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BUSINESS AMBIENCE FOR IMPLEMENTING JUST-IN-SEQUENCE STRATEGY – THE AUTOMOTIVE INDUSTRY IN SERBIA: CASE STUDY

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Abstract. Persistent issues in the automotive industry – such as delivery delays and frequent stock-outs – indicate that the vision of perfectly synchronized flows of raw materials, parts, and components within complex industrial production and logistics systems remains a significant challenge. To mitigate demand variability and uncertainty, companies often maintain high levels of safety stock, which significantly increases costs and erodes competitiveness. At the same time, such supply chains are characterized by limited responsiveness, resulting in unfulfilled targets related to reduced lead times and reliable customer deliveries. As a response, supply chains in the automotive sector are increasingly opting for the implementation of Just-in-Sequence (JIS) strategies to ensure adaptation to diverse product requirements and cost savings, as well as enhance both responsiveness and efficiency. Within this context, the objective of this research is to identify key elements necessary for the successful implementation of the JIS strategy in an automotive company. The research findings reveal notable differences in the perceptions of employees from Production, Logistics, and Sales sectors regarding the importance of the analysed variables and the potential for implementing a JIS strategy.

Keywords: Just-in-sequence, Just-in-time, supply chain, lead time, automotive, variables.

JEL Classification: L14, L23, L62.

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1. Introduction

To meet the evolving demands of the automotive industry, Taiichi Ohno introduced the fundamentals of the Just-in-Time (JIT) philosophy, later enhanced by Shigeo Shingo to include error detection and zero-defect production (Ohno, 1988; Shingo, 1989). Compared to the period when JIT reached peak of its popularity, today's automotive manufacturers are facing serious market challenges. In recent years, automobile consumers have become increasingly demanding, placing greater emphasis on product personalization, so meeting these individual requirements has become essential for achieving a sustainable competitive advantage (Milovanović & Popović, 2019). Relying on safety stock to meet uncertain demand increases operational costs, while pressure to shorten delivery times adds complexity to products and processes, highlighting the need for agility, sustainability, and resilience (Lotfi et al., 2023).

Therefore, the primary objective of emerging production and logistics concepts in the automotive industry is to enable mass production of highly customized products, while ensuring the efficiency of the production system. Despite the fact that JIT has the potential to improve the delivery process of standardized products by minimizing inventory levels, it fails to provide solutions for products with a high number of variants. Consequently, JIT reveals its limitations: increased space requirements, growing inventory levels, and higher material handling costs (Gnoni et al., 2017; Anđelković, 2017). As a result, companies are imposed with new requirements regarding changes in inventory management strategies and the implementation of a new approach known as Just-in-sequence (Cedillo-Campos et al., 2017). As an innovative approach (Juhász & Bányai, 2024, p. 99), JIS enables companies and supply chains to cope with the complexity of products and processes, while also providing a more suitable response to the demand for mass customization, which JIT system struggles to accommodate.

JIS ensures parts are delivered at the right time, quantity, quality, and sequence (Cedillo-Campos et al., 2017; Jodlbauer et al., 2023). While JIT focuses on timely delivery to the production line, JIS adds precise sequencing and cost-efficient delivery from suppliers to users without warehouse retention (Bányai, 2023; Thun & Hoenig, 2011). JIS optimizes production by delivering elements directly to the assembly line in sequence, reducing inventory, storage space, and capital blocking, while enabling a quick, cost-efficient response to customer demands (Thun & Hoenig, 2011; Singh & Modgil, 2023; Juhász & Bányai, 2024, p. 100). One of the key advantages, especially in terms of competition, is that JIS supply system is very difficult to replicate. Considering these advantages, JIS has become the standard for delivering automotive parts characterized by high diversity, value, and large quantities, over the last two decades and today. Typical examples include seats, wiring systems, bumpers, exhaust systems, and even carpets and engines. JIS, while common in automotive manufacturing, is increasingly adopted in industries requiring mass customization—such as electronics (Dell, Siemens), heavy machinery (John Deere, Caterpillar), furniture (Steelcase), and chemicals (BASF)—to manage complex supply chains efficiently (Wagner & Silveira-Camargos, 2011; Juhász, 2024; Molinaro, 2010; Christopher, 2016; Chopra & Meindl, 2016).

Given the clear advantages of JIS over JIT, its implementation in the automotive industry is increasingly inevitable. However, the differences between the JIS and JIT strategies raise the issue of what kind of business ambience needs to be established to ensure the successful implementation of the JIS strategy. Furthermore, existing academic studies highlight the high sensitivity of the JIS strategy to risk events (Falsafi et al., 2018; Choi et al., 2023; Bányai, 2023; Bose et al., 2025), which may further jeopardize its implementation if some of the necessary elements of the business ambience are lacking. Most studies focus on isolated elements, neglecting systemic perspectives, limiting understanding of factors determining JIS feasibility and resilience. To address these gaps, this study examines the following research questions:

- To what extent do employees from different sectors (Production, Logistics, Sales) perceive the identified elements as important for the successful implementation of the JIS strategy?
- Are there statistically significant correlations between the key elements necessary for a successful implementation of the JIS strategy?
- Do employees perceive that risk events have more severe consequences under the JIS strategy compared to JIT?

This paper aims to systematize and assess the importance of the elements necessary for the successful implementation of the JIS strategy, analyzed in previous studies, as well as to evaluate the risk sensitivity of companies and supply chains in the automotive industry—especially in situations where certain elements are neglected or omitted. Accordingly, the main contributions of this paper are as follows:

- the development of a structured framework of key elements that enhances understanding of the business environment aligned with the requirements of the JIS strategy;
- the analysis of employees' perceptions across sectors involved in the implementation of the JIS strategy (Production, Logistics, and Sales) regarding the importance of these key elements;
- the identification and assessment of risk factors associated with the implementation of the JIS strategy in the automotive industry;
- comparative analysis of employees' perceptions of the severity of risk event consequences when applying the JIS strategy versus the JIT strategy.

