Implementing Digital, Intelligent and Sustainable Logistics (DISL) to SMEs and Large Companies - Identification and Significance of Drivers and Barriers

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Abstract:

Purpose: The purpose of this article is to identify and analyse the significance of the existing drivers and barriers in the implementation of solutions in the field of Digital, Intelligent and Sustainable Logistics (DISL) to SMEs and Large Companies.

Design/Methodology/Approach: As part of this article, the survey conducted among Polish entrepreneurs was used. The results of the survey were analysed as part of the statistical analysis. The ANOVA analysis of variance was used for the gradation in terms of the significance level of both drivers and barriers, while the non-parametric Mann-Witney test was used to verify the differences in the perception of the drivers and barriers of DISL implementation for the variable: the size of the company.

Findings: The performed statistical analysis allowed to verify the hypotheses relating to the identification of statistically significant differences in the perception of drivers and barriers to DISL implementation. As a result, it was possible to indicate differences for both variables in terms of their level of importance, which turned out to be true.

Practical Implications: The area related to the analysis of the results of the conducted research in terms of identification and examination of the significance level of individual drivers and barriers to DISL implementation is particularly important from the point of view of the need for digitalisation and reducing the carbon footprint by modern supply chains.

Originality/Value: This paper primarily analyses the results of surveys completed by managers of micro, SMEs and large companies in terms of drivers and barriers for the DISL implementation as a key aspect of the development of current supply chains.

Keywords: Digital, Intelligent and Sustainable Logistics (DISL), drivers, barriers, SMEs, Large Companies.
JEL codes: J24, R40, M10, M11, M12.
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1. Introduction

In this paper, we introduce the concept of digital, intelligent, and sustainable logistics (DISL). The analysis of the literature highlights existing megatrends in the global supply chains that are currently rapidly progressing toward digitalisation, industry 4.0 or sustainability to increase safety, tackle growing emissions and congestion problems, make processes within supply chains more automated, efficient and sustainable. However, the implementation of DISL related solutions is affected by drivers and barriers that we discuss in the remainder of this paper.

In order to get a better insight into that matter, we have analysed drivers and barriers affecting DISL implementation as a part of a quantitative research project. Additionally, the results include the company's size as the differentiating factor to validate the perception of drivers and barriers by different companies, which would allow establishing a sound approach for DISL implementation (overcoming barriers and highlighting the drivers as significant benefits).

2. Literature Review

The digital transformation and the growing interest in Industry 4.0 have crucial importance for the competitiveness within the logistics sector (Miscevic *et al.,* 2018), additionally reinforced by the COVID-19 (Burroughs and Burroughs, 2020). Feijao *et al.* (2021) indicate that the pandemic has hastened the digitisation of supply chains by three to four years. It leads to substantive local, national, and international market pressures and changes, additionally emphasised by shareholders'/investors' aspirations and needs. Warner and Wäger (2019) underline the role of strong capabilities to effectively establish, execute, and modify business models to stay competitive in the emerging digital transformation, with a challenge to become even partially virtual for many supply chains.

Companies operating within supply chains aim for autonomous logistics (Hülsmann and Windt, 2007). In logistics systems, autonomous control is characterised by the ability of logistic objects to process information and render and execute decisions independently. It is a result of, e.g., congested transportation routes, complex access to logistic infrastructure or uncertainties in the collection and delivery times (Sanchez-Rodrigues *et al.,* 2010) and the exigence of better track and trace solutions and timely deliveries. To act autonomously, the use of ICT in autonomous supply chains communication and control is necessary, as well as the use of self-organising logistics models (Bartholdi *et al.,* 2010).

Global supply chains are also progressing toward intelligent solutions, e.g., intelligent transportation systems (Montreuil, 2011) and intelligent integration of external and internal transportation (Fan *et al.,* 2020). In warehousing processes, deep learning approach can support inventory optimisation and demand forecasting processes (Ren *et al.,* 2020). Moreover, smart technologies development (e.g., AI -

artificial intelligence, blockchain, cloud computing, IoT - Internet of Things) contributes to the so-called smart (intelligent) supply chains, where intelligent logistics services play a crucial role (Liu *et al.,* 2021). Such an approach reinforces agility and flexibility in supply chains, enabling to improve the customisation of products and services (Kuo *et al.,* 2021).

Intelligent logistics services become a new tool to enhance the customer service experience, pushing companies toward a model for customer orientation in intelligent logistics, as proposed by McFarlane *et al.* (2016). Moreover, at the enterprise level, the scheduling and optimisation problems of logistics systems using advanced smart algorithms have been proposed, improving the organisation's business benefits (Li *et al.,* 2020; Fan *et al.,* 2020).

