
Technological Innovation and Risk in the Management of Integrated Supply Chains – A Survey Results

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Abstract:

Purpose: The purpose of this article was to attempt to characterise the degree of implementation and use of technological innovations in logistics companies and to determine their impact on risk factors, identification methods and tools for its minimisation.

Design/Methodology/Approach: The study used the desk research method of statistical data analysis, the comparative analysis method and the method of critical analysis of the subject literature. A survey technique was used to obtain primary data, the research tool of which was a research questionnaire distributed electronically (CASI) in the form of a survey questionnaire. The survey technique was complemented by the telephone interview method (CATI) and the face-to-face interview method (CAPI).

Findings: The results of the research carried out show that despite the occurrence of risk, companies decide to implement various types of innovations, especially those from the technological area. This is mainly due to fear for the future of the organisation connected with its development and the technological rush that is currently observed in the economic space. Despite the high risk involved in this type of investment, companies try to minimise the risk of failure, and the greatest concerns in their operation relate not so much to aspects of the internal environment as to the socio-economic situation of the world.

Practical Implications: Nowadays, in order for companies to implement innovative solutions in the technological area, they are obliged to provide access to their source and prepare information about existing solutions and possibilities of their use. The results of the survey confirm that for new ideas to bring the desired result, they must be carefully defined, analysed and adapted to the organisation's profile. Such activities are of particular importance when introducing innovations aimed at ensuring an appropriate level of process execution in integrated supply chains.

Originality/value: The obtained results lead to questions and discussion as to whether it is currently possible to "be" non-innovative in the technological field, and whether it is possible to avoid the risks associated with the implementation of innovative solutions? As the research results show, it is impossible.

Keywords: Innovation, risk management, supply chain innovation, technology.

JEL classification: O32, D81, O14, H54.

Paper Type: Research article.

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1. Introduction

The ongoing interaction between the dynamically changing environment and the organisation means that the effectiveness of the organisation is determined by the efficiency of its networked or integrated supply chain (Richardson *et al.*, 2021). The economic and political changes brought about by the COVID-19 pandemic and the global crisis mean that companies are no longer solely an individual economic system, but are components of the entire global economy. Such a situation decisively changes the principles of their operation in the ownership, organisational, technical-production and economic sphere. The global dynamisation of the environment and the increasing level of clients' requirements and preferences force companies to constantly seek new - innovative solutions which will ensure their competitiveness on the market and enable stable development.

Implementation of technological innovations influences the correct decision-making and selection of effective solutions in enterprises that will improve their operations. Most often companies decide to implement innovations in the area of technology and engineering through system applications supported by advanced computer tools. The application of such systems allows the revision of complex processes or behaviours in order to obtain optimal solutions, in which simulation plays an essential role (Xiang *et al.*, 2019).

Undoubtedly, with the emergence of increasingly complex and networked supply chains, the risks of managing them efficiently have increased (Baryannis *et al.*, 2019; Colicchia and Strozzi, 2012). Risk is a phenomenon that is often unavoidable, often very difficult to predict. An organisation's ignorance of the possibility of potential risks can contribute to its stagnation and, in extreme cases, to its bankruptcy. Therefore, from the point of view of the organisation, an important issue is the ability to effectively identify risks throughout the period of the company's existence on the market. In this situation, it is important to constantly control the logistics processes occurring within the integrated supply chain, so as not to lead to a reduction in the level of reliability of its operation and thus, the emergence of uncontrolled risk.

The main aim of the article was an attempt to characterise the implementation of technological innovations in logistic enterprises in the context of their influence on risk factors, methods of risk identification and tools for risk minimisation. The basis for the conclusion process was a review of English literature and Own study conducted in a group of logistic enterprises operating in the region of Łódź (łódzkie province, Poland). The considerations undertaken in the study and the conclusions from the research that constitute its value may contribute to the identification of key areas related to the implementation of technological innovations, which significantly reduce the occurrence of risk in the process of integrated supply chain management.

