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MASTER'S THESIS

**COLD LOGISTICS RISK MANAGEMENT: THE CASE OF THE RUD
UKRAINE COMPANY**

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LIST OF ABBREVIATIONS

ATP - Agreement on the International Carriage of Perishable Foodstuffs
BPMN - Business Process Model and Notation
CMR - Convention on the Contract for the International Carriage of Goods by Road
DCFTA - Deep and Comprehensive Free Trade Area
EMS - European Modular System
EOQ – Economic Order Quantity
EORI - Economic Operators Registration and Identification
EPS - Expanded polystyrene foam
ERP - Enterprise resource planning
EU – European Union
FCR - Forwarder's Cargo Receipt
FRC - Refrigerated – Reinforced – Class C
HVAC - Heating, ventilation, and air conditioning
IoT - Internet of Things
ISO - International Organization for Standardization
JIS - Just in Sequence
JIT – Just in Time
KPI - Key performance indicators
LCL - Lower control limit
RFID – Radio Frequency Identification
RMD- Risk Management Department
UCL - Upper control limit
USB - Universal Serial Bus

1 INTRODUCTION

The activity of any enterprise is risky because the actions of participants in business relations in the conditions of existing market relations cannot be carried out with complete certainty. Therefore, it is important for each company to anticipate changes in factors and conditions that may have a significant impact on its functioning. In recent years, increased regulatory requirements have forced companies to invest significant resources in risk assessment and the implementation of control systems with strict oversight (Cervantes-Cabrera and del Carmen Briano-Turrent, 2018).

Organizations should implement risk management to improve decision-making, efficient information gathering and improve corporate governance. Risk management is a process that involves the identification, assessment, and management of risks that affect or may affect the operations of a business or project. Risk management can also contribute to the growth of companies (Hoyt and Liebenberg, 2011). The increasing complexity of supply chains increases the probability of their failure, thereby increasing the need for risk management (Sofyalıoğlu and Kartal, 2012).

The literature provides many examples of supply chain disruptions and uncertainty. Trkman and McCormack (2009) classified them as endogenous and exogenous uncertainty. Endogenous uncertainty means that the origin of risk and uncertainty lies within the supply chain, giving rise to potential alterations in the connections between the local firm and its suppliers. The primary forms of this uncertainty include market fluctuations and technological turbulence. Exogenous uncertainty means that the origin of risk arises outside the supply chain. They proposed categorizing these risks into two significant types: discrete events, such as terrorist attacks, contagious diseases, or workers' strikes, and ongoing risks like changes in inflation rates and consumer price indices. These disruptions can lead to interruptions in the flow of goods, services, funds, and information within the supply chain, thereby hindering its performance, justifying why supply chain risk management has become an important research topic (Hachicha and Elmsalmi, 2013).

In manufacturing companies, logistics processes—such as storage, warehousing, material handling, packaging, inventory management, transport, and information flow—operate as interconnected systems, where disruptions in one area can cause imbalances throughout the entire operation (Szymonik and Bielecki, 2015). Logistics-related risks in such organizations span operational, financial, and physical domains. Employees also play a crucial role in maintaining the continuity of these processes. As companies are increasingly required to adapt quickly, the importance of building resilient supply chains has become more evident, further emphasizing the complex risk environment faced by manufacturing firms managing their internal logistics (TeoLupus, n.d.).

As noted in the literature, sources of risk in logistics and transportation operations can arise from various factors. These include poor decision-making due to inaccurate, unreliable, or

insufficient information; failure to provide, misinterpret, or comply with the rules and procedures related to documentation and carrier obligations; as well as human, technical, or accidental factors (Christopher, 2016; Waters, 2011). In this context, transportation processes refer to the set of planning, execution, and control activities involved in the movement of goods, including documentation, compliance, handling, and coordination between stakeholders (Kersten et al., 2009).

To navigate the complex and often uncertain landscape of the logistics industry, companies must begin the process of identifying, assessing, and prioritizing potential risks (Hallikas et al., 2004). Cold Chain Logistics involves the controlled transportation of products to maintain specific temperature ranges during their journey from one location to another (point A to point B). Understanding these temperature ranges is crucial for effective Cold Chain Risk Management (Ding et al., 2023). However, ensuring compliance with storage conditions poses a significant challenge in cold logistics across the entire food supply chain. This requires an extensive network of cold warehouses, well-equipped transportation, and minimizing delays during the loading and unloading process (Wei, 2016). Seasonal temperature variations, especially during summer, intensify this challenge, increasing demand due to reduced product shelf life and necessitating additional resources for temperature maintenance, with some warehouses lacking equipment for operating in temperatures as high as +30°C.

In a broader organizational context, business process modeling, as identified by Kim and Kim (2007), serves as a valuable technique in the shipping and logistics sector. This method aids in visualizing and analyzing processes and workflows, facilitating the smoother flow of both goods and information across the supply chain. Through business process modeling, inefficiencies and areas of waste can be identified, leading to streamlined processes and improved overall organizational performance (Badura, 2014). This precise understanding of shipping and logistics processes empowers organizations to recognize bottlenecks and inefficiencies, ultimately enabling them to enhance operations and reduce costs.

Within organizational risk management, the concept of risk visualization involves a systematic effort to enhance the quality of risk communication throughout the entire risk management cycle. It employs interactive images, such as charts, conceptual diagrams, visual metaphors, and mapping techniques, to bolster understanding and facilitate the management of risks within specialized teams, management groups, or stakeholder circles. As the business environment continues to grow in complexity, recognizing the significance of visualizing risks becomes imperative for effective communication and decision-making processes (Eppler and Aeschimann, 2009).

