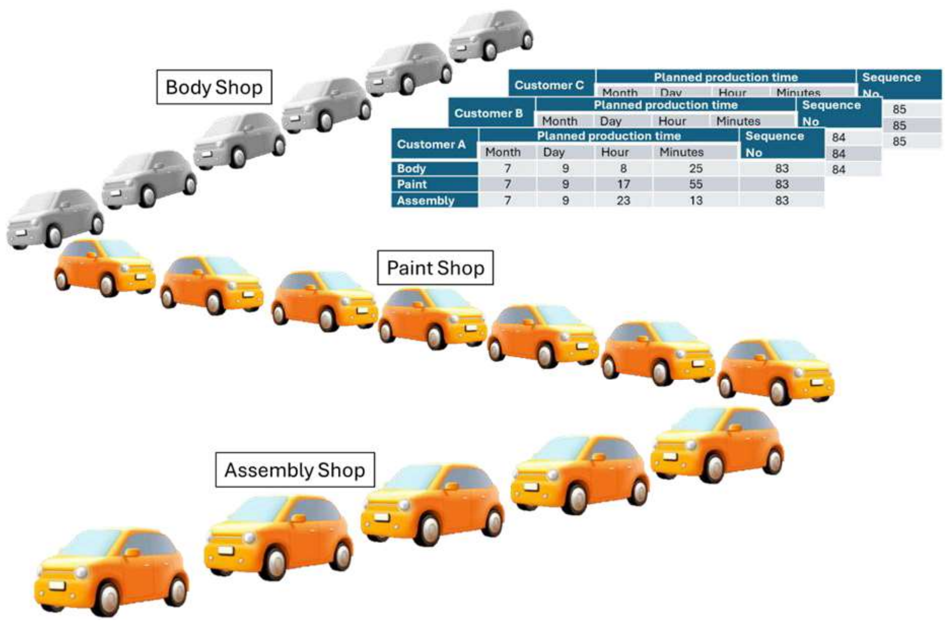

Figure 3. Schedule about when the car is going to be produced and produce it as scheduled

4. The Impact of Poor-Quality Parts in the Automotive Industry on Intralogistics

The quality of parts used in vehicle assembly significantly influences the efficiency and functionality of intralogistics processes in the automotive industry. Poor-quality parts can lead to numerous negative consequences that disrupt the optimization and continuity of intralogistics operations. Below, the key aspects of this impact are analyzed.

Poor-quality parts often result in defective components, directly affecting production processes (Đorđević et al., 2020a). Part deficiencies can cause production line stoppages, requiring additional time for replacement or repair. These disruptions disturb the production rhythm and necessitate the reorganization of logistics flows to compensate for losses. Furthermore, poor-quality parts may require emergency procurement of replacement components, which further burdens intralogistics processes and disrupts planning.

To mitigate the risk of production downtime caused by defective parts, companies are often forced to increase inventories of spare components. This increase in inventory directly impacts storage and inventory management costs, placing additional strain on intralogistics systems. Additionally, defective parts must be returned to suppliers, requiring extra logistical efforts and costs associated with transportation and administrative procedures. Inventory management becomes significantly more complex in situations where defective parts, their replacements, and returns must be tracked. Poor-quality parts require additional resources for monitoring and control, which can lead to increased complexity in intralogistics processes. Moreover, a loss of trust in existing suppliers may necessitate the search for new partners, further straining logistical capacities and requiring adjustments to existing processes.

Defective parts cause delivery delays, customer dissatisfaction, and increased logistics for returns and warranty claims.

Poor-quality parts complicate long-term planning and reduce the flexibility of intralogistics processes. Unpredictable situations, such as production stoppages or the need for emergency part procurement, require rapid changes in logistics flows, which can be challenging to manage while maintaining operational continuity. This reduced flexibility can limit a company's ability to adapt to changes in demand or production requirements.

5. Logistics and quality

Logistics and Quality are closely linked. The main link depends on the fact that the poor quality of the product and the consequent need to carry out repairs, checks or corrections of the work, force us to keep safety stocks, therefore to delay downstream delivery times and ultimately delay delivery to the end customer(Đorđević et al., 2023) (Figure 4).