Along with the Introduction, the paper contains the literature review, including the analysis of previous research on key elements for successful implementation of the JIS strategy. Existing literature is focused on individual elements or specific groups of elements, so the literature review in this paper serves as a synthesis of the elements identified so far. Additionally, one section of the paper is dedicated to the research methodology, outlining the hypotheses, as well as the rationale for defining the sample, specifically the selection of the company and employees from relevant sectors within it. This section also defines the variables that were evaluated by the employees, which pertain to the elements necessary for implementing the JIS strategy. The section on the analysis and discussion of the results presents the findings of the conducted research, along with similarities and differences between the results obtained and those from previous studies. The conclusion section provides a final assessment, highlighting the study's limitations and suggesting future directions for research on this topic.

2. Elements necessary for implementing the Just-in-sequence strategy – literature review

Although the JIS strategy is considered an evolutionary advancement of JIT with significant advantages, its implementation remains complex and demanding. Despite the growing academic interest, empirical research under real-world conditions is still limited, highlighting the need for further analysis and identification of research gaps.

In the globalized supply chain environment, characterized by increased risk intensity and complexity, studies by Pettit et al. (2013), and Ivanov (2020) emphasize the importance of supply chain resilience. JIS can enhance efficiency but also introduce vulnerabilities, requiring careful evaluation of both benefits and risks when transitioning from JIT.

JIS increases sensitivity to production disruptions (Thun & Hoenig, 2011; Falsafi et al., 2018; Juhász & Bányai, 2021; Choi et al., 2023; Bányai, 2023; Olaniyi et al., 2024; Bose et al., 2025) due to shortages, defective parts, delays, or quality issues. Since components are sequenced for specific assembly schedules, disruptions often halt production lines. The complexity of process synchronization across the supply chain further amplifies risk, while quality issues require supplier guarantees to meet defined standards (Alvarez et al., 2024).

Due to its reliance on precise sequencing, JIS struggles to adapt to sudden demand changes (Hottenrott et al., 2021), making stable and predictable demand essential (Bányai, 2024, p. 77). Although JIT faces similar limitations, the consequences under JIS are more severe due to fewer alternative solutions. Successful implementation depends on the alignment of technology, workforce, infrastructure, and spatial organization (Juhász & Bányai, 2021). An analysis of published research in this field reveals the following key elements for creating an environment conducive to the implementation of JIS strategy: transparency and information technology, supplier management, process synchronization and production sequencing stability, human resource management, and crisis management.

JIS requires more advanced and integrated *information systems* than JIT, functioning as an interface among all supply chain partners to ensure accurate, timely, and transparent data exchange and prevent disruptions (Thun & Hoenig, 2011; Bautista & Fortuny-Santos, 2016; Ostermeier et al., 2023). Compatibility between the databases of manufacturers, suppliers, and other partners is crucial for early detection of potential disruptions (Anđelković, 2017; Wagner & Silveira-Camargos, 2012). Studies on Industry 4.0 emphasize that information systems are a key enabler for developing JIS, particularly in the automotive industry (Juhász & Bányai, 2018; Singh & Modgil, 2023). Reliable and efficient systems that ensure real-time transparency and continuous information flow are essential, as any delay or inaccuracy can cause production disruptions (Bautista & Fortuny-Santos, 2016; Choi et al., 2023; Gnoni et al., 2017).

Implementing JIS strategy requires complete synchronization of processes among all partners in the supply chain after the customer places an order (Papoutsidakis et al., 2021, p. 12). The previous element of JIS, information technology and transparency among partners in the supply chain, positively influences *production stability and the sequence* order (Heinecke et al., 2013). Stable production is imperative for the implementation of JIS concept. The stability of the production process and production planning (Meissner, 2010; Bányai et al., 2019; Turi, 2024) is essential to ensure timely delivery according to the appropriate schedule (Klug, 2022b). Errors in sequencing of the components can be very costly and potentially result in delays on assembly lines. Sequence stability is necessary for efficient planning and operation with less working capital. With a stable sequence schedule, suppliers also face fewer issues in planning their production (Anđelković, 2017; Wagner & Silveira-Camargos, 2012).

Supplier management under JIS involves the selection and monitoring of suppliers based on predefined criteria and standardized key performance indicators (KPIs). KPIs serve as early warning signals when suppliers fail to meet expectations regarding quality, quantity, or delivery time. The selection of competent suppliers is particularly important for ensuring synchronized and sequenced delivery (Papoutsidakis et al., 2021, p. 12). The key selection criteria include product quality, price, delivery reliability, and geographical proximity. Because defective or nonconforming parts are difficult to replace, zero-defect quality of raw materials and reliable processes are essential (Meissner, 2010; Lotfi et al., 2024).

Due to the system's dependence on Just-in-sequence deliveries and minimal inventories, supplier proximity to the production line is a critical factor for successful JIS implementation (Hüttmeir et al., 2009; Choi et al., 2023, p. 2336; Turi, 2024). In the automotive sector, suppliers are often concentrated in nearby "supplier parks," reducing transportation costs and minimizing the risk of delays (Bányai, 2023, p. 1008).

Effective JIS implementation also requires close coordination and strong partnerships with a smaller number of carefully selected suppliers. Such collaboration supports synchronized production, facilitates product development, and fosters trust-based relationships that enhance innovation and reliability (Anđelković, 2017; Wagner & Silveira-Camargos, 2012; Frieske & Stieler, 2022; Juhász & Bányai, 2024; Gnoni et al., 2017; Bányai, 2024, p. 78).

Additionally, *human resource management* is crucial for the implementation of JIS. Employees are responsible for executing processes. Therefore, employees must be qualified and well-trained, as well as assigned to appropriate positions (Gnoni et al., 2017). Furthermore, since they are involved in the processes on a daily basis, they can provide valuable advices and suggestions for improvement.