2. Technological Innovation in the Context of Risk Minimisation in Organisations - Theoretical Background

The notion of innovation in logistics is undoubtedly a contemporary topic in the canon of international research (Nilsson and Göransson, 2021). With reference to the contemporary management model, innovation activities are primarily those of the entire supply chain, encompassing all interactions between suppliers, manufacturers, distributors and clients (Yu *et al.*, 2019; Chieh-Yu, 2008). Innovation also means the way it is disseminated using a variety of market and non-market channels, from initial deployment to contact with different consumers, presence in different countries, regions, sectors or markets (Tanaka *et al.*, 2005).

Logistics companies, like industrial companies operating in volatile and unpredictable economic conditions, recognise that major competitive strategies based on low costs, product differentiation or specialisation depend primarily on their ability to innovate, i.e. the ability to create and implement innovations through the absorption of modern knowledge and information from the environment and the company's internal resources (Zhu *et al.*, 2019; Druehl *et al.*, 2018).

There are two main reasons why logistics companies use technological innovation. First, innovation adoption is important for the innovation system as a whole and involves the flow of knowledge from innovation creators to the companies adopting the innovation. Furthermore, the learning process during innovation can result in improvements to the innovation in question and the development of new products, processes and other innovations (Lee and Schmidt, 2017). Second, the main impact of innovation on business results from the diffusion of the original innovation to other companies (Tanaka *et al.*, 2005). Thus, the use of innovations may relate to modification of product offerings, market segmentation, economic efficiency, quality improvement, or learning capabilities (Liu *et al.*, 2021). Determining the source of companies' motivation to engage in innovation activities and its role, facilitates the examination of the drivers of innovation activities, such as the presence of strong competition or opportunities to enter new markets.

However, there are many risk factors that may hinder innovative activity. These include, economic factors, e.g., high costs, lack of demand, company-specific factors, e.g., lack of modern technology, tools, qualified staff or relevant know-how. Given the above rationale, the contemporary model of network linkages in the supply chain carries an increased risk of losing control over it (Afracz *et al.*, 2021). This is primarily due to the fact that the greater the diversity and complexity of the organisations that make up the modern supply chain, the higher the risk of losing continuity of its operation (Hotlan *et al.*, 2020). Therefore, an extremely important issue in ensuring the stability of a network supply chain is the flexible cooperation of all co-partners. Through cooperation, a synergistic effect is achieved manifested in numerous optimisations of logistics processes in supply chains (Adams *et al.*, 2015). These optimisations can be expressed through cost reductions, fast and client-

compatible planning, as well as the added value offered. Thus, the ability of companies to innovate technologically is the basis for the development of production, as well as becoming a major strength of their competitiveness (Du *et al.*, 2019).

Undoubtedly, the strengthening of the position of the client towards enterprises brought about by the progressive liberalisation and globalisation of the economy, requires changes to be made in the operation of enterprises, primarily in the organisation or management of supply chain flows. Companies need to integrate knowledge and information about clients and partners at all levels of the supply chain into one main base, which is necessary for the proper management of an integrated supply chain (Luthra *et al.*, 2016). Therefore, it is necessary to reorganise the entire unit and develop new methods and operating strategies focused on increasing innovation performance by applying research and development (R&D) investments, which are the main drivers of technological innovation (Zhang, 2021).

However, the application of technological innovation is not straightforward. This is due to the fact that the factors influencing the capacity for technological innovation are not the same for all companies and vary depending on the economic region in which the organisation operates. In global studies, one can encounter a twofold approach to the validity of the use of technological innovation. The main difference between researchers is determined by the factors influencing technological innovation. On the one hand, it is believed that the main stimulator of the application of technological innovation in companies is research and development (Alarcón and Sánchez, 2013), while on the other hand, the theory is postulated that the stimulators of organizational innovation are market uncertainty, company revenues, new product development or threats from competitors (Demirel and Mazzucato, 2012; Coad *et al.*, 2016). Therefore, it can be concluded that the application of technological innovation in companies is carried out in three areas:

- central, in the form of expenditure on R&D activities,
- internal, depending on the structure of the company (capital, scale of operations, ownership rights, etc.),
- external, in the form of foreign direct investment, strategic alliances, market conditions or government support (Zhang, 2021; Zhang and Lv, 2021).