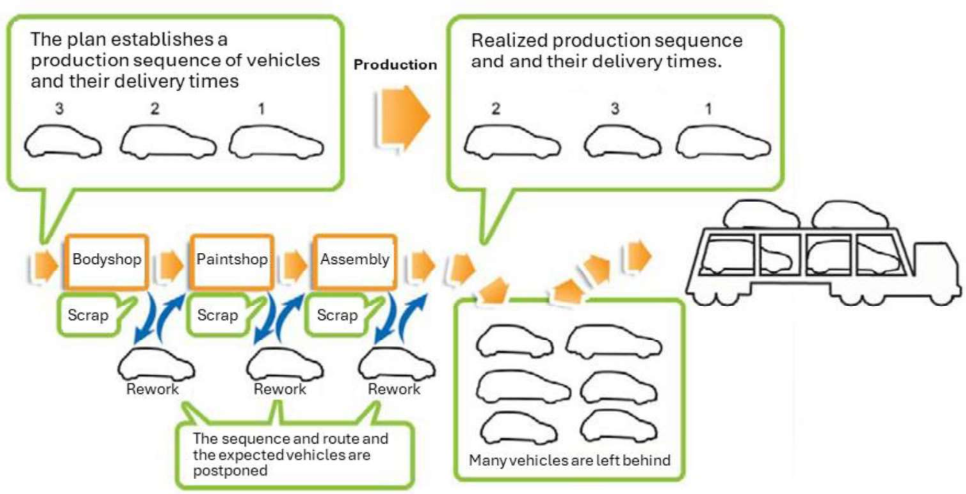

Figure 4. Scheduled sequence with fixed time

Furthermore, the defective products to be repaired that are put aside from the main production flow end up swelling the warehouses and consequently increase costs. In fact, we see how the cars, which are removed from the flow to repair them from faults and poor quality, end up destroying the scheduled production sequence.

In this way, even if production has been scheduled in flow and with predefined fixed times, the final result is that the delivery sequence is very different, and many cars that are expected by the customer are left behind.

Furthermore, these products to be repaired increase logistics costs by filling the warehouse and leaving empty spaces on the means of transport where they were supposed to be loaded.

On the contrary, the reduction of defects and the improvement of quality translate into a reduction of logistics costs.

6. Intralogistics (Production logistics) KPIs

Scheduled Sequence Achievement Ratio (SSAR) measures adherence to planned production sequences, while Scheduled Time Achievement Ratio (STAR) tracks on-time completion within scheduled windows (Đorđević et al., 2020b). (for car body exit) (Figure 6, Figure 7). High SSAR/STAR indicate efficiency and reliability; low values signal delays or disruptions.

7.1. Scheduled Sequence Achievement Ratio (SSAR)

SSAR measures how well a logistics or production process adheres to a predefined schedule or sequence (Figure 5). It is often used in manufacturing, supply chain, or delivery operations to evaluate the efficiency of following a planned sequence of tasks or shipments.

$$SSAR = \frac{The\ number\ of\ cars\ followed\ the\ scheduled\ sequence}{The\ number\ of\ produced\ cars} \times 100$$

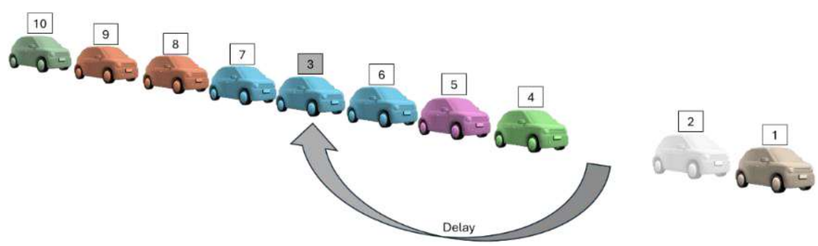

Figure 5. Scheduled sequence achievement ratio (SSAR)

High SSAR (close to 100%) indicates efficient, reliable operations with minimal disruptions, while low SSAR signals inefficiencies, delays, or poor resource management.

7.2. Scheduled time achievement ratio (STAR)

STAR (Scheduled Time Achievement Ratio) is a performance metric used to measure how effectively an operation, process, or system adheres to its planned or scheduled timeline. It evaluates the ability to complete tasks, deliveries, or production steps within the scheduled time frames. In the automotive industry, STAR measures the actual time (within 1h pitch) when the car body comes out of the line versus scheduled time and evaluates the % within +/- 1h (Figure 6).