The Rud UA company is the largest producer of ice cream in Ukraine and the largest producer of fermented milk products. In recent years, the company has successfully exported its products to almost 30 countries around the world. In my thesis, I will focus on

the supply chain of the company, from the moment it receives a request from a customer until the moment when goods reach their final destination in order to make an analysis of which part is more sensitive and subject to any risk. The main focus will be based on a European market and European clients with the use of road transportation.

The aim of the master's thesis is to present theoretical aspects of risk management based on the identification and analysis of risk factors in the company RUD UA, as well as the diagnosis of problems in the examined area. For a better immersion of the topic, I will make a business process model of the company's processes in order to identify bottlenecks or inefficiencies and to see how the performance can be improved if it's needed. My goal is to identify and assess risk in the transport process and based on that create a risk map in the transport process in order to see which identified risk has which effect like disastrous, serious, medium, small, or slight.

For the main goal and specific goals formulated in this way, based on the analysis of the literature on the subject, as well as practical experience and observations, a research problem was formulated as follows:

Research questions:

- What risk factors significantly impact the logistics and road transportation in the company RUD?
- What is the level of impact of risks?
- What are the possible ways of mitigation of the appeared risks?

2 THE COLD LOGISTICS AND THE COLD CHAIN

The cold chain is an essential component of the supply chain. Ensuring the safety and integrity of perishable items, ranging from fresh produce and pharmaceuticals to vaccines and seafood, is of utmost importance in their journey (Ceanu, 2024).

According to McCarty (2024), cold chain management involves the systematic maintenance of controlled temperatures throughout the supply chain for goods, especially perishable items like food, pharmaceuticals, and biologics, from their origin to the final destination. This encompasses a range of tasks aimed at safeguarding the quality, safety, and overall integrity of the products during the entire supply chain process. Cold chain logistics plays a crucial role in this management by overseeing the controlled transportation and storage of temperature-sensitive goods.

2.1 Overview of the cold logistics and cold chain

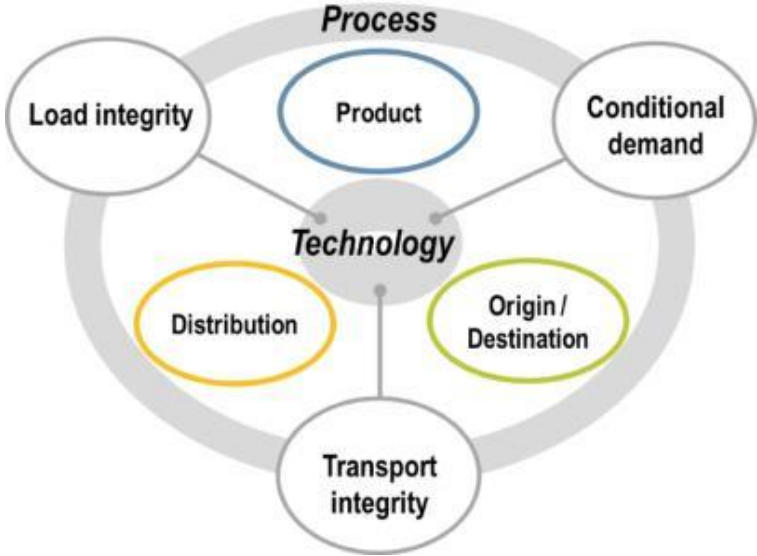
As was identified by Rodrigue and Notteboom (n.d.), the cold chain encompasses the conveyance of products sensitive to temperature changes across a supply chain using

thermal and refrigerated packaging techniques and logistical arrangements to safeguard the integrity of shipments.

The cold chain, a crucial component of modern supply chains, is pivotal in preserving the integrity and quality of temperature-sensitive products throughout their journey from production to consumption (Hundy et al., 2016). Cold logistics, encompasses the planning, coordination, and execution of temperature-controlled transportation and storage. The cold chain refers to a series of interconnected processes involving the transportation, storage, and distribution of products under controlled temperatures. This specialized logistics system is designed to ensure that goods, such as pharmaceuticals, food items, and chemicals, maintain their specified temperature range to prevent spoilage, degradation, or loss of efficacy (Payyoli, 2021).

The extent of this physical divide increases the likelihood of freight damage during the intricate transportation processes involved. Various goods are susceptible to damage from shocks or adverse temperature fluctuations. Perishable items, especially in the realm of food production, undergo chemical reactions that degrade their quality over time, with lower temperatures helping to mitigate this process. The efficient movement of shipments requires time and coordination, and any delays can have adverse effects, particularly for perishable cargo. Businesses in the food, pharmaceutical, and medical sectors are depending more and more on the cold chain as a safety measure against any deterioration or compromise throughout this transportation process (The Geography of Transport Systems, n.d.). A cold chain (as also shown in Figure 1) can be defined as the close interaction of three technologies: product, origin or destination and distribution.

Figure 1: Elements of the cold chain



Source: The Geography of Transport Systems (n.d.).

Product characteristics, such as perishability and fragility, necessitate specific temperature and humidity conditions during transport to maintain its physical attributes. The challenge lies in ensuring that the transport process does not compromise the product's value. Origin and destination refer to the locations of production and consumption. Advances in cold chain logistics enable the use of distant sourcing strategies, expanding globally. Distribution involves employing temperature-controlled containers, trucks, and warehousing facilities for transporting products in a controlled environment (The Geography of Transport Systems, n.d.).

