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FACTORS THAT INFLUENCE LOGISTICS DECISION MAKING IN THE SUPPLY CHAIN OF THE AUTOMOTIVE INDUSTRY

Summary. Logistics activities are present in different business functions, which is why unified decision making in logistics has a significant effect on the organization of logistics processes in companies. Scientific literature highlights various aspects of logistics decision making, but so far, no survey has been conducted that can accurately illustrate the effect of centralized logistics and the effect of the level of logistics knowledge of employees from other departments on unified decision making in the organization of logistics processes. For this purpose, a statistical analysis was carried out on a sample of companies from the Slovenian automotive industry, which is one of the leading high-tech industries in the world. The results of multiple linear regression show that the greater the knowledge of logistics among the employees from other departments, the more logistics costs are taken into account during the development of the product. This is an important finding for the automotive industry, as well as for other manufacturing industries, especially with respect to efficient planning of logistics processes, starting from the early stages of product development. This enables better control over logistics costs, as all business functions within the company participate in the process. The results presented here highlight future guidelines for the organisation of logistics processes in the high-tech automotive industry. It was verified by multiple linear regression.

1. INTRODUCTION

One of the major challenges for systemic logistics management stems from organizing the logistics processes of the company [1]. Every department that is part of the company's logistics system manages individual logistic processes that form a group of processes. Each process entails costs related to its execution [2]. As employees in various departments (sales, purchasing, manufacturing, and logistics) make various strategic and operational logistics decisions on a daily basis, it is all the more important for the successful management, planning, and control of logistics processes that these departments are able to work in unity with each other [3].

The management of logistics processes in companies is organized in two ways: centralized in an autonomous logistics department or decentralized in individual departments. The centralization of logistics has its advantages, as it brings all logistic activities under unified management, which also limits the decision-making autonomy of individual departments within the company. One of the disadvantages of centralized logistics activities is a more restricted flow of information to suppliers or customers. Decentralized logistics has an advantage in this regard, because individual departments have direct contact with individual participants in the company's supply chain. The sales department has direct contact with the buyer and with manufacturing, the purchasing department has direct contact with the supplier and with manufacturing, whereas the manufacturing department has direct contact

with sales and purchasing. The main issue with this approach lies with the fact that individual departments lack sufficient logistics knowledge, which can result in the wrong logistics decisions being taken and in uncoordinated decision making.

In the distribution of goods, the sales department aims to satisfy the customer with smaller batches in terms of quantity and with a guarantee of sufficient safety stock. This kind of approach will increase the transport costs of the company. Costs will also increase owing to additional warehouse handling operations and additional warehouse space. Larger stocks and longer payment periods will compromise the company's liquidity. The purchasing department will also be able to make wrong logistic decisions, as it will be able to procure larger quantities of goods to secure quantity discounts for the company. However, even if this is the case, the company will incur additional warehouse costs and encounter potential liquidity issues when purchasing larger quantities of goods [4-5]. In these cases, the effectiveness of logistics activity management depends on the broadness of logistics knowledge of employees from other departments.

Therefore, the purpose of the study is to determine the effect of centralized logistics and of the logistics knowledge of employees from other departments on the unity of logistics decision making in manufacturing companies and the trade-off between low logistics costs and a high customer service level.

For this purpose, a statistical analysis was carried out on a sample of companies from the Slovenian automotive industry, which is one of the leading high-tech industries in the world. Scientific literature highlights various aspects of logistics decision making, but so far, no survey has been conducted that could accurately illustrate the effect of these two factors on unified decision making in the organization of logistic processes. The findings of the study are thus highly relevant for the organization of logistics processes, which will form the basis for managing the entire supply chain of automotive companies and in other industry sectors.

The structure of the article is as follows: the introduction is followed by the literature review that highlights important aspects that influence logistical decision making. In the third point, the research methods and the institution that participated in the research are presented. After the methodology, the fourth point shows the results of the research. This is followed by a discussion of the results, highlighting research limitations and recommendations for future studies.