In logistics, manufacturing, or project management, STAR is often used to assess punctuality and efficiency. For example:

- In logistics, it might measure the percentage of deliveries made on time.
- In manufacturing, it could track how often production milestones are met according to the schedule

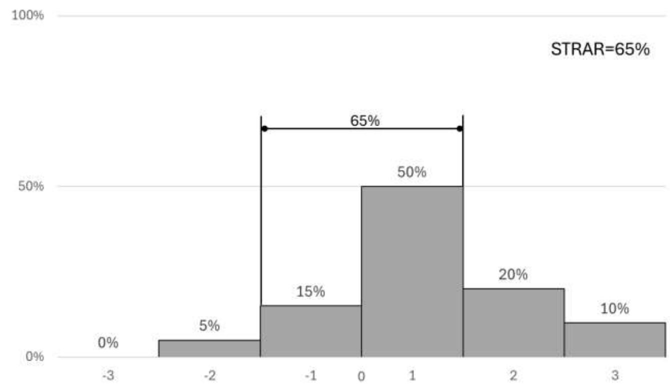

Figure 6. Scheduled time achievement ratio (STAR)

- High STAR (close to 100%) reflects punctual, well-managed operations, while low STAR indicates delays and inefficiencies.

7.3. How SSAR and STAR Work Together

SSAR ensures that the sequence of operations (e.g., loading, unloading, production, or delivery) is followed as planned. STAR ensures that each step in the sequence is completed on time. Together, these KPIs help logistics teams:

- Identify inefficiencies in the process.
- Improve scheduling and sequencing accuracy.
- Enhance overall supply chain performance.

The following example shows how SSAR and STAR can be connected. In a manufacturing or delivery environment, SSAR would measure whether products were assembled or delivered in the correct order; and STAR would measure whether each step in the process was completed on time. For instance, if a delivery truck is supposed to follow a specific route sequence (SSAR) and deliver packages within a specific time window (STAR), these KPIs would track how well the driver adheres to both the sequence and the schedule.

SSAR and STAR can be improved in various ways:

- Optimize Scheduling: Use advanced planning tools to create realistic and efficient schedules.
- Monitor in Real-Time: Implement tracking systems to monitor adherence to sequences and timelines.
- Train Staff: Ensure employees understand the importance of following schedules and sequences.
- Analyze Deviations: Investigate root causes of deviations from the plan and implement corrective actions.
- Leverage Technology: Use automation and AI to improve scheduling accuracy and predict potential disruptions.

7.4. Standard production lead times (SPLT) and Standard production lead times ratio (SPLTR)

The difference between the standard production lead times and actual production lead times is presented as:

$$SPLTR = \left(\frac{Actual\ Production\ Lead\ Time}{Standard\ Production\ Lead\ Time\ (SPLT)}\right) \times 100$$

In figure 7 is presented an example of Standard production lead times ratio (SPLTR).

SPLTR outcomes are: 100% (perfect adherence), >100% (delays), or <100% (improved efficiency), helping evaluate production performance and alignment with planned timelines.

The relationships between the causes of actual production lead times (SPLTR) and the standard production lead times (SPLT) is presented in figure 8.