Awan (2022), highlighted the following key elements of the cold chain: production, packaging, transportation, storage, and distribution. In the cold chain, production is the key element affecting the quality of products sensitive to temperature. Special equipment and a controlled environment are necessary for the production process. Synchronization with logistics ensures a seamless cold chain, minimizing delays and optimizing efficiency (Awan, 2022). Packaging as well as production plays a pivotal role in the cold chain, serving as a critical element for preserving the quality and integrity of temperature-sensitive products. Insulation, temperature protection, and precautions against external contaminants are all part of the rigorous criteria for cold chain packaging (Awan, 2022). Furthermore, refrigerated vehicles, containers, and air freight systems are critical components of cold chain logistics, necessitating accurate temperature control and monitoring. The selection of transportation options and routing optimization are crucial in preserving the integrity of perishable items during transit (Awan, 2022). In addition, storage is a critical component of the cold chain. It ensures the quality and safety of temperature-sensitive items. Cold storage facilities should be developed with accurate temperature and humidity controls to provide the best conditions for perishable items. Insulation, refrigeration systems, and backup power solutions are critical requirements for cold storage to ensure ongoing operations (Awan, 2022).

The coordination between distribution and other stages, such as production and transportation, is essential for maintaining the integrity of the cold chain. Distribution networks must abide by stringent temperature controls and monitoring to prevent deviations that could compromise product quality. Timely and precise deliveries, aligned with demand forecasts, contribute to minimizing the time products spend in transit and storage. The efficiency of distribution processes is paramount in ensuring the availability of high-quality perishable goods for consumers, highlighting the intricate dynamics within the cold chain (Awan, 2022).

Awan (2023a), pointed out the industries where the cold chain is applicable. In his article, the author mentioned industries such as pharmaceuticals, beverages, and food. In specified industries goods that are sensitive to temperature must be moved across the supply chain while keeping their temperature range. There are different types of cold chains. Each has its applications and requirements. The key characteristics of these cold chain types are summarized in Table 1.

Table 1: Types of cold chain and their features

Type of a cold chain	Features
Food cold chain	Maintaining the integrity of perishable items such as fresh fruits and vegetables, meat, dairy products, and frozen foods is of utmost importance in the food and beverage sector. The optimal temperature for preserving fresh produce varies according to the specific item. <ul style="list-style-type: none"> – Fruits and vegetables - between 0°C and 5°C – Meat, dairy, and seafood - between 0°C and 5°C – Frozen food products - lower than -18°C.
Blood cold chain	Biological products like blood derivatives and insulin need to be stored and transported within the temperature range of 2°C to 8°C
Pharmaceutical cold chain	Vaccine, temperature range for transportation and storage between 2°C and 8°C.

Source: adapted from Awan (2023a).

2.2 Logistics and cold chain relationship

"Cold logistics" and "cold chain" are related terms, but they apply to significantly distinct parts of the transportation and storage of temperature-sensitive items, particularly those that require refrigeration or controlled temperatures. As Hundy et al. (2016) identified, the cold chain is a broader concept that encompasses the entire process of handling, storing, and transporting goods that are temperature-sensitive. It includes all stages, from the initial production or manufacturing of the goods to their distribution, retailing, and ultimately reaching the end consumer. The goal of the cold chain is to maintain a consistent and controlled temperature environment to preserve the quality, safety, and efficacy of the products.

Cold logistics specifically focuses on the planning, implementation, and management of the transportation and storage of temperature-sensitive goods. It is a subset of logistics that deals specifically with the challenges and requirements associated with maintaining a cold chain (Pavlenko, 2022).

In the cold chain, logistics places a crucial focus on maintaining temperature control and continuous monitoring across the entire supply chain. This logistical process demands careful planning for specified temperature ranges throughout transportation, storage, and distribution. This requires the usage of refrigeration technologies, real-time monitoring systems, and adherence to stringent quality standards (Couriers, 2023). The initial stage in achieving efficient cold chain management is temperature monitoring. To reduce the risk of temperature fluctuations during transportation, carriers employ straightforward methods such as assessing the potential risks along standard routes to determine the safest alternative (Roambee, n.d.). Among the prevalent and successful temperature-tracking solutions for cold chains are (Roambee, n.d.):

- Infrared Thermometers – enables users from a distance to scan shipments and gauge the temperature at the surface.
- Wired Digital Thermometers - sensors are strategically positioned in the cold storage area and connected to a monitoring/logging device via wiring. This setup is typically employed for overseeing extremely cold environments, such as deep freeze or frozen shipments, where conventional temperature loggers may not endure the harsh conditions.
- Temperature Data Loggers - typically, they form an integral part of the cold chain during shipment. Temperature data loggers are often categorized as:
 - Passive Temperature Loggers - Devices powered by batteries that systematically record temperature data at predetermined intervals. The collected data can be downloaded for analysis through (USB) - Universal Serial Bus.
 - Wireless Temperature Loggers – Bluetooth or (RFID) - Radio-frequency identification, temperature sensors that measure and record temperature information.

Traceability is a critical component of managing perishable products in the cold chain, as it helps stakeholders to monitor product location, condition, and compliance with temperature standards throughout the supply process. In recent years, digital solutions such as blockchain have become increasingly popular to improve transparency and trust in food logistics. For instance, Walmart, in collaboration with IBM, has implemented blockchain technology to enhance traceability of fresh produce from farm to retail. This innovation has substantially reduced the time required to trace the origin of a product—from several days to seconds (IBM, 2023). In addition to improving recall efficiency and food safety, the system facilitates real-time information sharing among supply chain stakeholders. The adoption of comparable blockchain-based traceability solutions could provide considerable benefits for exporters of perishable goods, such as ice cream or dairy products, from Ukraine to the European Union.

In cold chain operations, managing inventory effectively is crucial to avoid shortages. Logistics strategies must encompass accurate demand forecasting, optimized order quantities, and just-in-time principles to ensure that perishable products are efficiently managed at every stage of the supply chain (SalesBabu, n.d.).