2. LITERATURE REVIEW – FACTORS INFLUENCING LOGISTICS DECISION MAKING

One of the major constraints affecting logistic decision making in companies derives from the fact that the optimal level of customer service must be taken into account when planning logistics processes. The higher the level of customer service, the higher the satisfaction level of the end customer, but at the same time, the costs also increase. Logozar [6], therefore, argues that logistics activities should be planned up to the level where logistics costs are at their lowest, while at the same time maintaining a certain level of logistics service. If the level of customer service drops, logistics costs will drop as well, but the company may lose some customers in the process. Pajic and Kilibarda [7] also point out that the function of logistics in the field of sales and distribution of products is to achieve the highest quality of services at the lowest possible cost. These are two conflicting goals that need to be examined and addressed along with the pursuit of an optimal solution. Other authors [8-12] share this opinion and propose that the reduction in the cost of one logistic component can lead to an increase in the cost of another logistic component, which results in higher overall logistics costs.

However, in order for employees to be able to make logistics decisions aimed at finding the optimal ratio between logistics costs and the quality of logistics customer service, they must have access to transparent information on logistics processes. Farahani et al. [13] argue that insufficient information about logistics costs is the greatest obstacle to quality decision making. If employees who are involved in logistics are unable to obtain transparent information at all stages of the flow of material, they are also unable to improve the efficiency of logistics processes. Inaccurate information also makes it difficult to measure the effect of their decisions throughout the company's supply chain. This was also demonstrated by Skerlic and Sokolovskij [5], who developed a logistics cost

management model in the product life cycle that significantly improves the level of information on logistics costs and logistics activities. They emphasized the importance of estimating logistics costs as early as in the initial phase of product development, and thereby confirmed that in this initial phase of product development, all departments within the company (sales, purchasing, production, etc.) play an important role in logistics decision making. Unified logistics decision making is only possible with a systematic model that provides an overview of the entire spectrum of logistics activities in the company.

The next major constraint that affects the process of logistics decision making is related to the field of organizing business processes in companies. Zekic et al. [14] point out that many companies are organized in a strictly functional manner. This type of organizational structure within a company involves functional departments (units) that are managed by functional managers. The presence of functional boundaries leads to the optimization of performance indicators only of specific departments, which also affects the values of the logistics system indicators. Each functional manager is interested in the achievement of target values of indicators of only his/her own department. In this case, the overall goals of the company are secondary [15]. As logistics activities are present in different departments (such as sales, purchasing, and manufacturing), the absence of unity between functional departments affects the quality of logistics decision making, which is lacking with this type of organizational structure of logistics processes.

Skerlic and Muha [4] also point out that in certain companies the management of logistics activities is based on the level of experience of employees in a particular area of operations, which can lead to differences in the perception of important elements in the logistics process of selling and purchasing goods. This kind of logistical decision making may partially cater to the interests of individual functional departments. For example, the sales department would be able to grant shorter payment deadlines to customers, while also securing large safety stocks. However, the company's operations would be negatively affected, as transport and storage costs would increase. The company's liquidity would be negatively affected as well. The authors suggest that the purchasing department could also affect logistics decision making, as it may order large quantities of goods from suppliers to obtain quantity discounts. This sort of fragmented logistics decision making could potentially affect the higher storage costs owing to the need for more storage space and longer inventory turnover, which would result in a higher cost of capital in stocks and the liquidity of the company being damaged.

Muha [3] points out that one of the obstacles to effective logistics decision making presents itself at the global level in the classification of logistics costs, as there is no single definition or standard to unify individual logistics costs. Non-unified classification can affect the identification of all relevant cost logistics components in practice, as logistics costs occur in various areas of operations, such as sales, purchasing, production, and logistics. The author believes that this is the reason why the interests of individual departments that are not in line with the common interests of the company as a whole are often brought into the forefront, especially in the procurement and distribution of goods. This further demonstrates that the issues surrounding logistics decision making are multifaceted and require a wider professional and scientific approach.