It follows that the situation regarding the creation and implementation of innovative solutions of a technical and technological nature in the private sector is slightly different than in the public sector (Wirick, 2009). Investments related to the implementation of innovations of a technological nature are a long-lasting, laborious process and, in most cases, burdened with a high risk of failure, although on the subject of risk itself, companies perceive it very differently.

The concept of risk is described quite extensively in the literature as uncertainty in the prediction of future events, which may result from incompleteness and

inaccuracy of the available statistical data by which the future can be estimated. There can be measurable uncertainty (risk) and non-measurable uncertainty (uncertainty *sensu stricto*) (Knight, 2006). The distinction between these two phenomena is related to the possibility or otherwise of using statistical measures to help estimate risk (Manuj and Mentzer, 2008). Risky decision-making can involve loss as well as gain.

Thus, common to the definitions of risk and its estimation cited in the literature is that risk is unpredictable and always carries specific consequences (Dolgui *et al.*, 2018; Ho *et al.*, 2015). Therefore, its identification and analysis is such an important issue in the implementation of technological innovation.

Failure to identify risks associated with supply chain functionality carries enormous risks to the continuity of the entire organisation (Aloini *et al.*, 2012). Risk in a sustainable supply chain refers to a potential condition or event related to the continuity of the supply chain that may cause problems in identifying risks elsewhere in the supply chain, making the risk factors in Sustainable Supply Chain Management (SSCM) complex, potential and uncertain (Zhanga *et al.*, 2020). This means that in order to effectively manage the organisation and not suffer excessive losses due to the implementation of modern technological solutions, the risk management process itself in an integrated supply chain should be an ongoing process. The procedures created or ways of acting in a risk situation should be constantly updated and monitored in relation to changes occurring in the entire environment. For this purpose, companies use dedicated methods of risk identification, for which the key element is the information relevant to the business. Information obtained and transformed into knowledge, allows the company to make accurate, coordinated decisions, which have a major impact on minimising risk under conditions of uncertainty.

The basic and most commonly used method of risk identification is the analysis of data on the history of events occurring in the enterprise. Depending on the specifics, companies may use different risk identification methods. Among the most commonly used are (Hernadewita and Saleh, 2020): multi-criteria Analytic Hierarchy Process (AHP), Failure Mode and Effects Analysis (FMEA), Supply Chain Operation Reference-Model (SCOR), Preliminary Hazard Analysis (PHA) and Hazard and Operability Studies (HAZOP). In practice, it is most common to encounter a combination of the above methods, which are treated as complementary.

Depending on the type of enterprise or the economic sector in which it operates, the usefulness of a given method may vary. It is important that all employees of an enterprise should participate in the development of assumptions and application of a given method. Only such a combination of knowledge and experience allows the organisation to efficiently identify risks and make the right decisions to limit the negative effects of their impact.

3. Research Methodology

Nowadays, the market situation forces companies to implement and practically apply new solutions, especially in the technological area. This is dictated by the high degree of changeability not only of the environment, but above all of clients, including their requirements and expectations in relation to purchased products. Activities related to the use of innovative technologies and system solutions allow companies to reduce costs while maintaining a high level of quality of services. However, the use of innovation, especially in the technological area, is associated with the occurrence of potential risk. Therefore, the current market situation forces companies to identify, measure and minimize risks in the integrated supply chain. Activities associated with the use of modern methods of risk identification allow companies to reduce unpredictable risks while maintaining a high level of inventory flow in network supply chains.

This is also the case among logistics enterprises, which are somehow condemned to bear the risk, dictated by a large number and variability of factors occurring in the developing economy. It is particularly visible in the case of enterprises operating in the Łódź Province, which is perceived as a highly competitive and attractive investment area of Poland. The choice of the Łódź region, which is located in the centre of Poland and constitutes an area with a high intensity of logistic activity, is not accidental. This is mainly due to the fact that the specific features and location of the Łódź region, and in particular the conditions exemplified by, traditional know-how, access to specific natural resources, rapid growth in demand for specific goods or services, high human capital and educated staff, and specific knowledge, place this region among the top regions with high innovation potential in Poland.