Predicting consumer demand involves estimating the quantity of products or services likely to be bought, often with the help of analyzing quantitative data (Campbell, 2023). Effective inventory management is based on correct demand forecasting. To effectively plan inventory levels, cold chain operators need to understand consumer demand patterns, market trends, and seasonal fluctuations. When considering key factors, historical data, supplier and customer collaboration, and market research play an important role. Utilizing advanced analytics and machine learning algorithms is instrumental in analyzing extensive datasets and making precise predictions, thereby minimizing the risk of either overstocking or understocking inventory (Awan, 2023b).

Collaboration is crucial for efficient inventory management in cold chain operations. Establishing strong relationships with suppliers and customers fosters better communication, transparency, and coordination throughout the supply chain. The exchange of information concerning demand forecasts, inventory levels, and production schedules facilitates a more coordinated strategy for inventory management (Awan, 2023b).

Aligning production and delivery schedules with demand allows businesses to minimize lead times – the duration of time needed to complete a process/purchase order, from the beginning to the end, when it is delivered to the final customer (Mecalux, 2019), optimize stock levels and enhance order accuracy. To achieve a good balance, companies in the cold chain industry need to adopt inventory optimization techniques that allow them to find the right balance between cost efficiency, and product availability (Awan, 2023b).

In cold chain operations, inventory optimization techniques such as (JIT) – Just-In-Time inventory management, (EOQ) – Economic Order Quantity calculations, and analysis of the safety stock should be considered (Awan, 2023b).

(JIT) – Just in Time is an inventory management strategy that works on the principle of obtaining stocks as close as possible to the time of their use. By reducing extra inventory and storage expenses, JIT strives to increase operational efficiency and reduce waste (Adobe Communications Team, 2022).

In cold chain operations dealing with perishable products, JIT assumes a vital role in preserving product freshness and quality. Employing precise demand forecasting, collaborative planning with suppliers, and efficient logistics, businesses can ensure the timely arrival of inventory, mitigating the chances of surplus or stockouts. JIT's approach enables businesses to fine-tune their inventory levels, align with customer demand, and optimize cost-effectiveness (Awan, 2023b).

(EOQ) – Economic Order Quantity is the optimal quantity of units a company should purchase to meet demand while minimizing inventory costs such as shortage costs, holding costs, and order costs. EOQ estimates are especially useful in cold chain operations, where inventory carrying costs might be high due to temperature-controlled storage needs. Businesses can strike the appropriate balance and maximize their inventory levels while keeping expenses under control by taking factors such as storage costs, product shelf life, and transportation costs into account (Awan, 2023b).

Analysis of the safety stock refers to an additional quantity of a product stored in a warehouse to prevent situations of stockouts. It acts as a safeguard against fluctuations in demand, providing a buffer to ensure that there is sufficient inventory available even when demand unexpectedly rises or supply chain disruptions occur (King, 2011). Ensuring the integrity of temperature-sensitive products is critical, particularly in situations where unforeseen events such as transportation delays or equipment failures could pose a threat. In this context, maintaining an adequate safety stock becomes indispensable to mitigate

potential risks and safeguard product quality. Through the analysis of historical demand patterns, lead times, and variability, businesses can accurately determine the required level of safety stock. This proactive approach helps mitigate risks and ensures the seamless continuity of operations, especially in contexts involving temperature-sensitive products (Awan, 2023b).

Efficient inventory management in cold chain operations relies on implementing inventory optimization techniques. Businesses can strike a balance between cost efficiency and product availability by adopting the EOQ model, just in time and performing an analysis of the safety stock (Awan, 2023b).

2.3 Specification of the cold logistics

Cold logistics, as a specialized branch of supply chain management, involves careful coordination and execution of processes to maintain the integrity of temperature-sensitive products, temperature requirements, cold storage facilities, packaging standards, and transportation equipment, outline are crucial to effectively managing perishable goods. A defining characteristic of cold logistics is compliance with certain temperature requirements (Steedman, 2022).

Different products have different temperature requirements for preservation, and logistics strategies must be adapted to this to ensure that these requirements are consistently met. The specification of temperature ranges and the deployment of advanced cooling technologies are of great importance to prevent spoilage, deterioration, or loss of product performance (Aung and Chang, 2014).

Deep freezing is a method in which food items are rapidly cooled by exposure to extremely low temperatures, typically between -30°C and -50°C . This process is essential for preserving food texture, nutritional value, and safety. Although the target storage temperature for frozen products such as ice cream is usually -18°C , the initial freezing process must be significantly colder to ensure the product's temperature is reduced quickly (CLASP, 2020). Industry leaders, such as Unilever, apply strict cold chain protocols to maintain optimal temperature conditions throughout production, storage, and distribution. For instance, Unilever employs digital tools and artificial intelligence to monitor and optimize its end-to-end ice cream supply chain, ensuring that products remain within strict temperature control from manufacturing to the point of sale (Unilever, 2025).

Table 2 shows the general product classification based on temperature requirements.