Many authors therefore look for ways to achieve effective integration of business functions. McCarthy-Byrne and Mentzer [16] propose an approach by which companies can develop an organizational structure that enables the effective integration of different logistics processes. Introducing the proposed approach improves relations between the departments, which contributes to better connectivity between the participants in the supply chain. Malihi and Aghdasi [17] propose a conceptual model that aligns the company's business goals with individual business functions. The modelling of these processes is followed by final optimization. Popova and Sharpanskyh [18] describe the relationships between the organisational goals and performance indicators of the company and suggest ways for modelling these relationships. The authors emphasize the importance of examining both individual processes and performance indicators in advance.

Despite the shortcomings in the field of organising business processes in companies, Zekic et al. [14] and Gromovs and Lammi [19] point out that there is an important aspect that affects the quality of logistics decision making. The authors emphasize the importance of managing the supply chain, which is based on organizational learning and reinforcing logistics knowledge. This was also confirmed by a

study conducted among manufacturing and trading companies [20], which revealed the need for personnel development in terms of knowledge of basic logistics skills, basic supply chain management concepts, and supply chain strategy. This underlines the fundamental need for a better understanding of logistics processes and of the effects of globalisation on logistics activities in companies.

Based on the literature review, it can be concluded that the effectiveness of logistics decision-making is influenced by: insufficient information on logistics costs, a lack of knowledge of the interdependence of logistics costs, and an inefficient organisation structure in which the logistics function is decentralised. The reasons behind the complexity of logistics decision-making are illustrated in Fig. 1, on an example of the product cost estimation process for an individual product in the automotive industry [21]. A detailed analysis of the results of this study shows that logistics cost decision making begins only toward the end of the entire process, before calculating the total product cost (Fig. 1).
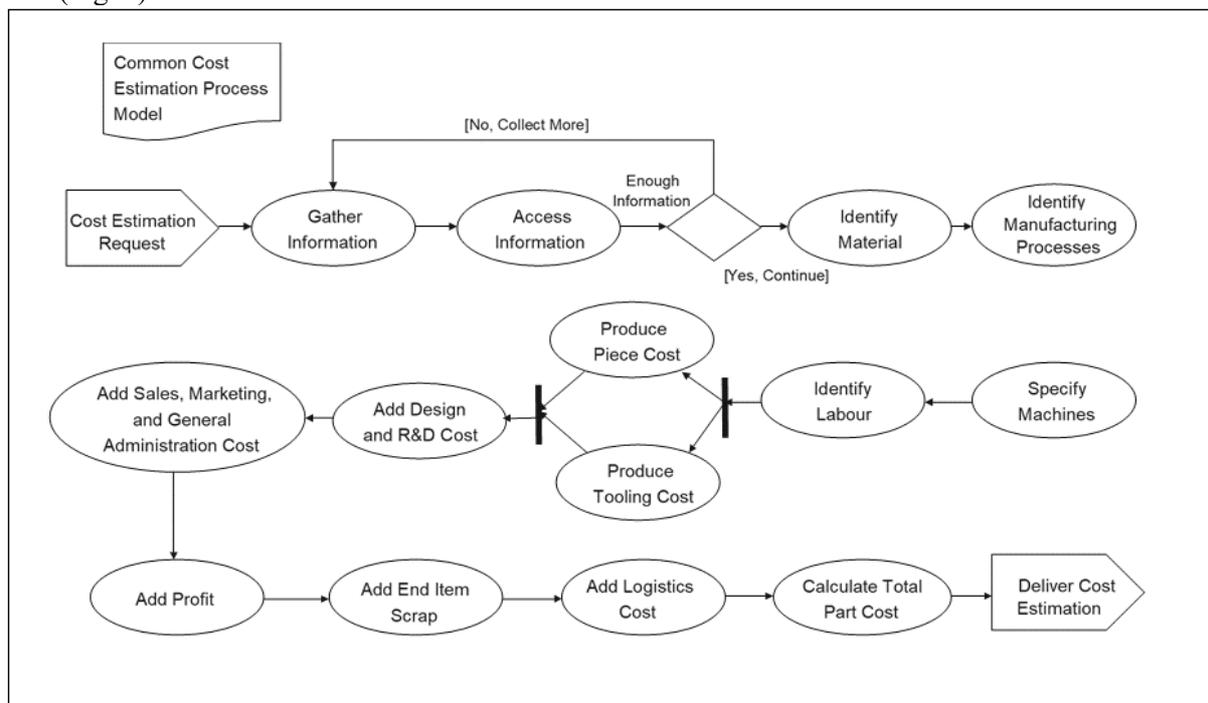