Table 1. Key elements of the JIS ambience and related risks (source: authors)

Elements of JIS ambience		Risks related with JIS	
Transparency and information technology ▪ Transparency between suppliers and manufacturers (A1) ▪ Implementation of information technology among supply chain participants (A2) ▪ High level of detail in information (A3) ▪ Daily information exchange (A4) ▪ Compatibility of information technology among supply chain participants (A5)	Bautista and Fortuny-Santos (2016), Gnoni et al. (2017), Juhász and Bányai (2018), Bányai (2018), Choi et al. (2023), Ostermeier et al. (2023), Singh and Modgil (2023)	▪ Communication and coordination errors with suppliers/customers (R10)	Thun and Hoenig (2011), Hofmann and Rüsch (2017)
Process synchronization and production sequencing stability ▪ Production stability (A14) ▪ Stable sequencing schedule (A15) ▪ Demand stability (A16)	Meissner (2010), Bányai et al. (2019), Papoutsidakis et al. (2021), Klug (2022b), Turi (2024)	▪ Machine breakdowns in production (R3) ▪ Changes in customer requirements (R7) ▪ Changes in customer demand levels (R8)	Thun and Hoenig (2011), Hottenrott et al. (2021)
Supplier management *Proximity of suppliers (A9)* ▪ Supplier experience and competencies (A10) ▪ Quality of raw materials with zero defects (A11) ▪ Supplier involvement in product development (A12) ▪ High level of coordination and cooperation with suppliers (A13)	Hüttmeir et al. (2009), Meissner (2010), Wagner and Silveira-Camargos (2012), Anđelković (2017), Gnoni et al. (2017), Choi et al. (2023), Frieske and Stieler (2022), Bányai (2023, 2024), Turi (2024), Juhász and Bányai (2024)	▪ Lack of quality raw materials (R1) ▪ Diversification of the supplier network (R2) ▪ Low flexibility (R9)	Thun and Hoenig (2011), Alvarez et al. (2024)
Human resource management ▪ High level of employee training (A6) ▪ Allocation of employees based on their qualifications (A7) ▪ Long-term work experience of employees in the same or similar jobs (A8)	Gnoni et al. (2017)	▪ Insufficiently trained workers (R5) ▪ Lack of employee commitment (R6)	
Crisis management ▪ Simulation of unforeseen events (A17) ▪ Defining a plan for risky situations (A18) ▪ Implementation of a "learning through work" system (A19)	Wagner and Silveira-Camargos (2011, 2012), Heinecke et al., (2013), Bautista and Fortuny-Santos (2016), Anđelković (2017), Gnoni et al. (2017)	▪ Delivery delays (R4)	Fan et al. (2021), Hofmann and Rüsch (2017)

JIS offers greater flexibility, shorter cycles, and lower inventory, but its higher sensitivity to disruptions increases risks compared to JIT. Thus, the risks are quite similar to those associated with JIT (sensitivity to delays, quality issues, failures of information systems, damages during transport, etc.), but the negative consequences in the case of JIS implementation are much greater (Heinecke et al., 2013; Gnoni et al., 2017). For this reason, *crisis management*, as a proactive response to unpredictable events, is noted as one of the conditions for the successful implementation of the JIS strategy. This proactive response consists of defining training plans, contingency plans for unforeseen situations (Wagner & Silveira-Camargos, 2011, p. 5714), simulations for unexpected events, preparation for risky occurrences through *learning by doing* (Anđelković, 2017; Wagner & Silveira-Camargos, 2012), and continuous efforts to identify problems and determine solutions (Bautista & Fortuny-Santos, 2016).

The absence of any element recognized as significant for establishing an environment conducive to the implementation of the JIS strategy can increase the risk exposure of the entire supply chain. For example, neglecting variables important in the domain of information technology and transparency enhancement can lead to errors in coordination and communication among supply chain partners, as well as increase delivery errors and delays, and reduce the accuracy of demand forecasting – which is crucial for achieving production and sequencing stability (Hofmann & Rüsch, 2017). A study conducted by Fan et al. (2021) shows that crisis management, combined with the use of information technology, can ensure process continuity and thereby reduce the risk of interruptions.

Taking into account Table 1, it can be concluded that none of the analyzed studies is fully comprehensive, as none examines all the identified elements necessary for successful JIS implementation. Comparative empirical analyses of how different sectors within organizations perceive the importance of these elements are also lacking. The most comprehensive studies to date are those by Gnoni et al. (2017) and studies conducted or co-authored by Bányai. Most research focuses on supplier management, highlighting its critical role for JIS implementation and sustainability. Over time, the first three analyzed elements have remained the primary focus.

A key contribution of this study is its comprehensive focus on all five identified elements across nearly two decades of research. While many studies address supply chain risk analysis, only a few specifically examine risks associated with the JIS strategy, and none have analyzed human resource–related risks, such as lack of knowledge, experience, or commitment. The subsequent sections will assess the significance of these elements and the exposure to risks in the context of JIS implementation. This study also aims to integrate all elements and associated risks, addressing a connection that previous studies have only partially established (Hofmann & Rüsch, 2017; Fan et al., 2021).

3. Research methodology

Based on the literature review, areas most frequently mentioned as particularly significant in the transition from a JIT to a JIS supply and production system have been identified. However, the question arises as to whether these areas are valued equally by employees in sectors that are key to the implementation of the JIS strategy, or whether there are differences in their perceptions. Is there a correlation between the variables in the specified areas important for JIS implementation? Answers to these questions would be helpful in defining an acceptable business environment that would stimulate the complete/successful implementation of JIS strategy and eliminate potential constraints in that process. Considering the questions faced by the authors, the following hypotheses have been defined:

H1: There is a difference among employees in the perception of the importance of the elements for the implementation of the JIS strategy.

H2: There is a positive correlation between the elements needed for the implementation of the JIS strategy.

H3: The presence of risk factors has more serious consequences when the JIS strategy is implemented, compared to the JIT strategy.

By selecting a company from the automotive industry that acts as a supplier in its supply chain and applies the JIS strategy in the delivery of its final products to customers, the authors intend to address the defined questions and dilemmas, as well as to define a framework for the implementation of the JIS strategy in supply chains within mentioned industry. The reasons for choosing this company include:

1. It is considered a prototype for JIS implementation in the automotive sector (Wagner & Silveira-Camargos, 2012; Gnoni et al., 2017; Juhász & Bányai, 2018; Bányai et al., 2019; Klug, 2022a, 2022b),
2. It applies JIS in product delivery,
3. It also uses JIT in production and delivery, allowing employees to compare the benefits of both strategies.

3.1. Sample analysis

The sample includes 36 employees from Production, Logistics, and Sales, holding managerial, leadership, and analyst positions (Table 2). Employees in these positions have the authority to make decisions regarding the implementation of the JIS system, which is why their opinion is of particular importance for understanding the environment required Ffor JIS implementation.