Table 2: Food categorization based on temperature

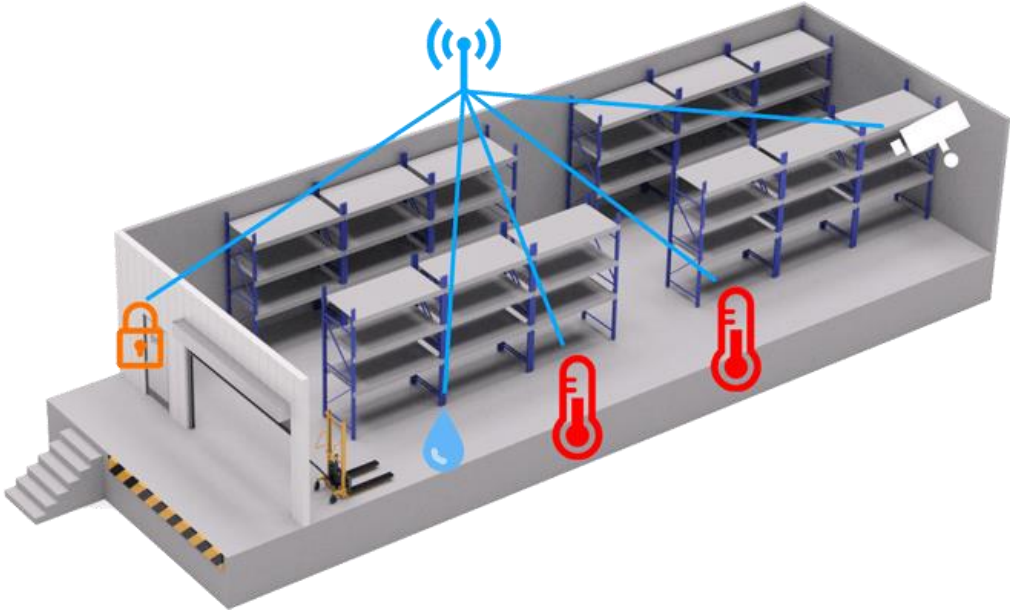
Required temperature	Type of product
Frozen (-18 °C)	Frozen meats, fish, frozen ingredients, ice cream
Chilled (0 -10 °C)	Fresh meats, milk, butter, fresh vegetables/fruits
Milled chilled (10-20°C)	Some milk products, chocolates
Normal (>20°C)	Oil, extracts, jams

Source: adapted from CLASP (2020).

Conger (2024), pointed out that cold storage facilities are key in the cold logistics infrastructure. He mentioned that to preserve the shelf life, integrity, and quality of perishable products, like food or medicines, a cold storage warehouse should be used to keep them in a particular temperature range. Cold storage is essential for preserving the integrity of any product or item that is sensitive to low temperatures.

(HVAC) - Heating, ventilation, and air conditioning cooling systems can be employed in the cold warehouse in conjunction with insulation to keep temperatures lower. Temperature regulation and air quality management, including humidity, filtration, and air flow, are the key functions of HVAC systems (Sheldon, 2021). In addition, sensors for humidity and temperature control can be used in cold warehouses, as shown in Figure 2.

Figure 2: Temperature monitoring sensor in the warehouse



Source: AKCP (n.d.).

APA Engineering (n.d.) justifies that the specification of packaging standards is critical in safeguarding products during storage and transportation. Packaging materials must have strong insulation and protection against temperature fluctuation, moisture and external

affection. Compliance with international packaging standards ensures the reliability of the cold chain and prevents product deterioration. (ISO) - International Organization for Standardization, standards are globally accepted requirements for products, services, and systems. They are implemented to ensure quality, safety, and efficiency, making them crucial to the packaging business. ISO 9001 holds significant importance as a quality management standard for numerous businesses. In the context of packaging manufacturers, it serves as a distinct indication to customers that the company is capable of producing packaging of ISO-quality standards. This certification signifies that the company operates a comprehensive and integrated quality management system (Clifton, 2019).

The packaging for frozen products, such as ice cream, should include thermal insulation and sufficient refrigerants to consistently sustain a product temperature of -18 °C or lower. Insulated shipping boxes are essential, as they minimize heat exchange between the external environment and the product. Expanded polystyrene (EPS) foam is commonly used due to its strong thermal insulation properties. In many cold chain applications, dry ice remains a relevant and widely used refrigerant due to its ability to maintain extremely low temperatures and its sublimation properties, which eliminate residual liquid. It typically provides sufficient cooling for the expected in-transit period and may offer an additional 24 hours of protection in case of delays. However, due to safety and handling concerns, some carriers or regions may limit its use, prompting the consideration of alternative refrigerants such as gel packs or phase change materials, depending on shipment duration and conditions (Insulated Products Corporation, n.d.).

Refrigerated trucks are an essential mode of transport for cold chain logistics. The choice of transportation equipment directly influences the efficacy of the cold chain (S&A Refrigerated Truck, n.d.).

For perishable or temperature-sensitive goods, the shipper should specify transport temperature. The documentation should include set-point temperature, (UCL) - upper control limit, and (LCL) - lower control limit which are used to determine the appropriate temperature zone and minimum/maximum safe levels for the product (International Refrigerated Transportation Association, 2017).

2.4 Global cold chain management

Cold chain management requires consideration of diverse environments, cultural differences, and the intricacies of international logistics. The following key elements of global cold chain management should be considered: cross-border regulatory compliance, cultural and language considerations, global transportation networks, risk management strategies, and collaboration and coordination across borders (Wood, 2023).

Managing global cold chains involves strategically planning, executing, and overseeing the efficient and effective movement and storage of perishable goods, along with associated

services and information, from various points of origin to production facilities, distribution centers, and consumption points, to satisfy global customer needs. This process entails the integration of existing business activities, encompassing specialized measures for preserving perishable goods throughout the value chains. This integration accommodates scenarios where additional suppliers of specific raw materials or more production cells for certain semi-finished products are involved, all with the overarching goal of creating value for the end user (Baldiwala, 2001).

One of the main challenges in global cold chain management is navigating the varied regulatory landscapes across different countries. Each nation may have its standards and requirements regarding the transportation, storage, and handling of temperature-sensitive products. Successful global cold chain management necessitates a deep understanding of international regulations, harmonization efforts, and the implementation of compliance strategies that ensure adherence to local and global standards (Wood, 2023).