Fig. 1. An example of the product cost estimation process in the automotive industry. Source: [21]

As the logistics decision-making process does not start sooner, that is, before estimating the total cost of the product, there may be considerable discrepancies stemming from a lack of knowledge on logistics costs by other departments (sales, purchasing, manufacturing, etc.) and decentralized logistics within the company. These are also the key reasons that guide the research into the analysis of the effect of centrally managed logistics and the effect of the logistical knowledge of employees from other departments on the connectedness of logistics decision making in manufacturing companies.

Based on a review of the literature, logistics decision making was divided into five variables, which will be tested in the empirical part of the research. The first variable "All logistics costs are taken into account in the development of the product" was developed based on a study by Roy et al. [21], highlighting the importance of a detailed cost estimate in the automotive industry. The second variable "All departments within the company are involved in setting up the logistics system" and the third variable "Logistic decisions are made during regular meetings" are based on the guidelines by McCarthy-Byrne and Mentzer [16], who propose organisational approaches that improve relationships and cooperation between departments in the company, which contributes to better connectivity between the participants in the supply chain. This has led to great progress toward efficient logistics decision making. The fourth variable "Information on logistics costs is available to all employees" is derived from the conclusions of Farahani et al. [13]. The authors emphasize that the main obstacle to

making quality decisions is insufficient information on logistics costs. If logistics employees do not receive transparent information at all stages of the flow of material, they are unable to improve the efficiency of logistics processes.

The fifth variable "The employees transfer logistics knowledge to one another" was developed on the basis of Zekić et al. [14], who emphasize the importance of supply chain management based on organizational learning and strengthening logistics knowledge. This kind of approach ensures that the goals of efficient logistics decision making are achieved.

3. RESEARCH METHODOLOGY

The case study is part of a wider study that examines the subject of logistics processes and logistics costs in the Slovenian automotive industry. The wider study analyzed the importance of using different cost models in logistics, the importance of managing in-house logistics processes, and the effect of different customer requirements in the automotive industry on Logistics [4]. However, as the factors that influence logistics decision making in the supply chain of the automotive industry chain have not been researched, they are specifically analyzed in this article.

A total of 30 manufacturing companies participated in the survey by filling out an online questionnaire, which contained a set of questions related to logistics management. The first step in the process was to contact the management of each company to inquire about their willingness to participate in the study. If the answer was yes, the company would then provide the contact information of the responsible person who would be filling in the questionnaire. In most cases, the questionnaire was filled in by management-position employees of automotive companies (heads or directors of logistics). These individuals were then sent a link to a website where they could fill in the questionnaire. The participants were contacted by telephone before they started filling in the questionnaire, in case they needed any further clarifications. The questionnaire was examined by four logistics professionals in a test environment, and only then it was communicated to the respondents via a web link. It was examined by the logistics manager of a large-sized company, the logistics manager of a small-sized company, as well as the head of the sales department and the head of the purchasing department of a large-sized production company.

The wider study was created in cooperation with the Slovenian Automotive Cluster (ACS), which is an economic interest association of Slovenian suppliers to the automotive industry and motor vehicle manufacturers. The ACS network connects automotive component manufacturers operating in the developed metal, electrical and electronic, mechanical, metallurgical, rubber, chemical, and textile industries. The ACS carries out the following activities: encouraging the research and development of more complex products and systems with greater added value; promoting joint members' activities to improve their products and operations in research and development, manufacture and quality, and to maintain business excellence; collecting information on any new developments in the automotive industry and in the automotive supply industry and forwarding any new information to its members; and establishing, developing and maintaining information, educational, and other infrastructure for its members' needs [22]. The ACS plays an important role in the development of the Slovenian automotive industry, which is why its participation in the first study dealing with logistics in the Slovenian automotive industry was of the utmost importance.