Table 2. Sample structure (source: authors)

Position in the company	Manager	Team Leader	Shift Leader and Analyst	Total	
Production	1	2	12	15	42%
Logistics	1	2	8	11	31%
Sales	1	1	8	10	28%
Total	3	5	28	36	
	8%	14%	78%		
Work Experience (in years)	8.67	4.80	2.61		
Education Level	College/ University	Community College	Secondary School		
	21	12	3		
	58.33%	33.33%	8.33%		

3.2. Variables

Dependent variables include 19 elements grouped into five areas: transparency/IT, HR, supplier management, process synchronization, and crisis management. These variables are: high level of transparency between suppliers and manufacturers (A1), implementation of information technology among supply chain participants (A2), high level of detail in information (A3), daily information exchange (A4), compatibility of information technology among supply chain participants (A5), high level of employee training (A6), allocation of employees based on their qualifications (A7), long-term work experience in similar roles (A8), proximity of suppliers (A9), supplier experience and competencies (A10), quality of raw materials with zero defects (A11), supplier involvement in product development (A12), high level of coordination and cooperation with suppliers (A13), production stability (A14), stable sequencing schedule (A15), demand stability (A16), simulation of unforeseen events (A17), defining a plan for risky situations (A18), and implementation of a *learning through work* system (A19).

Respondents assessed the significance of these variables for JIS implementation and evaluated risk-related variables based on daily problems and potential consequences, comparing them to their experience with JIT. The risk variables were: lack of quality raw materials (R1), diversification of the supplier network (R2), machine breakdowns in production (R3), delivery delays (R4), insufficiently trained workers (R5), lack of employee commitment (R6), changes in customer requirements (R7), changes in customer demand levels (R8), low flexibility (R9), and communication and coordination errors with suppliers/customers (R10). A five-point Likert scale (1 = lowest, 5 = highest) was used for evaluation. The independent variables included work experience, education level, position, and sector (Production, Logistics, and Sales).

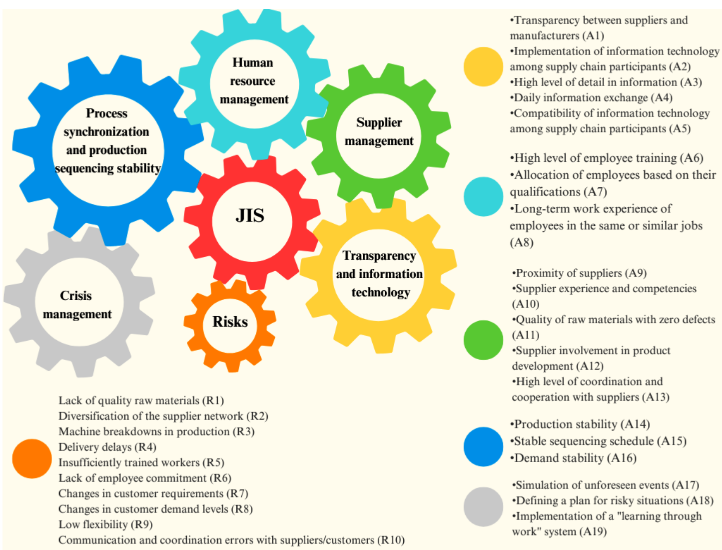

Figure 1. JIS business ambience model and related risk exposure in high-uncertainty contexts (source: authors)

Given the defined hypotheses and variables, Figure 1 presents the model of JIS business ambience and related risk exposure in high-uncertainty contexts. The arrow indicating the direction of movement of the elements essential to the implementation process suggests that these elements are interrelated and equally important for executing the JIS strategy. Neglecting even a single element could hinder its full implementation. Furthermore, risks assumed to have more severe consequences under the JIS strategy than under the JIT strategy are marked with arrow pointing in the opposite direction. This indicates that while the elements contribute to successful JIS implementation, the occurrence of risk events may jeopardize the viability of a system based on this strategy.

Based on previous research analyzing the significance of individual elements for JIS implementation (Wagner & Silveira-Camargos, 2012; Heinecke et al., 2013; Bautista & Fortuny-Santos, 2016; Gnoni et al., 2017; Juhász & Bányai, 2018; Papoutsidakis et al., 2021; Choi et al., 2023; Ostermeier et al., 2023; Singh & Modgil, 2023; Turi, 2024; Frieske & Stieler, 2022; Bányai, 2024), the proposed model integrates all five key elements and addresses a critical challenge specific to JIS—its heightened exposure to risk events compared to JIT. While the analysis of risks associated with JIS is not new (Thun & Hoenig, 2011; Hofmann & Rüsch, 2017; Hottenrott et al., 2021; Fan et al., 2021; Alvarez et al., 2024), this paper aims to systematize the identified risks and link them to the core elements required for successful implementation.

4. Analysis and discussion of research results

To test the previously defined hypotheses, a combination of descriptive statistics, cluster analysis, the *Chi-square* test, *Spearman's* correlation coefficient, and non-parametric tests (*Kruskal-Wallis*, *Mann-Whitney* and *Wilcoxon* tests) was employed due to the small sample size. Furthermore, the use of non-parametric tests was additionally justified by the violation of the normality assumption. The normality of the data was assessed using standard statistical tests, specifically the *Shapiro-Wilk* and *Kolmogorov-Smirnov* tests. Both tests revealed significant deviations from normality for all variables (p-values < 0.05).

The descriptive statistics show that all variables were rated highly, with average scores above 3.5, except for *Proximity of suppliers* (A9), *Supplier experience and competencies* (A10), and *High level of employee training* (A6). This is particularly concerning because previous studies have shown that these variables are especially important in the process of implementing the JIS strategy (Hüttmeir et al., 2009; Gnoni et al., 2017; Papoutsidakis et al., 2021, p. 12; Choi et al., 2023, p. 2336; Bányai, 2023, p. 1008; Turi, 2024).