The term "cross-border compliance" describes the observance of laws, rules, and guidelines that are relevant to doing business across international borders. The purpose of cross-border compliance is to reduce risks, ensure ethical standards, and safeguard a company's reputation in the global marketplace. Cross-border compliance can bring business opportunities for a competitive advantage, operational efficiency, and global reputation. Being able to prove that your business is compliant can provide an advantage over competitors. It has the potential to attract partners, investors, and clients who respect ethical business conduct. Streamlining international compliance procedures can result in increased operational effectiveness. Standardized processes, centralized compliance teams, and technological solutions can all help achieve this (Wood, 2023).

In the context of exporting from Ukraine to the European Union, cross-border compliance also involves a series of concrete legal, logistical, and documentation requirements. Exporters must prepare essential documentation such as the EX-1 export declaration, commercial invoices, and packing lists and obtain an Economic Operators Registration and Identification (EORI) number to engage with the EU customs system (European Commission, 2024). Furthermore, compliance with EU product standards is essential. Exporters from Ukraine can also benefit from the preferential tariff regime under the EU–Ukraine Deep and Comprehensive Free Trade Area (DCFTA), provided that the goods meet the rules of origin requirements and are accompanied by proof of origin, such as the EUR.1 certificate (European Commission, 2023). When it comes to the transportation of goods, specific documents such as the CMR waybill are required for international road freight (UNECE, 2023).

Cultural and language diversity creates additional challenges in global cold chain management. Effective communication and collaboration among stakeholders from different cultural backgrounds are imperative for seamless operations. Challenges that may occur are a breakdown of communication, lack of trust, variation in a time zone, and

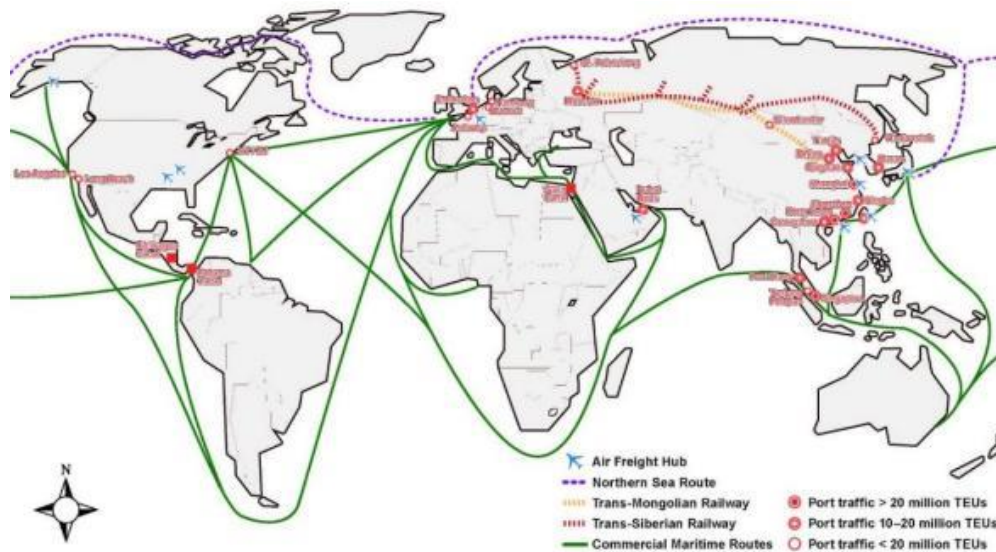
differences in business norms. Due to differences in communication style and languages, communication breakdown may be considered the most significant challenge. Successful business partnerships are built on trust. Cultural differences can cause misunderstandings and a lack of trust between stakeholders, which can affect collaboration, willingness to disclose important information, and decision-making. Global supply chains frequently cut across several time zones. With large time disparities, it can be difficult to plan meetings, coordinate activities, and respond quickly to emergencies. Every culture has its conventions around business conduct, manners, and expectations (Sharma, 2023).

However, these obstacles can be successfully overcome with proper preparation, an open mind, and applying the right tactics. Businesses may overcome obstacles and capitalize on the advantages that global collaborations offer to their supply chain operations by cultivating an atmosphere of comprehension, empathy, and good communication. International supply chains can become more effective, robust, and successful with a peaceful attitude toward cross-cultural cooperation (Sharma, 2023).

The expansiveness of global supply chains demands a robust transportation infrastructure. Global cold chain management requires strategic planning for selecting transportation modes, optimizing shipping routes, and using intermodal solutions to ensure the timely and reliable movement of temperature-sensitive goods (Medium, 2023). Crainic and Kim (2007), defined intramodality as the usage of more than one type of transport during one delivery.

Rodrigue and Ducruet (n.d.) highlights that transport networks are constantly expanding, and this requires the modernization of the infrastructure to cope with the changes. Seaports and airports are being expanded, transported, or relocated. Air transport is integrated with road or rail transport using a multimodal transport system. The maritime transport network is also being modified by expanding the Suez and Panama Canal. There is development of internal corridors and increased traffic on inland waterways. These global advancements in transport infrastructure are shown in Figure 3, which highlights new routes such as the Northern Sea Route, and an alternative waterway such as the Nicaragua Canal. These developments signify strategic initiatives to create alternative pathways for maritime transportation, offering new options and potentially impacting global trade routes (Mangan and Lalwani, 2016).

Figure 3: Global transport network



Source: Open Library (n.d.).