The process of logistics decision-= making in companies was measured by 5 different statements covering various aspects of logistics decision making in companies. The reliability of measurement was acceptable (Cronbach coefficient $\alpha = 0.71$). The correlation between the logistics knowledge of employees from other departments and the centralized organization of logistics (independent variables), and the logistic decision-making processes (dependent variable) was verified by multiple linear regression. The next step consisted in assessing the interaction effect of logistics knowledge and the organization of logistics on the dependent variable. Several regression models were built, where dependent variables were individual aspects (indicators) of the logistic decision-making process. Regression coefficients with $p < 0.05$ were considered statistically significant.

4. RESULTS

Table 1 shows the sample of companies included in the survey, which included 2 companies with 11 to 50 employees (6.7%), 13 companies with 51 to 250 employees (43.3%), and 15 companies with more than 250 employees (50%).

Table 1

The number of employees in the surveyed companies

	f	f %
from 11 to 50	2	6.7
from 51 to 250	13	43.3
more than 250	15	50.0
Total	30	100.0

f = frequency; f% = share (%)

Source: Authors

The companies that took part in the survey were asked to choose between two possible answers to the question of how they manage their logistics costs (Table 2). The majority of the companies (78.9%) use a personalised information system (e.g. Enterprise resource planning - ERP), followed by companies that systematically educate their employees on the importance of managing logistics costs (47.7%). In 26.3% of companies, the management of logistics costs is left up to individuals in the departments, while in one of the companies, logistics costs are dealt with exclusively by the controlling department.

Table 2

The way of managing logistics costs

	f	f %
The use of a customised information system (e.g. Enterprise resource planning - ERP)	15	78.9
Systematic education of employees on the importance of managing all costs	9	47.4
Logistics costs management is left up to individuals in departments	5	26.3
Logistics costs management is dealt with exclusively by the controlling department	1	5.3

f = frequency; f% = share (%)

Source: Authors

The measurement was validated by means of exploratory factor analysis. It is determined whether substantively similar statements actually measure the same construct or latent variable. Factor analysis is performed using the principal axis method. High weights on the same factor indicate that the statements strongly correlate with this factor and thus measure the same construct. The number of factors is determined on the basis of eigenvalues $\lambda > 1$. The adequacy of using factor analysis on the data is verified by the KMO (Kaiser-Meyer-Olkin) measure, which should be higher than 0.50, and a Bartlett's Test of Sphericity, which tests whether the correlation matrix is uniform (only ones in the diagonal and zeros off the diagonal), [23]. H0 states that there are no correlations between the variables. When $p \leq 0.05$, it is concluded that there is a correlation between the measured variables.

The reliability of the measurement is checked by Cronbach's alpha. Measurement reliability distinguishes between measurement reliability over time and reliability as the internal consistency of a measuring instrument. Cronbach's alpha measures the latter. A high correlation is expected between statements measuring the same content area. A value of $\alpha > 0.70$ means adequate measurement reliability, and a value of $\alpha > 0.60$ means satisfactory measurement adequacy [23-24].

The KMO measure and the Bartlett's Test of Sphericity (Table 3) indicate the adequacy of the data for factor analysis (KMO = 0.58; Bartlett $\chi 2$ (10) = 34.58; p <0.001). All statements have weights on the factor greater than 0.30. One factor explains 36% of the variability of the measured variables. The measurement reliability is adequate (Cronbach's $\alpha = 0.71$).

The results of the effect of the logistics knowledge of employees from other departments and the centralization of logistics on logistic decision making in companies that operate in the Slovenian

automotive industry are shown in Table 4 (the result of multiple regression, showing the standardised regression coefficients and p values). The greater the knowledge of logistics among the employees from other departments, the more logistics costs are taken into account during the development of the product. Further assessment showed that the logistics knowledge of employees from other departments and the centralisation of logistics are not statistically significantly related to any of the other aspects of the logistics decision-making process.