The analysis indicates a high level of intra-sector agreement, with low standard deviations for most variables (Appendix, Table A1). Production employees prioritize variables related to crisis management, process synchronization, and production sequencing, while the Logistics sector rates all groups highly (average > 4.0). The Sales sector assigns lower ratings, particularly for supplier management and human resources. Considering these results, it can be concluded that the Sales sector, by neglecting the significance of the analyzed variables, may jeopardize the implementation of the JIS strategy. The recent study includes in the analysis only the production and logistics sectors (Bose et al., 2025), so it is not unexpected that the significance of the Sales sector is excluded from the JIS implementation process. However, in our study, the Sales sector is included because, in the analyzed company, it directly addresses the requirements of Original Equipment Manufacturer (OEM) customers in the automotive industry.

To examine how employees were classified into groups based on their ratings of the tested variables, a cluster analysis was conducted. The analysis resulted in the identification of two clusters, as shown in Table 3. The first cluster comprised employees who rated the analyzed variables as more important (22 employees), while the second cluster consisted of employees who assigned lower ratings (14 employees) (Table 4).

Table 3. Final cluster centers

	Cluster	
	1	2
A1	4.05	4.00
A2	4.50	3.71
A3	4.50	3.00
A4	4.82	3.07
A5	4.14	2.71
A6	3.77	2.79
A7	4.00	3.07
A8	4.05	3.00
A9	4.05	2.57
A10	3.59	1.86
A11	4.05	3.07
A12	3.77	3.50
A13	4.05	3.29
A14	4.95	3.79
A15	4.41	3.00
A16	4.32	4.14
A17	4.36	3.64
A18	4.91	3.93
A19	4.36	3.36

Table 4. Number of cases in each cluster

Cluster	1	22.000
	2	14.000
Valid		36.000
Missing		.000

The cross-tabulation of employees based on their cluster membership and the sector they belong to reveals that a larger number of employees from the Production sector (10 in total) and all employees from the Logistics sector are in the first cluster. Meanwhile, the majority of the second cluster consists of employees from the Sales sector. Based on Table 5, it can be concluded that the greatest discrepancies regarding the importance of the variables exist between the Production and Logistics sectors on one hand, and the Sales sector on the other.

Additionally, the application of the *Chi-Square* tests confirmed that the sector in which employees work impacts their perceptions of the importance of certain variables ($p < 0.05$), as highlighted in Table 6. The influence of other independent variables was also examined. Unlike sector affiliation, other independent variables, such as experience, education level, and position within the sector, do not affect employees' perceptions of the importance of the dependent variables.

Table 5. Cluster number of case * sector crosstabulation (source: authors)

		Sector			Total
		Production	Logistics	Sales	
Cluster Number of Case	1	10	11	1	22
	2	5	0	9	14
Total		15	11	10	36

Table 6. Chi-Square tests (source: authors)

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	18.187[a]	2	.000
Likelihood Ratio	22.517	2	.000
Linear-by-Linear Association	5.948	1	.015
N of Valid Cases	36		

Note: a. 2 cells (33,3%) have expected count less than 5. The minimum expected count is 3.89.

Since the perceived importance of variables needed to be compared across more than two sectors, the non-parametric Kruskal–Wallis test was used. The results of this test indicated statistically significant differences between sectors with respect to the analyzed variables. This finding suggests a lack of consensus among employees within the company under study regarding the relevance of the tested variables, thereby leading to the acceptance of the first hypothesis.

Nonetheless, cluster analysis and the *Chi-square* test revealed that the majority of employees from the Production and Logistics sectors were grouped within the first cluster, which assigned high importance to the examined variables. To further examine cross-sectoral differences, particularly among Logistics and Production employees, Mann-Whitney and Wilcoxon tests—both suitable for comparing two independent samples—were applied. Appendix Table A2 shows the agreement and disagreement on the perceived importance of variables. While most Production and all Logistics employees rated variables highly, the two sectors agreed on only 7 of 19 variables, though at least one variable within each of the five elements was recognized as important. In contrast, low agreement was observed between Sales and both Production and Logistics, with the weakest alignment between Logistics and Sales. Moreover, no consensus was found between the observed sectors on any variable related to *Human Resource Management* or *Risk Management*. This result aligns with the limited scholarly attention given to the examination of these elements in the context of JIS implementation, particularly in the past decade. Only a few studies—mostly conducted more than ten years ago—have emphasized the importance of these factors (Wagner & Silveira-Camargos, 2012; Heinecke et al., 2013; Bautista & Fortuny-Santos, 2016; Anđelković, 2017; Gnoni et al., 2017). There are also variables for which none of the analyzed sectors showed alignment. Particularly concerning is the disagreement over the variable *Stable sequencing schedule* (*A15*), as stable sequencing is a key component in most definitions of JIS implementation (Meissner, 2010; Heinecke et al., 2013; Bányai et al., 2019; Bányai, 2024, p. 77; Turi, 2024).

Spearman's correlation revealed mostly positive relationships, though some variables showed low or concerning correlations. For example, variable *Supplier involvement in product development* (A12) is not correlated with any variables from the areas of transparency and information technology, nor with variable *Supplier experience and competencies* (A10), suggesting that the inclusion of suppliers in product development is not grounded in their experience and competencies. This result may reflect the subordinate position of the analyzed company, which operates as a build-to-order supplier and follows strict production and product specifications provided by its OEM customer. As such, the company has limited autonomy and cannot involve its own suppliers in early product development without OEM approval. Therefore, the finding does not necessarily indicate poor supplier relationships or low transparency, but rather structural constraints within the supply chain. Furthermore, no correlation was found between *High level of transparency between suppliers and manufacturers* (A1) and any variable in the element *Human resource management*, which contrasts with the findings of Gnoni et al. (2017). Similarly, no correlation was found between *Demand stability* (A16) and variables in *Crisis management*, which is opposite to earlier research (Heinecke et al., 2013; Wagner & Silveira-Camargos, 2012). However, the most concerning issue is the failure to recognize the connection between *Demand stability* (A16) and other variables related to process *Synchronization and production sequencing stability*, while in earlier studies, we could find different conclusions (Bányai et al., 2019; Klug, 2022b; Bányai, 2024, p. 77; Turi, 2024). One possible explanation is that demand forecasting and planning are managed by sector not fully integrated into the sequencing and process planning teams, thereby creating a disconnect between perceived demand stability and other operational variables. A high degree of correlation was recorded among all variables related to *Human resource management*. A high degree of correlation was also observed among the variables *Proximity of suppliers* (A9), *Supplier experience and competencies* (A10), and *High level of employee training* (A6). Notably, these variables received the lowest ratings from employees. This result may be a cause for concern, particularly given that these variables are correlated with the largest number of other factors. Consequently, neglecting them could have adverse effects on the performance of the interrelated variables. Based on these findings, it can be concluded that the second hypothesis is only partially confirmed.