Global cold chain management involves an identification and mitigation of risks associated with international trade, geopolitical factors, and unforeseen events such as pandemics or natural disasters. To develop risk management strategies is essential to the cold chain resilience and to guarantee the supply chain continuation in the face of disruptions. For cold chain transportation and risk mitigation, the following strategies might be considered for usage (Adapt Ideations, 2023):

- The implementation of advanced technology to cope with the complexity of the supply chain. The application of a cold chain monitoring system can enable proactive risk management by temperature detection and monitoring, following the real-time location of the goods, constant data collection, and access to the cloud-based platform.
- (IoT) - Internet of Things solutions for proper temperature management. For temperature-sensitive products, it is crucial to have constant access to temperature indicators during the entire supply chain. With IoT technologies suppliers will be able to receive an instant notification in case of any changes in product temperature, and have access to individual temperature parameters. For rapid risk mitigation and proactive decisions, real-time data monitoring will enable this.
- For minimization of unexpected equipment failure, guarantee accurate temperature settings, regular maintenance and inspection are required.
- For cold chain logistics, meeting quality control and regulatory standards is essential.
- In the cold chain disruptions, human mistakes play a significant factor. That's why for effective risk mitigation constant educational training should be provided.

Successful global cold chain management depends on effective collaboration and coordination among all stakeholders, including suppliers, manufacturers, distributors, and

regulatory authorities. For responsiveness and achieving end-to-end visibility, it is vital to establish global partnerships, implement real-time information-sharing technologies, and ensure non-technological factors such as clearly defined procedures, skilled personnel, and a culture of trust and accountability (Vela, 2023).

3 ROAD TRANSPORT

According to Rodrigue and Slack (n.d.), road transport means freight or passenger transportation by using cars, trucks, or buses through a prepared surface. Roads alongside rails are considered major forms of transport in terms of land travel.

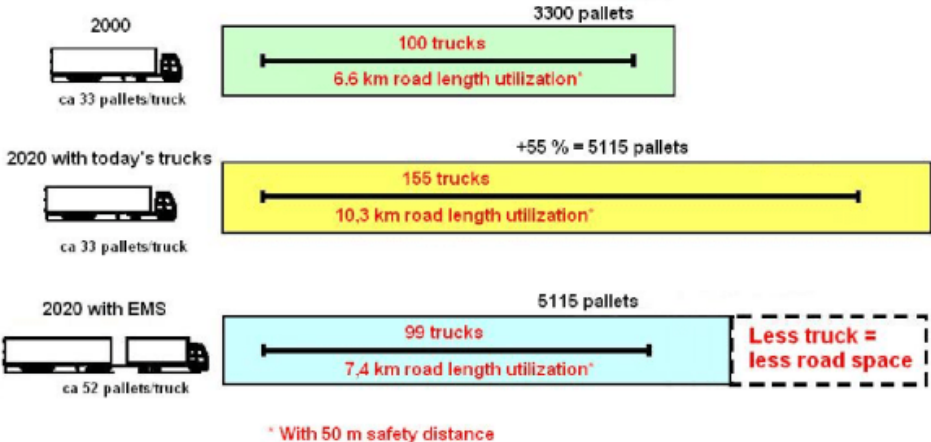
In 2050, freight traffic in Europe is expected to increase by 80% compared to the data in 2011, which will lead to an increase in traffic jams and accidents (European Commission, 2011). Engström (2016), stated that highways are used for short and long-distance transport, especially at the beginning and end of multimodal transport (usage of several modes of transportation for cargo delivery) chains. Road freight transport should be reoriented to other modes of transport to ensure sustainable development. Achieving climate and transport policy goals requires a truly multimodal transport system. Trends such as population growth, globalization, urbanization, digitalization, and demographic change will increase the pressure on freight transport. To enhance the sustainability of the road freight transportation system, a more comprehensive understanding of the role of roads in goods distribution is required.

For at least a decade the main problems remain the same: the lack of drivers in Europe, the increase in costs related to the transportation of goods, the growth of traffic jams, as well as the increase in the level of greenhouse gas emissions. Road transport costs have increased in recent years due to wage increases, truck driver regulations, rising fuel prices, and road tolls. All this has an impact on the price of goods or raw materials and, in general, on the competitiveness of the industry. From an economic point of view, gradual increases in weight, size, and payload limits for trucks into legislation is one of the most effective and sustainable solutions (Confederation of European Paper Industries, 2013). An article by Raluca, (2024), in Politico magazine points out that the trucking industry requires a lot of paperwork and compliance with all regulatory requirements, which slows down operations and increases costs for companies. Digitization of all transport documents is an option to optimize processes, increase the competitiveness of the industry, and reduce the number of errors associated with it.

Figure 4 illustrates the impact of vehicle configuration on transport efficiency and road space usage over time. While it may initially appear to reflect improved utilization rates, the figure more accurately highlights how the adoption of longer and higher-capacity vehicles—such as those used in the European Modular System (EMS)—can lead to more efficient freight transport. In 2000 and 2020, standard trucks carrying approximately 33

pallets each were required to move increasing volumes of goods, resulting in greater road length utilization. In contrast, EMS vehicles introduced in 2020, with a capacity of around 52 pallets per truck, significantly reduced the number of trucks needed and the total space occupied on the road—despite transporting the same volume. This difference underscores the relevance of enabling longer and heavier vehicles across the EU road network. Addressing regulatory limitations, such as inconsistent weight restrictions among Member States, and allowing higher payloads can support more efficient logistics. Wider use of EMS has the potential not only to reduce congestion and optimize operational costs but also to contribute to lower emissions and improved competitiveness in the freight sector (Confederation of European Paper Industries, 2013; Larrodé & Muerza, 2021).

Figure 4: Implementation of the European Modular System, an example of Volvo Trucks



Source: Akerman and Jonsson (2007).