The main objective of the research was an attempt to determine the level of implementation and application of technological innovations in logistics companies in the context of minimising risks associated with integrated supply chain management. Due to the increasing pressure of the environment, the main emphasis was placed on identifying areas where technological innovations were applied and the type of innovations implemented in the context of risk minimisation. In addition, the basic methods and risk factors were identified, which, in the perspective of the dynamization of the environment, enable companies to identify and control potential risks in business activities.

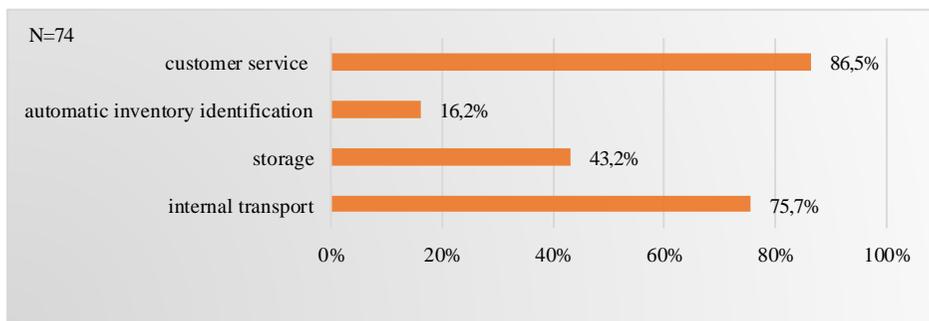
The sample for the research was purposive. A list of 132 logistic companies (transport, storage, forwarding) operating in the Łódź region was prepared on the basis of data obtained from public administration sources available on the Internet and from enterprises databases. After the formal and substantive verification 74 companies were qualified for the analysis. The survey was conducted among private enterprises belonging to the small and medium-sized enterprises (SMEs) sector, regardless of their capital and period of operation on the market.

The survey was conducted in 2020. The research used the desk research method of statistical data analysis, the method of comparative analysis and the method of critical analysis of the subject literature. The survey technique was used to obtain primary data, the research tool of which was a research questionnaire distributed electronically (Computer Assisted Self-Interviewing, CASI) in the form of a survey questionnaire. The survey technique was complemented by Computer-Assisted Telephone Interviewing (CATI) and Computer Aided Personal Interview (CAPI) methods.

4. Research Results

Taking into account the current development of logistics enterprises, firstly, areas were identified where companies apply technological innovations to minimise the risk of losing market position or reducing revenues. In business practice, the basic areas in which technological innovations are applied include: the area of internal transport, the area of warehousing, the area of automatic inventory identification and the widely defined area of client service.

Figure 1. Areas of technological innovation implementation in a logistics enterprise



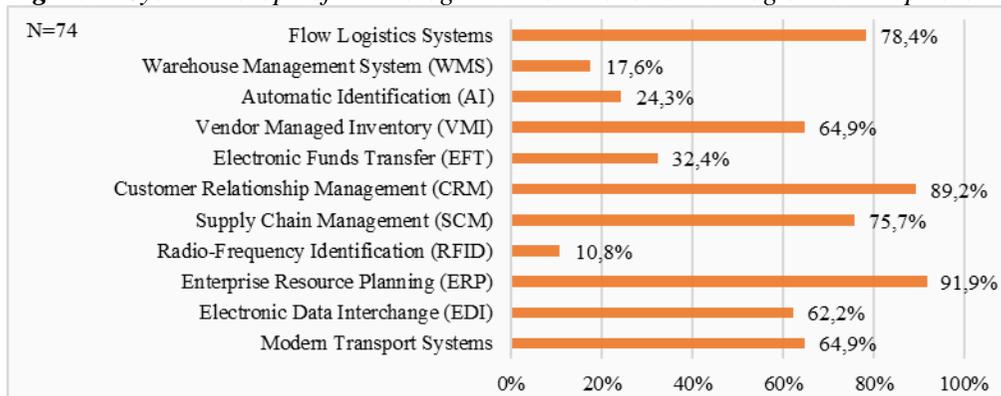
Source: Own study based on research.