Table 3

Measuring the connectivity of the logistics decision-making process

Statements	Weights
All logistics costs are taken into account in the development of the product	0.47
All departments in the company are involved in setting up the logistics system.	0.67
Logistic decisions are made during regular meetings	0.35
Information on logistics costs is available to all employees.	0.60
The employees transfer logistic knowledge to one another	0.80
Proportion of explained variance	36%
Cronbach's α	0.71

Source: Authors

Table 4

The effect of the level of logistics knowledge of employees from other departments and the centralisation of logistics on a specific aspect of the logistics decision-making process

Independent variables:	**Dependent variables:**				
	All logistics costs are taken into account in the development of the product	All departments within the company are involved in setting up the logistics system	Logistic decisions are made during regular meetings	Information on logistics costs is available to all employees	The employees transfer logistic knowledge to one another
The level of logistics knowledge of employees from other departments	**0.39 (0.048)**	0.21 (0.316)	-0.06 (0.761)	0.16 (0.440)	0.1 (0.632)
Centralised Logistics	-0.06 (0.741)	-0.12 (0.557)	0.05 (0.780)	-0.15 (0.441)	-0.19 (0.362)

Source: Authors

Table 5 shows the results of the interaction effect of the logistics knowledge of employees from other departments and centralized logistics on individual aspects of logistics decision making (the result of multiple logistic regression, the standardised regression coefficients, and p values are shown). It was found that there is an interaction effect of the measured variables on the transfer of logistics knowledge between employees.

The interaction effect of the logistics knowledge of employees from other departments and centralised logistics on individual aspects of logistics decision-making is shown in Fig. 2. In companies with centralised logistics, employees from other departments with a higher level of logistics knowledge tend to do less transferring of their logistics knowledge to other employees, than in companies with decentralised logistics.

Table 5

The interaction effect of the logistics knowledge of employees from other departments and centralized logistics on individual aspects of logistics decision making

Independent variables:	Dependent variables:				
	All logistics costs are taken into account in the development of the product	All departments within the company are involved in setting up the logistics system	Logistic decisions are made during regular meetings	Information on logistics costs is available to all employees	The employees transfer logistic knowledge to one another
The level of logistics knowledge of employees from other departments (LC)*	0.05 (0.804)	0.11 (0.586)	0 (0.981)	0.03 (0.872)	0.1 (0.606)
Centralised Logistics (CL)	0.38 (0.058)	-0.02 (0.921)	0.23 (0.278)	-0.18 (0.381)	-0.04 (0.819)
LC x CL	-0.32 (0.207)	-0.26 (0.343)	0.12 (0.654)	-0.36 (0.17)	**-0.63 (0.015)**

* The variable is centred around an arithmetic mean to avoid multicollinearity. Source: Authors

5. DISCUSSION AND CONCLUSIONS

Most of the companies operating in the Slovenian automotive industry manage logistics costs using a customized information system (e.g. ERP). In addition, they systematically educate employees about the importance of managing all costs, which clearly indicates that they are aware of the importance of cost optimization of logistics in the company. The main part of the study consisted in the analysis of the effect of the logistics knowledge of employees from other departments and the centralization of logistics on the logistics decision making in the companies. In particular, the impact of both variables on a specific aspect of the logistics decision-making process was analysed. The results of the analysis clearly point out that the greater the knowledge of logistics among the employees from other departments, the more logistics costs are taken into account during the development of the product.
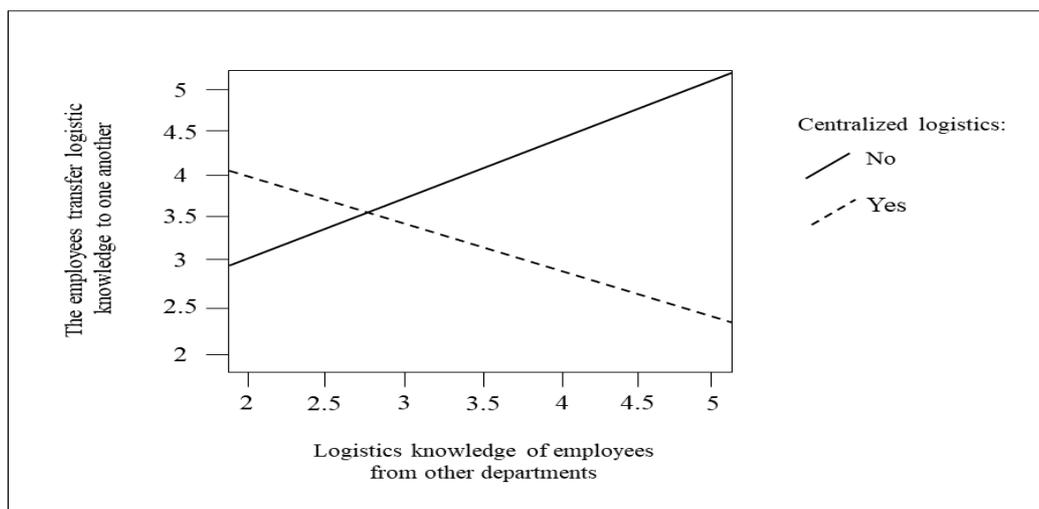