Due to the requirement of reconsidering the use of resources for organisational operations and tackling resource scarcity (Genovese *et al.,* 2017), the supply chains are also searching for "green" solutions (Kersten *et al.,* 2017). The implementation of sustainable practices influences operational (i.e., enhanced transportation planning, better inventory and warehouse management), economic (i.e., lower inventory cost, sales growth and cost efficiency) and environmental (i.e., emission tracking data and freight efficiency) dimensions (Raut *et al.,* 2018; Garcia-Dastugue and Eroglu, 2019). The pressure to implement sustainable practices in logistics is exerted by the local customers, society, and stricter policy regulations (Zhang *et al.,* 2020).

Apart from the described drivers, some important barriers have been noticed. Firstly, the cost of tools to be implemented is essential. Many small and medium-sized organisations struggle to adopt digitalisation projects due to the slow payback time of digital and analytical skills investments on economic performance (Hong *et al.,* 2018). Secondly, digital, intelligent, and sustainable transformation in organisations needs to be supported by developing digital skills (Mu and Lee, 2005), which requires a significant shift in strategic approaches, corporate procedures and, most importantly, issues relating to human and organisational culture.

Then, the employee resistance to change becomes a significant factor (Fawcett *et al.,* 2015), as well as the commitment of top management towards the required organisational transformations. The influence of various skill types on the perception of barriers and drivers of implementing was analysed (Kalinowski *et al.,* 2022).

According to the authors of this publication, there are statistically significant differences between the individual drivers as well as barriers to DISL implementation included in the survey. In addition, these differences will allow the gradation of the identified drivers and barriers in terms of their significance level. These considerations made us propose hypotheses H1 and H2:

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H1: There are statistically significant differences between the drivers of implementing DISL in Micro, SMEs and Large Companies.
H2: There are statistically significant differences between the barriers to implementing DISL to Micro, SMEs and Large Companies.

According to the authors, the company's size will also have statistically significant importance concerning drivers' perception and barriers to DISL implementation. This claim results in the formulation of hypotheses H3 and H4:

H3: There are statistically significant differences between the way the DISL implementation drivers are perceived by Micro, SMEs and Large Companies.
H4: There are statistically significant differences between the way the DISL implementation barriers are perceived by Micro, SMEs and Large Companies.

3. Research Methodology

The identification and analysis of drivers and barriers for implementing DISL in Polish enterprises carried out in this article were based on a questionnaire survey addressed to micro and SMEs employing up to 250 employees and large enterprises employing over 250 employees. Managers of 50 Polish enterprises (28 micro and SMEs and 22 large companies) participated in the survey.

Respondents participating in the study assessed both the drivers and barriers to implementing Digital, Intelligent and Sustainable Logistics in their companies. To verify the hypotheses, the results obtained in the survey were first subjected to statistical ANOVA analysis. ANOVA is a statistical method based on the analysis of variance, which allows for testing the significance of differences between the average values achieved for the analysed factors (Sawyer, 2009).

In the case of achieving differences between the mean values of the ratings of drivers and barriers for which the p-value <0.05, it was possible to identify statistically significant differences within the studied group. The identification of these differences was used in the next step of grading the significance level of both drivers and barriers to DISL implementation.

In the second part of the study, a statistical analysis was carried out using the Mann-Whitney test, which aim was to be used to identify differences in the perception of both drivers and barriers of DISL implementation, divided into the identified groups of respondents - Micro, SMEs and Large Companies.

The Mann-Witney test is a non-parametric method of perceiving the distribution between two groups. This test involves ranking the results of the dependent variable in the analysed groups, after which it is necessary to compare the groups (Emura and Hsu, 2020).

4. Survey Study

In the first step of the survey analysis attempting to quantify the obtained results for drivers and barriers was made. The questionnaire contained 12 drivers and 10 barriers, the significance of which was assessed by enterprises representatives using the 7-point Likert scale. Table 1 contains the sets of drivers and barriers that were surveyed.