In the surveyed group of logistics enterprises, the area with the greatest potential for innovation was the area of client service together with client relationship management (CRM) systems used for its professionalisation (Figure 1). This answer was indicated by more than 85% of the respondents. Over $\frac{2}{3}$ of enterprises representing this industry indicated that a high percentage of innovation is implemented in internal transport in the form of modern transport systems and modern forklift trucks. On the other hand, the lowest percentage of innovations was used by the surveyed enterprises in the area of automatic inventory identification - such activities were declared by slightly more than $\frac{1}{4}$ of the surveyed. This is probably due to the technological immaturity of enterprises, especially in the area of identification of stored stocks or using only simple scanning solutions based on Excel sheets. Often the barrier to the use of advanced technologies for stock identification in the warehouse is the system itself, which has functionalities not

adjusted to the process realities, as well as insufficient understanding of its assumptions by the users.

Far-reaching globalisation processes and very fast technological progress force companies to implement more and more innovative solutions in order to achieve, at least for a short period of time, a competitive advantage. The same is happening in logistics companies, which have started to treat innovation as a basis for development and growth of the entire supply chain. From the perspective of the internationalisation of the economy, the use of innovative technological solutions enables them to compete and optimise their operations in dynamically changing markets (Figure 2).

Figure 2. Systemic scope of technological innovations used in logistics enterprises



Source: Own study based on research.

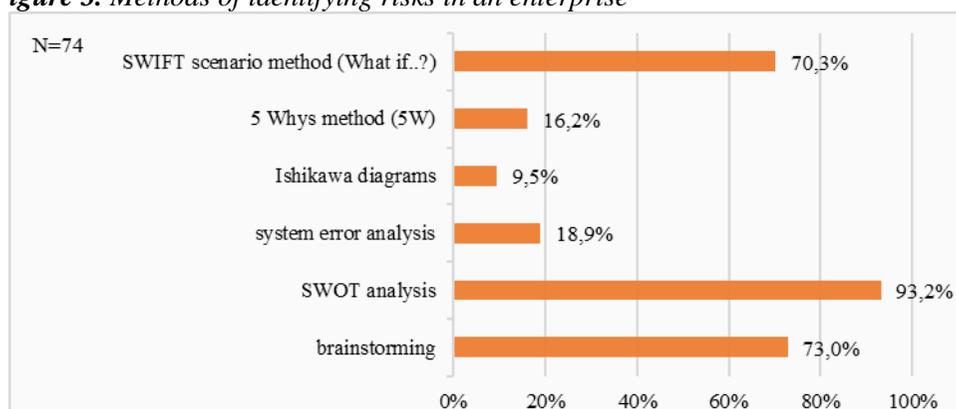
Innovative systems related to integrated supply chain activities, indicated by almost the majority of respondents, include mainly IT systems responsible for collecting and managing databases (Enterprise Resource Planning, ERP) and related Client Relationship Management (CRM) systems. This is understandable in the case of logistics companies, whose priority in their service activities is client loyalty and providing them with above-average added value. Next, more than $\frac{2}{3}$ respondents indicated that Flow Logistics systems and related Supply Chain Management (SCM) systems are a source of innovation for their companies.

This is probably due to the fact that the use of Flow Logistics in the area of distribution and the entire supply chain ensures high throughput of cargo, which in turn determines its higher efficiency and effectiveness, while eliminating unnecessary costs and accelerating response to client needs. The lowest percentage, more than 10% of companies, decided to implement RFID (Radio-Frequency Identification) automatic inventory identification systems as part of their technological innovations. In spite of the fact that RFID technology, next to

traditional barcodes, is focused in the common GS1 standard, barcodes are still cheaper in use, which limits the use of RFID technology.

An essential component for improving integrated supply chain management processes is the identification of potential risks, which has a significant impact on controlling and managing business risks. In order to manage risks effectively, it is first necessary to identify methods for risk identification (Figure 3). Effective risk identification influences the speed and accuracy of decisions, which in turn translates into the degree of development and operation of the organisation in its environment.