Fig. 2. The interaction effect of the logistics knowledge of employees from other departments and centralised logistics on the transfer of logistic knowledge between employees. Source: Authors

These results build upon the findings of the study by Roy et al. [21], where the cost estimation process in the automotive industry is presented. In the present study, logistics costs are only estimated at the end of the process, before calculating the total product costs. If employees from other departments in companies the automotive industry had more knowledge of logistics, the process of estimating logistics costs could be divided into several stages: after estimating manufacturing costs (by the manufacturing department), after estimating sales costs and administrative costs (by the sales department), before estimating the total cost of the product (by the sales and purchasing or logistics department) and after the delivery of the products (by the sales and purchasing or logistics department). This would make it easier to identify inconsistencies or inefficiencies in the process of purchasing goods, manufacturing, sales and after-sales activities. This is also important from the point of view of efficient measurement and modelling of logistics costs, since, as pointed out by Waller and Fawcett [25], errors resulting from a lack of knowledge of the interdependence of logistics costs are common in logistics decision-making. This is an important finding for the automotive industry, as well as for other manufacturing industries, especially with respect to efficient planning of logistics processes and costs, starting from the early stages of product development. In this logistics decision-making process, individual departments that are part of a company's supply chain must identify all logistics activities that support product distribution, manufacturing, and purchasing of input raw materials. A special focus is placed on sales and purchasing departments. The sales department must choose the best way to transport goods, define the packaging method, choose the most appropriate packaging, decide on the amount of safety stock, and set a payment deadline. On the contrary, the purchasing department must choose the best method for collecting goods from suppliers, define the quantity of the safety stock of input raw materials, and set a payment deadline. As logistics costs are present in different business areas, it is even more important for these departments to have an appropriate level of logistics knowledge, in addition to the knowledge related to their field of activity. Only by adopting this approach, companies can avoid wrong decisions that may result in higher overall logistics costs and a lower quality of logistics customer service.

An interesting phenomenon that emerges when studying logistic processes in companies is shown in the analysis of the interaction effect of the logistics knowledge of employees from other departments and centralized logistics on individual aspects of logistics decision making. In companies with centralized logistics, employees from other departments with a higher level of logistics knowledge tend to transfer their knowledge to other employees less often than companies with decentralised logistics. Based on this, we can infer that employees in companies with centralized logistics believe that there is no need for a mutual transfer of knowledge. As a result, they expect this knowledge to be provided by the centralized logistics department.

The results represent an update of the existing scientific literature, as they show the effect of organizational and personnel aspects on the connectivity of business functions in the logistics decision-making process. As logistics activities are present in various business functions, unified decision making in companies is one of the prerequisites for ensuring the economic feasibility and quality of logistics processes. The results of the survey therefore provide important guidelines for managing the supply chain of companies in the automotive industry and other industrial sectors.

The limitations of the study stem from the statistically small sample of Slovenian automotive companies, which is why the results cannot be generalized on a global scale. These limitations point to future research directions in the examined field, as a similar study in Central and Eastern European countries is warranted, with a comparison of the results.

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