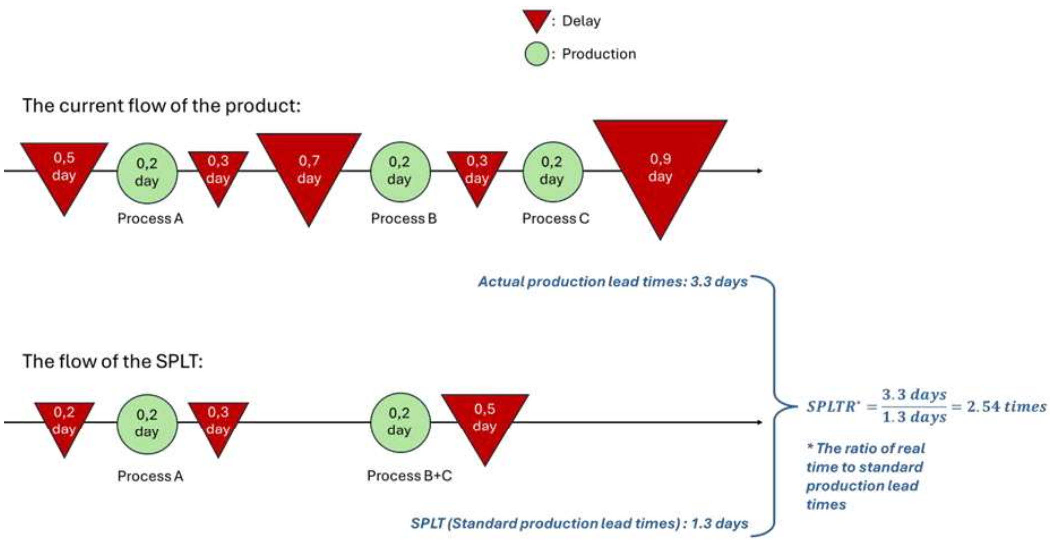

Figure 7. Standard production lead times ratio (SPLTR)

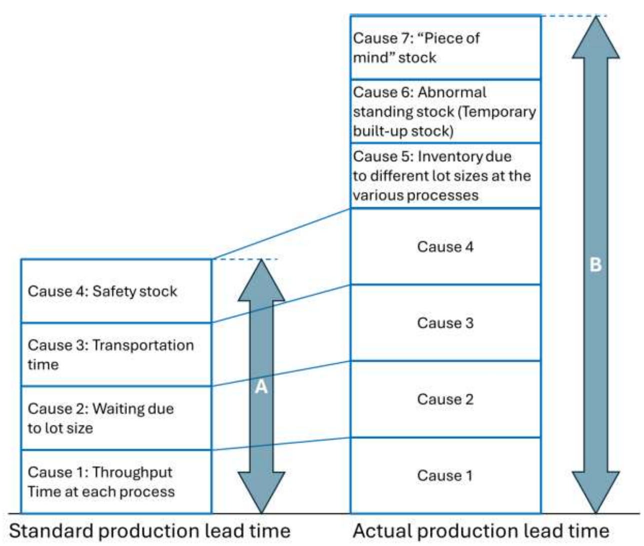

Figure 8. Types of cause of deviation from standard

7. Conclusion

Poor-quality parts in the automotive industry have a significant negative impact on intralogistics processes, including increased costs, reduced efficiency, and complications in inventory management and customer relationships. Therefore, it is crucial to invest in high-quality parts and implement rigorous quality control processes to minimize these risks and ensure the optimization of intralogistics operations. It is also crucial that production processes are executed in a standardized and high-quality way to prevent rework and avoid disrupting downstream processes. Any such issues can ultimately result in higher logistics costs.

References:

Davidović, B. (2005). *Menadžment kvalitetom logistike*. Beograd: Izdavač nije naveden.

Đorđević, M., Dašić, P., Živković, M., & Atanasijević, S. (2020a). Logistics KPI in automotive industry. In *X International Conference Quality System Condition for Successful Business and Competitiveness* (pp. 21–26). Izdavač nije naveden.

Đorđević, M., Kostić, S., Puskarić, H., Vujanac, R., Atanasijević, S., & Đorđević, M. (2025). Defining material flow depending on material characteristics. *International Journal for Quality Research, 19*(2). https://doi.org/10.24874/IJQR19.02-02

Đorđević, M., Todorović, G., & Misković, A. (2023). Logistics housekeeping as KPI to guarantee high service level. In *XI International Conference Quality System Condition for Successful Business and Competitiveness* (pp. 57–62). Izdavač nije naveden.

Đorđević, M., Vujanac, R., Kostić, S., & Đorđević, M. (2020b). QA matrix as quality tool in automotive industry. In *VIII International Conference Quality System Condition for Successful Business and Competitiveness* (pp. 53–57). Izdavač nije naveden.

Lean Enterprise Institute. (2008). *Lean lexicon* (4th ed.). Lean Enterprise Institute.

Vujanac, R., Đorđević, M., & Miloradović, N. (2017a). Mechanical tugger trains system for internal material handling. In *6th International Conference Transport & Logistics* (pp. 73–76). Izdavač nije naveden.

Vujanac, R., Đorđević, M., & Miloradović, N. (2017b). Semi-automatic mechanical transport-handling system for production and assembly lines. In *XXII International Conference on Material Handling, Constructions and Logistics (MHCL)* (pp. 173–176). Izdavač nije naveden.

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