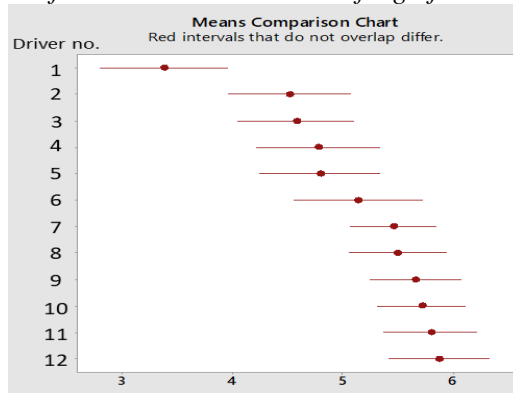**Table 1.** D*rivers and barriers of DISL implementation to companies*

No.	Driver description	Barrier description
1	Pressure from the local community	Implementation cost
2	Pressure from shareholders/investors	Lack of know-how / intellectual capital
3	More stringent regulations and legal conditions	No technological support
4	Global environmental challenges	Time needed to implement DISL solutions
5	Market pressure from local customers	Poor commitment of the top management
6	Market pressure from international customers	Insufficient market pressure
7	The potential of digital transformation	Resistance of employees to changes
8	Financial pressure to reduce costs (increase efficiency)	Lack of standardisation in the implementation of DISL solutions
9	Improving the business benefits of the organisation	No short-term benefits
10	Increased competition	There is no single framework to regulate the implementation
11	More effective tracking and timely deliveries	-
12	Providing better customer service	-

Source: *Own study.*

The next step of the research verified whether there are statistically significant differences between the perception of both drivers and barriers to DISL implementation. The statistical ANOVA method was used in this analysis. The results of the analysis showed that in the case of DISL implementation drivers, it is possible to identify statistically significant differences between the mean values of their significance assessment (p-value <0,05).

In the case of 12 analysed drivers, the ANOVA method showed that there were 6 groups for which the mean values of the results obtained in the survey differ statistically significantly from each other. This analysis made it possible to make a gradation of the significance level of the perception of these drivers, which is presented in Figure 1.

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**Figure 1.** *The division of drivers due to the level of significance of their perception*

Source: Own study.

As shown in Figure 1, the least important driver of implementing DISL in enterprises is *1. Pressure from the local community* while the most important driver, according to respondents, is *12. Providing better customer service*. It should be noted, however, that *11. More effective tracking and timely deliveries* were placed second in terms of significance. In the set analysed above, it is possible to identify statistically significant differences in the perception of DISL implementation drivers, which means that Hypothesis number 1 has been positively verified.

The above actions were repeated for the DISL deployment barriers. The barriers were divided into three groups, including barriers 1 and 2 (Table 1), which differ statistically significantly from the barriers from the second group, i.e., 9 and 10. In addition, the third group of barriers was also identified, including barriers 3-8, for which the average values do not differ from the average values of the scores achieved in the other two groups. This analysis allowed for the gradation of the examined barriers in relation to the level of their significance as perceived by the respondents of the survey. These results are shown in Figure 2.

Figure 2. *The division of barriers due to the level of significance of their perception*
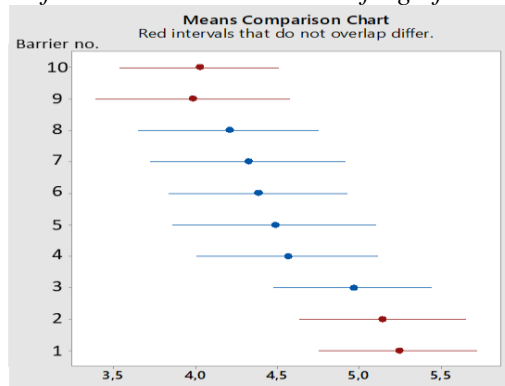
Source: Own study.

As shown in Figure 2, the most important barriers to implementing DISL indicated by enterprises (characterised by the highest average) include: *1. Implementation cost* and *2. Lack of know-how / intellectual capital*. According to the respondents, the least significant barriers are *9. Time needed to implement DISL solutions* and *10. No short-term benefits.* In the set analysed above, it is possible to identify statistically significant differences in the perception of DISL implementation barriers, which means that Hypothesis number 2 has been positively verified.

The next step of the research was to verify the differences in pairs due to the size of enterprises, i.e., Micro, SMEs and Large Companies. The non-parametric Mann-Witney test was used to compare the perception of drivers in pairs. The test results are presented in Table 2.

Table 2. *The Mann-Whitney U test for the drivers variable in case of Size of the company*