Figure 3. *Methods of identifying risks in an enterprise*



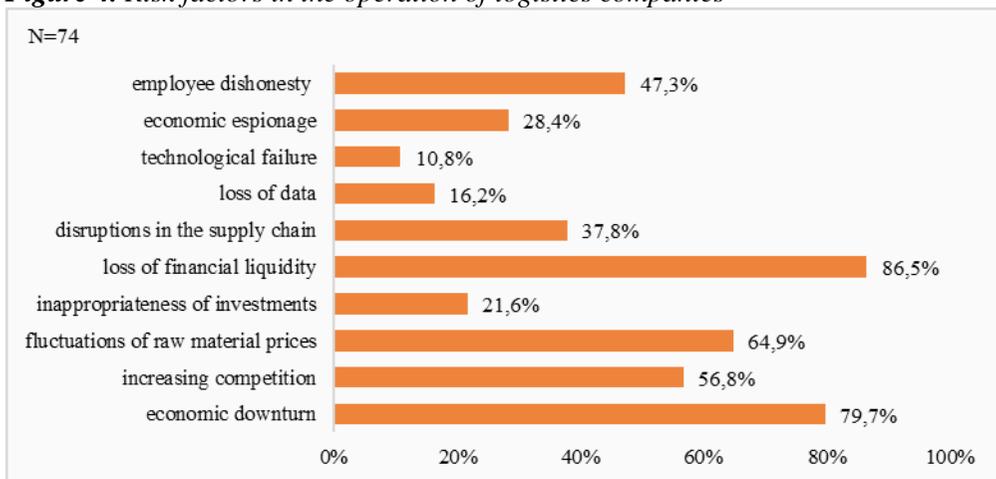
Source: Own study based on research.

The most popular method of risk identification among the surveyed companies (over 90%) is the SWOT analysis. This method, thanks to its universality, allows you to determine the factors that make up the strength or weakness of the company and indicate the opportunities and threats coming from outside. The choice of this method may result from the fact that the know-how built over many years of the organisation's operation on the market allows it to accurately perceive the future and market trends and to predict the direction of changes in the environment.

Other techniques and methods that were important to over 70% of the companies surveyed were the SWIFT scenario technique (structured "what if?" technique) and the brainstorming method. They are similar to the analysis of the organisation's experience and are based on the identification of potential deviations from design assumptions and procedures and the estimation of the impact of risks and potential threats in the organisation. It is worth noting that few companies, only nearly 10%, use the Ishikawa diagram when identifying risks. This may be due to the fact that a common problem encountered when constructing the Ishikawa diagram is the difficulty in classifying individual causes into appropriate groups or subgroups of the organisation. This method also has the disadvantage of not being transparent when analysing complex problems.

Integrated supply chain management carries a high risk associated with the implementation of modern solutions. This is due to the fact that such solutions are costly and require adaptation of the entire organisation to be effective. Undoubtedly, the environment in which the organisation operates and the nature of its activities are of great importance for the selection of an appropriate concept to minimise the risk in individual organisations. Identification of key risk factors related to the implementation of innovative solutions (Figure 4) is the basis for its minimisation. Most of the risk factors are beyond the control of the companies, while others are trying to influence them in such a way as to minimise as much as possible their negative impact on their activities and the flow of resources.

Figure 4. Risk factors in the operation of logistics companies



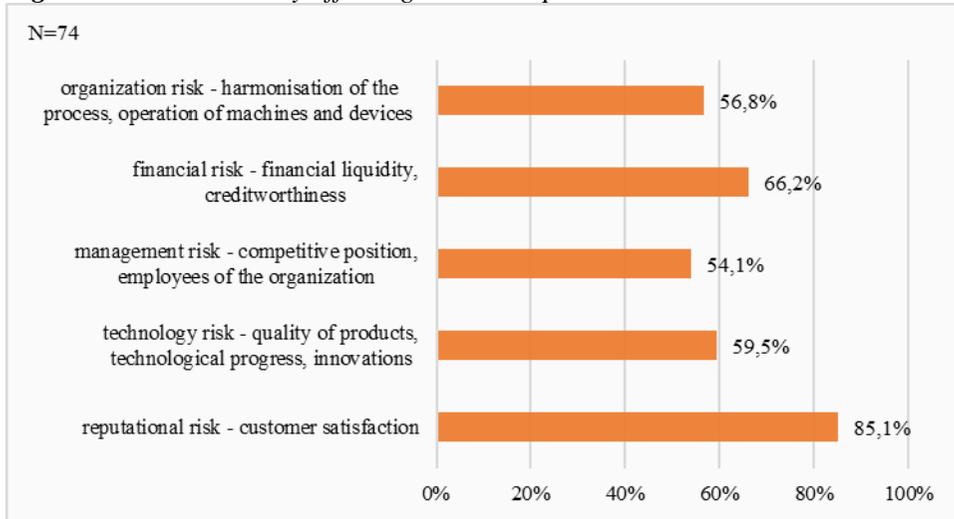
Source: Own study based on research.