The literature suggests that the amortization of risks associated with events is more challenging when implementing JIS strategy compared to JIT strategy (Heinecke et al., 2013; Gnoni et al., 2017; Hottenrott et al., 2021). JIS strategy can help avoid or minimize the negative effects of certain risk events, especially in fully automated production conditions (Nguyen et al., 2020). However, given that the production process in the company that participated in the research is labor-intensive, all limitations and potential risks are further exacerbated. By evaluating risk events, employees were effectively assessing the severity of the consequences that such events could have in the context of JIS strategy implementation. Given that the respondents had prior experience with the application of the JIT strategy and were familiar with the consequences of risk events occurring under those conditions, they possessed sufficient background to assess the differences in outcomes. Their higher ratings confirmed that the occurrence of risk events entails more severe consequences under JIS implementation compared to JIT. According to employees' ratings, the risk of machine failure was the only factor to receive an average score higher than 4 (Appendix, Table A3). It is also the only variable that received a minimum rating of 3. For 5 out of 10 potential risk events, the minimum rating was 1.

Considering the previous results, which confirmed that the sector to which employees belong influences their perceptions of the importance of elements necessary for the implementation of the JIS strategy, a need emerged to examine the alignment among employees from different sectors in interpreting various risk factors—i.e., the potential consequences of those risks under JIS strategy conditions compared to the JIT strategy. Cluster analysis also indicated that employees from the Production and Logistics sectors perceived the severity of risk factors to be higher under the JIS strategy than employees from the Sales sector. As with the testing of elements required for the implementation of the JIS strategy, the *Kruskal–Wallis test* was used to test Hypothesis 3.

Table 7. Test Statistics[a,b] (source: authors)

	Risks									
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Chi-Square	23.061	3.149	14.369	23.860	23.860	3.370	18.499	19.308	24.165	26.750
Df	2	2	2	2	2	2	2	2	2	2
Asymp. Sig.	.000	.207	.001	.000	.000	.185	.000	.000	.000	.000

Notes: a. Kruskal Wallis Test. b. Grouping Variable: Sektor.

The results showed a statistically significant difference among sectors regarding the perceived severity of risk events, except in the cases of *Supplier network diversification* (R2) and *Lack of employee commitment* (R6) (Table 7). Employees agreed that these two risk events do not lead to greater consequences under the JIS strategy compared to the JIT strategy, which contradicts Hypothesis 3. Therefore, it can be concluded that Hypothesis 3 was not confirmed, not even partially. Additionally, since the lowest-rated variables across the entire sample were *Proximity of suppliers* (A9), *Supplier experience and competencies* (A10), and *High level of employee training* (A6), it is to be expected that employees would also assess the risks related to *Supplier management* and *Human resource management* as least severe. Table 8 summarizes the conclusions regarding the tested hypotheses.

Table 8. Research results (source: authors)

Hypothesis	Results	Elements and risks	Potential dangers
H1	Accepted	The lowest-rated variables across the entire sample were: Proximity of suppliers (A9), Supplier experience and competencies (A10), and High level of employee training (A6).	There is no consensus among employees from different sectors regarding the importance of elements required for JIS implementation. There is no agreement on the significance of the Stable sequencing schedule (A15) across individual sectors.
H2	Partially accepted	A high degree of correlation is present, among others, with the variables that were rated the lowest: Proximity of suppliers (A9), Supplier experience and competencies (A10), and High level of employee training (A6).	Demand stability (A16) is not correlated with any variable within its group.
H3	Rejected	Agreement among employees regarding the assessment of risk factors exists only in the cases of Supplier network diversification (R2) and Lack of employee commitment (R6). However, contrary to the defined hypothesis, employees agree that the consequences of these risks occurring will not be more severe under JIS compared to JIT.	It can be expected that employees will recognize the risks associated with lower-rated variables as less severe, considering the consequences. The study showed that the lowest-rated variables were Proximity of suppliers (A9), Supplier experience and competencies (A10), and High level of employee training (A6), as well as the risks that can be linked to them, namely Supplier network diversification (R2) and Lack of employee commitment (R6).

5. Conclusions

Manufacturing companies face intense competition and must balance meeting market demand with controlling costs, often struggling to reconcile high inventory levels with cost efficiency. The impression arises that it is impossible to reconcile these two requirements. However, the application of inventory management strategies, such as JIT and JIS, help ensure stable raw material supply and inventory levels while reducing costs.

Given the long-standing research on the individual elements critical to implementing the JIS strategy, the authors aimed to consolidate and connect these elements into a unified framework. It was reasonable to assume that the consolidated elements would be perceived as highly important by all employees involved in the implementation process, but the findings did not fully confirm this assumption.

In the analyzed case, there is a low level of agreement among employees regarding the importance of variables identified in the literature as particularly significant for the implementation of the JIS strategy. This indicates a low level of cooperation among the sectors within the company involved in the research. It seems that each sector is primarily focused on variables within its domain. It is also observed that the Sales sector, despite being directly involved in preparing deliveries according to the production sequences of the automotive parts customer (i.e., OEMs), rates the importance of these variables poorly, while, conversely, the Logistics sector highly rates all variables. The impression is that, in this case, the Logistics sector has taken on the primary responsibility for JIS strategy implementation, closely followed by the Production sector, while the Sales sector plays a secondary role.

The high degree of correlation between most of the analyzed variables suggests that certain variables cannot be completely disregarded by the sectors involved in the implementation process. However, a particular concern in this case is the absence of correlation among variables identified within the same element. For example, the variable *Demand stability* (A16) showed no correlation with other variables within the *Process synchronization and production sequencing stability* element, which directly contradicts previous studies. Additionally, a potential issue arises when a high degree of correlation is observed among variables that are simultaneously rated as less significant in the process of implementing the JIS strategy.