Variable	Rang sum Micro, SMEs	Rang sum Large company	U	Z	p	Z corr.	p	No. of. Micro, SMEs.	No. of Large company	Prob.
The Mann-Whitney U test (with continuity correction) for the variable: Size of the company. Marked results are significant with p <0,05000										
Market pressure from local customers	691,00	584,00	285,00	-0,440	0,660	-0,448	0,654	28	22	0,663
Market pressure from international customers	680,50	594,50	274,50	-0,645	0,519	-0,664	0,507	28	22	0,516
More stringent regulations and legal conditions	716,00	559,00	306,00	0,0292	0,977	0,0299	0,976	28	22	0,977
Pressure from the local community	728,00	547,00	294,00	0,264	0,792	0,268	0,788	28	22	0,794
Pressure from shareholders/investors	689,50	585,50	283,50	-0,469	0,639	-0,478	0,631	28	22	0,635
Increased competition	623,50	651,50	217,50	-1,759	0,079	-1,827	0,068	28	22	0,077
Financial pressure to reduce costs (increase efficiency)	624,50	650,50	218,50	-1,739	0,082	-1,799	0,072	28	22	0,080
Improving the business benefits of the organization	598,50	676,50	192,50	-2,248	0,025	-2,330	0,020	28	22	0,023
More effective tracking and timely deliveries	654,50	620,50	248,50	-1,153	0,249	-1,219	0,223	28	22	0,247
Global environmental challenges	664,50	610,50	258,50	-0,958	0,338	-0,978	0,328	28	22	0,336
The potential of digital transformation	662,00	613,00	256,00	-1,007	0,314	-1,046	0,296	28	22	0,317

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Providing better customer service	645,50	629,50	239,50	-1,329	0,184	-1,402	0,161	28	22	0,182

Source: Own study.

As presented in Table 2, for only one pair, it is true that there are differences in the perception of the significance level of DISL implementation drivers due to the size of the enterprise. The analysis shows that Large Companies attach much more importance to the driver Improving the business benefits of the organisation than Micro and SMEs. In the case of the other deployment drivers, no statistically significant differences in their perception can be found. The above analysis shows that Hypothesis 3 has only partially been positively verified. It is possible to identify differences in the perception of drivers by companies due to their size, however, this hypothesis was confirmed for only one driver.

As in the case of drivers, a non-parametric Mann-Witney test was carried out, comparing the perception of barriers in pairs in relation to the size of the company. The test results are presented in Table 3.

Table 3. *The Mann-Whitney U test for the barriers variable in case of Size of the company*

Variable	The Mann-Whitney U test (with continuity correction) for the variable: Size of the company Marked results are significant with p <0,05000									
	Rang sum Micro, SMEs	Rang sum Large company	U	Z	p	Z corr.	p	No. of. Micro, SMEs	No. of Large company	Prob.
Implementation cost	725,00	550,00	297,00	0,205	0,837	0,213	0,832	28	22	0,839
Lack of know-how / intellectual capital	742,50	532,50	279,50	0,547	0,584	0,559	0,576	28	22	0,581
No technological support	720,00	555,00	302,00	0,107	0,914	0,110	0,912	28	22	0,915
Poor commitment of the top management	763,00	512,00	259,00	0,948	0,343	0,960	0,337	28	22	0,346
Resistance of employees to changes	836,00	439,00	186,00	2,375	0,018	2,406	0,016	28	22	0,017
Insufficient market pressure	757,00	518,00	265,00	0,831	0,406	0,846	0,397	28	22	0,410
There is no single framework to regulate implementation	758,50	516,50	263,50	0,860	0,390	0,883	0,377	28	22	0,388

Lack of standardization in the implementation of DISL solutions	744,50	530,50	277,50	0,586	0,558	0,598	0,550	28	22	0,554
Time needed to implement DISL solutions	679,50	595,50	273,50	-0,664	0,506	-0,677	0,498	28	22	0,504
No short-term benefits	689,00	586,00	283,00	-0,479	0,632	-0,485	0,628	28	22	0,635

Source: *Own study.*

As presented in Table 3, for only one pair, it is true that there are differences in the perception of the significance level of DISL implementation barriers due to the size of the enterprise. The analysis shows that Micro and SMEs attach much more importance to the Resistance of employees to changes than Large Companies. In the case of the remaining implementation barriers, no statistically significant differences in their perception can be found. The above analysis shows that Hypothesis number 4 was only partially positively verified. It is possible to identify differences in the perception of barriers by companies due to their size, however, this hypothesis was confirmed for only one barrier.

5. Conclusions

The purpose of this article was to conduct research to identify potential differences in the perception of drivers and barriers for implementing DISL in Polish enterprises. The ANOVA statistical analysis results showed that it is possible to indicate statistically significant differences for both these variables, which allowed the authors of this publication to make a gradation in terms of the significance of the perception of the drivers and barriers of DISL implementation presented in Figure 1.

The results confirmed that both Hypothesis 1 and 2 were positively verified. In the next step, a non-parametric analysis was performed using the Mann-Witney test to verify the hypotheses relating to the differences in the perception of both drivers and barriers due to the company's size. In the case of both variables, the results showed that it is possible to indicate only one driver and one barrier for which differences in perception due to the size of enterprises are identifiable.

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