For the vast majority of respondents (over 85%), the greatest risk of failure in implementing and applying innovative solutions in the organisation is the loss of financial liquidity caused, among other things, by the economic downturn. Undoubtedly, this fear has a real justification in the current situation of the COVID-19 pandemic, when many companies went bankrupt as a result of lockdown or reduced the level of investment due to a significant economic slowdown in many industries. Another group of risk factors related to difficulties in implementing new solutions, from the point of view of half of the surveyed enterprises, are fluctuations in global commodity prices, the emergence of new competition and employee dishonesty, fostering information trafficking or sabotaging the organisation's activities. The least, just over 10% of the surveyed companies fear technological failures as a risk factor limiting the possibility of implementing innovations

In the literature, there are a number of different divisions of risk, for which the criterion of their separation can be, the place of occurrence, the subject, the characteristics of the industry related to the operation of the company, etc. In this

research, due to the impact of risk on the continuity of process execution in integrated supply chains, it was divided into five categories: organisational risk, reputation risk, technology risk, management risk and financial risk (Figure 5).

Figure 5. Risks adversely affecting business operations



Source: Own study based on research.

The vast majority of enterprises surveyed (over 80%) considered that the most unfavourable type of risk that could arise in their organisation is the risk of loss of business reputation. This risk has a wide dimension, as it is not only reputation "in the eyes of clients", but also relations with business partners, suppliers, financial institutions, local authorities or society. It would be unfavourable for a company to be perceived by its environment in terms of the so-called, "black PR". In most cases, such a situation leads to a decrease in the company's profitability or even its liquidation. Other categories of risk are also extremely important for enterprises. All its types were indicated by the majority of respondents as undesirable phenomena in everyday operation.

5. Conclusions

Modern logistics companies, in order to compete in the market, must constantly and systematically engage in the process of improving flows in the supply chain, which involves successive assumption of various types of risk. Constant changes in the environment and increasing level of client requirements and preferences force companies to take more and more initiatives, especially in the area of implementing innovative technological solutions.

However, creating innovations is not as simple as it may seem. Creating innovations is a long and laborious process, requiring from creators a lot of patience and often

big money invested in research. It rarely happens that the creation of an innovation is the result of a "sudden flash of intelligence" of a researcher or scientist. As a rule, new innovations are created in large technology centres in research and development (R&D) departments, and then transferred to those organisations that need them. This undoubtedly entails a high risk of failure in the process of their implementation.

Often organisations decide to implement such solutions without making appropriate changes in the mentality of employees regarding the transformation of the organisation or the management is not involved in the process of their implementation. But is it possible nowadays to give up being non-innovative in the technological area without bearing the risk connected with the implementation of innovative solutions? Rather not. While in the first option it is the risk connected with innovativeness that determines the survival and development of the organisation, the second option causes the occurrence of risk as well, but connected with limiting the growth of the enterprise, often ending in its bankruptcy.

Organisations that do not take risks in their activities related to the implementation of new technological solutions, simply cease to exist. So, risk always exists. It is important that the risks taken are identified and controlled, and that decisions are well thought out and properly aligned with the functional capabilities of the business.

The above-mentioned assumptions are confirmed by the results of research, which show that despite the occurrence of risk, companies increasingly often decide to implement various types of innovation, especially those in the technological area. This is mainly due to concerns about the future of the organisation related to its development and the technological momentum that can currently be observed in the economic space. Despite the high risk involved in this type of investment, companies try to minimise the risk of failure, and the greatest concerns relate not so much to aspects of the internal environment as to the socio-economic situation of the world. The most important issue for companies is to be able to effectively and accurately identify potential risks and, based on their analysis, make decisions that will be most beneficial to the functionality of the organisation.

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