The analysis of risk events did not support the third hypothesis, as consensus among employees was found only for two risk factors *Diversification of the supplier network* and *Lack of employee commitment*, and even in these cases, the results were contrary to the hypothesis. Specifically, the consequences of these risk events, when the JIS strategy is applied instead of the JIT strategy, were not perceived as more severe. Given that these two risks events correspond to the lowest-rated elements required for JIS implementation, it is important for future research to explore the relationship between the identified elements and associated risk events. Such studies could clarify whether specific elements are linked to particular risks and whether strengthening these elements could help prevent or mitigate adverse outcomes.

A comparison with previous research confirms that, while earlier studies effectively identified key components of JIS implementation, they frequently lacked a comprehensive, cross-functional integration of these elements. Previous studies lacked empirical analysis of departmental disparities in employee perceptions, as well as differing assessments of risk severity between JIS and JIT frameworks. Moreover, previous studies did not clearly specify which sectors were analyzed. As a result, the inclusion of employees from the Logistics sector in those studies may help explain the observed consensus regarding the importance of the examined variables. Our model addresses these gaps and underscores the importance of cross-sector collaboration and synchronized risk interpretation. This contributes to both academic literature and practical managerial applications.

5.1. Managerial implications

The lack of alignment between sectors directly involved in the implementation of the JIS strategy highlights the need for *cross-sector teams*. This suggests that the implementation of the JIS strategy should be viewed as a holistic process rather than one that can be divided among sectors. Cross-sector cooperation can be fostered through regular meetings and the use of digital platforms for information exchange, which facilitate process synchronization and real-time monitoring of sequences across sectors. In the analyzed case, there is a clear lack of involvement of all sectors in the entire implementation process.

Additionally, the *process-oriented approach* to implementing the JIS strategy implies the involvement of both upstream and downstream members of the supply chain relative to the focal company. Representatives from all analyzed sectors should be included in negotiations with both suppliers and customers, and cross-sector teams should participate in inter-organizational negotiations.

To achieve a higher level of alignment between sectors regarding the importance of elements essential for the implementation of the JIS strategy, the *standardization of processes and performance metrics* can be highly beneficial. This includes the introduction of common key performance indicators (KPIs) across all sectors, such as the percentage of deliveries made in the correct sequence, response time to demand fluctuations, and the number of sequencing errors per sector. In doing so, all sectors will be oriented toward the attainment of shared objectives. These implications are particularly relevant in cases where the JIS strategy has already been implemented and discrepancies in employee perceptions have been observed, as illustrated in the case analyzed in this paper. To avoid such cross-sector misalignments, *pilot projects* may be conducted within each sector prior to full-scale JIS implementation, along with *simulations* designed to test and strengthen cross-sector coordination. Additionally, the application of a *RACI matrix* can help clearly define roles and responsibilities in the JIS process, thereby reducing uncertainty regarding sector-specific duties. *Training employees* across all sectors—both prior to and following the introduction of the JIS strategy—can also contribute significantly to its successful implementation. It is essential that employees involved in the process are well-acquainted with the fundamental principles of the strategy.

However, the effectiveness of such initiatives may depend on *elements of organizational culture*. In countries with a strong tradition in the automotive industry and deeply rooted lean manufacturing cultures—such as Japan and Germany, where low power distance, a commitment to quality and precision, and a long-term orientation prevail—employee resistance to innovation tends to be lower. Also, there may be greater organizational alignment and systemic discipline supporting JIS. In contrast, in Serbia, where higher power distance, a focus on short-term objectives, and lower achievement motivation are more common, the acceptance of innovative business practices may be more limited and successful implementation may require stronger communication frameworks and training efforts. These contextual factors should be further explored in comparative international research.

5.2. Limitations and future research directions

Even though the research was conducted in the company in the automotive industry and consulted employees directly involved in the implementation of the JIS strategy (who possess the most relevant information), a single company cannot serve as the basis for drawing conclusions. The findings should be interpreted within the context of a single Serbian automotive supplier characterized by specific operational procedures, supply chain structures, and cultural factors. Therefore, generalization of the results to other industries or geographic contexts should be done with caution. Given that the necessary conditions are met within the company and employees have knowledge of both JIS and JIT strategies, the results can serve as a foundation for further research. Therefore, the sample size can be considered a key limitation. Therefore, analyzing this problem in a broader context and with a larger sample would also be a direction and recommendation for future research.

Furthermore, the authors assumed that decision-makers and other employees involved in the implementation process of the JIS strategy are rational and have perfect information. Future research could explore information asymmetry between employees in different sectors, which are also key to the implementation of the JIS strategy. The study used the company in the automotive industry as a model, but from the perspective of a supplier. Therefore, a limitation could be the position in the supply chain itself—whether the results would be the same if the significance of variables and the consequences of risk events were examined from the perspective of the OEMs in the automotive supply chain. Future research should focus on examining the significance of the JIS strategy among different participants in the supply chain.

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APPENDIX

Table A1. Descriptive statistics by sector (source: authors)

	Production					Logistics					Sales				
	N	Min	Max	Mean	Std. Deviation	N	Min	Max	Mean	Std. Deviation	N	Min	Max	Mean	Std. Deviation
A1	15	2.00	4.00	2.9333	.70373	11	4.00	5.00	4.8182	.40452	10	4.00	5.00	4.8000	.42164
A2	15	2.00	5.00	3.8000	.77460	11	4.00	5.00	4.8182	.40452	10	4.00	5.00	4.1000	.31623
A3	15	3.00	5.00	3.9333	.59362	11	4.00	5.00	4.8182	.40452	10	2.00	4.00	2.9000	.73786
A4	15	2.00	5.00	4.4667	.91548	11	4.00	5.00	4.8182	.40452	10	2.00	4.00	2.9000	.73786
A5	15	2.00	5.00	3.1333	.74322	11	4.00	5.00	4.8182	.40452	10	2.00	4.00	2.9000	.73786
				3.6533					4.8182					3.5200	
A6	15	2.00	4.00	3.0667	.59362	11	3.00	5.00	4.1818	.60302	10	2.00	4.00	3.0000	.66667
A7	15	3.00	5.00	3.9333	.70373	11	3.00	5.00	3.9091	.70065	10	2.00	4.00	2.9000	.73786
A8	15	3.00	5.00	3.9333	.59362	11	3.00	5.00	3.9091	.70065	10	2.00	4.00	2.9000	.73786
				3.6444					4.0000					2.9333	
A9	15	2.00	4.00	3.0667	.59362	11	4.00	5.00	4.7273	.46710	10	2.00	4.00	2.7000	.67495
A10	15	1.00	3.00	2.2000	.67612	11	4.00	5.00	4.8182	.40452	10	1.00	3.00	1.9000	.73786
A11	15	2.00	5.00	3.8000	.94112	11	4.00	5.00	4.0909	.30151	10	2.00	4.00	3.0000	.47140
A12	15	3.00	5.00	3.9333	.59362	11	3.00	5.00	3.3636	.67420	10	3.00	4.00	3.6000	.51640
A13	15	2.00	4.00	3.1333	.63994	11	3.00	5.00	4.6364	.67420	10	3.00	5.00	3.7000	.67495
				3.2266					4.3273					2.9800	
A14	15	3.00	5.00	4.6667	.72375	11	4.00	5.00	4.9091	.30151	10	3.00	5.00	3.8000	.63246
A15	15	3.00	5.00	3.9333	.59362	11	4.00	5.00	4.6364	.50452	10	2.00	4.00	2.9000	.56765
A16	15	3.00	5.00	3.9333	.59362	11	4.00	5.00	4.3636	.50452	10	3.00	5.00	4.6000	.69921
				4.1778					4.6364					3.7667	
A17	15	2.00	5.00	3.8667	.74322	11	2.00	5.00	4.4545	1.03573	10	3.00	5.00	4.0000	.47140
A18	15	4.00	5.00	4.6667	.48795	11	4.00	5.00	4.8182	.40452	10	3.00	5.00	4.0000	.47140
A19	15	4.00	5.00	4.6667	.48795	11	2.00	5.00	3.8182	.75076	10	2.00	4.00	3.1000	.56765
				4.4000					4.3636					3.7000	

Table A2. Test Statistics[a] – elements for implementing JIS (source: authors)

Production/ Logistics	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19
Mann-Whitney U	3.000	22.000	23.000	68.000	8.500	18.500	81.000	80.500	4.500	.000	71.500	42.000	12.500	72.500	35.000	53.000	42.500	70.000	30.000
Wilcoxon W	123.000	142.000	143.000	188.000	128.500	138.500	147.000	146.500	124.500	120.000	191.500	108.000	132.500	192.500	155.000	173.000	162.500	190.000	96.000
Exact Sig. [2*(1-tailed Sig.)]	.000[b]	.001[b]	.001[b]	.474[b]	.000[b]	.000[b]	.959[b]	.919[b]	.000[b]	.000[b]	.574[b]	.036[b]	.000[b]	.610[b]	.013[b]	.134[b]	.036[b]	.540[b]	.005[b]
Production/ Sales	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19
Mann-Whitney U	3.000	59.500	23.500	16.000	64.000	71.000	26.000	23.500	52.500	58.000	33.000	54.000	44.000	27.000	18.500	34.500	70.000	30.000	5.000
Wilcoxon W	123.000	179.500	78.500	71.000	119.000	126.000	81.000	78.500	107.500	113.000	88.000	109.000	164.000	82.000	73.500	154.500	190.000	85.000	60.000
Exact Sig. [2*(1-tailed Sig.)]	.000[b]	.397[b]	.003[b]	.001[b]	.567[b]	.849[b]	.005[b]	.003[b]	.216[b]	.367[b]	.019[b]	.261[b]	.091[b]	.007[b]	.001[b]	.023[b]	.807[b]	.012[b]	.000[b]
Logistics/ Sales	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19
Mann-Whitney U	54.000	15.500	2.000	2.000	2.000	12.000	19.500	19.500	1.500	.000	5.000	40.000	19.000	9.000	2.000	40.000	28.500	14.500	23.000
Wilcoxon W	109.000	70.500	57.000	57.000	57.000	67.000	74.500	74.500	56.500	55.000	60.000	106.000	74.000	64.000	57.000	106.000	83.500	69.500	78.000
Exact Sig. [2*(1-tailed Sig.)]	.973[b]	.004[b]	.000[b]	.000[b]	.000[b]	.002[b]	.010[b]	.010[b]	.000[b]	.000[b]	.000[b]	.314[b]	.010[b]	.001[b]	.000[b]	.314[b]	.061[b]	.003[b]	.024[b]

Notes: a. Grouping Variable: Sector. b. Not corrected for ties.

Table A3. Descriptive statistics – risk factors by sectors (source: authors)

	Production					Logistics					Sales				
	N	Min	Max	Mean	Std. Deviation	N	Min	Max	Mean	Std. Deviation	N	Min	Max	Mean	Std. Deviation
R1	15	1.00	3.00	2.1333	.63994	11	3.00	5.00	4.0909	.53936	10	1.00	3.00	2.1000	.73786
R2	15	1.00	3.00	2.1333	.63994	11	2.00	4.00	2.7273	.90453	10	1.00	3.00	2.1000	.73786
R3	15	3.00	5.00	4.4667	.83381	11	3.00	5.00	4.8182	.60302	10	3.00	4.00	3.6000	.51640
R4	15	3.00	5.00	3.8667	.63994	11	4.00	5.00	4.2727	.46710	10	1.00	3.00	2.1000	.56765
R5	15	3.00	5.00	3.8667	.63994	11	4.00	5.00	4.2727	.46710	10	1.00	3.00	2.1000	.56765
R6	15	2.00	5.00	3.0667	.70373	11	3.00	4.00	3.3636	.50452	10	2.00	4.00	3.0000	.47140
R7	15	3.00	5.00	4.0000	.53452	11	3.00	5.00	4.4545	.68755	10	2.00	4.00	3.0000	.47140
R8	15	3.00	5.00	4.0667	.59362	11	4.00	5.00	4.2727	.46710	10	2.00	4.00	2.9000	.56765
R9	15	3.00	5.00	4.0667	.59362	11	4.00	5.00	4.2727	.46710	10	2.00	3.00	2.2000	.42164
R10	15	3.00	5.00	4.0667	.59362	11	4.00	5.00	4.8182	.40452	10	1.00	3.00	2.1000	.56765
Valid N (listwise)	15					11					10				