The use of the European Modular System (EMS) has the potential to have a positive impact on overall freight transport. Improved truck efficiency will increase competition in the road transport sector and stimulate innovation in other modes of transport, such as rail, leading to benefits for consumers (ACEA, 2013).

3.1 The role of transport in logistics

According to Yue and Tseng (2005), the transport system is considered one of the most important economic activities among all logistics system components. The authors analyzed that the company's costs for transportation make up one-third of all costs. To satisfy the customer's requirements and ensure that the goods are sent at the right time and to the right place, the company must develop a transport system management. This approach establishes a bridge between producers and consumers, resulting in greater efficiency. It follows that transport is the basis of economy and efficiency in logistics and also expands other functions of the logistics system. In addition, the company's competitiveness increases with the help of a good transport system.

The logistics and transportation industry plays an important role in the global economy by moving products and goods globally. The term customs is used to describe the regulations and procedures that control the transfer of goods between countries (Kumar, 2023).

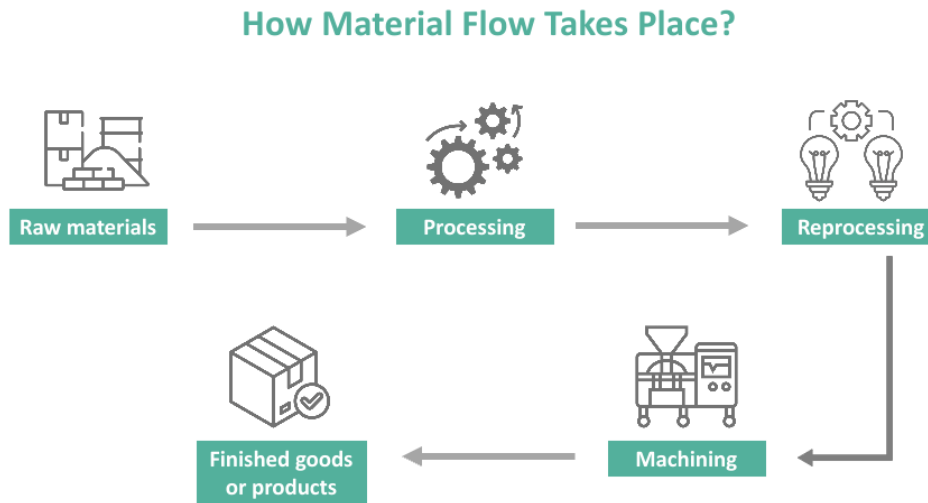
Due to the ongoing war in Ukraine, the European Union has introduced several temporary measures to facilitate the import of goods from Ukraine. The following key rules are important for the transportation of goods from Ukraine to the countries of the European Union (Gozzi, 2024; Ministry of Economy of Ukraine, 2024; Wisdorff, 2023):

- At the moment, customs duties and quotas are suspended. All import quotas and duties on most goods from Ukraine have been temporarily abolished by the European Union, thus the customs clearance process and costs for Ukrainian businesses have been reduced. Due to the above information on simplified customs procedures, clearance time and documentation requirements are reduced.
- The goods must meet the requirements of the European Union regarding the origin, for the temporary duty-free regime. The confirmation may contain information that these goods are sufficiently processed and completely manufactured on the territory of Ukraine.
- Safety standards and product protection must be appropriate for all goods that cross the border with Ukraine and (EU) – European Union countries. This includes requirements for packaging, product labeling, and conformity assessment for the product being transported. Depending on the type of goods sent for import, specific requirements may differ.
- Additional considerations to take into account are logistics routes and cargo insurance. Due to war, traditional logistics routes may be disrupted. Adequate insurance covering the protection of goods during transportation is essential.
- In 2024, a month-long protest by European farmers took place due to the duty-free import of Ukrainian grain products. The conflict arose due to the complaints of European farmers regarding the inconsistency in the quality standards of Ukrainian agricultural crops and the overflowing of the European market with these products. Because of this, the European Commission proposed to reimpose restrictions on such Ukrainian products as eggs, oats, and sugar. All other products, including barley and wheat, will remain duty-free for Ukrainian exports until June 2025. The introduction of duty-free imports took place as a sign of support for Ukraine after the full-scale invasion of Russia.

3.2 Material flow as the main subject of logistics

Material flow is a sequential process. This process describes the path of raw materials, from the moment of their extraction and processing to the final product and delivery to the consumer (Jayachandran, 2023). This process is illustrated in Figure 5, which represents the material flows.

Figure 5: The material flows



Source: Jayachandran (2023).

As described by Vis Table (n.d.), the material flow can be external and internal/in-house. External material flow can be referred to as the movement of materials, goods, or products between different entities or organizations in a supply chain. This movement is between suppliers, manufacturers, distributors, retailers, and the end consumers. Examples of external material flow are the transportation of raw materials from suppliers to manufacturers, the distribution of finished products from manufacturers to retailers, and the delivery of products from retailers to customers. Various transportation modes such as trucks, ships, trains, and planes are often used in external material flow.

Meanwhile, internal material flow means the movement of materials, goods, or products within a single organization or facility. These movements take place at a manufacturing plant, warehouse, or distribution center. An example of internal flow is the movement of raw materials within a manufacturing facility, the transfer of work-in-progress inventory between different stages of production, and the handling of finished goods within a warehouse before they are shipped to customers (Vis Table, n.d.).

Material flow is traditionally understood as a linear, sequential process describing the movement of raw materials from extraction and processing to the final product and its delivery to the consumer (Jayachandran, 2023). However, this linear perspective does not account for sustainable practices such as reuse, recycling, or remanufacturing.

To address this limitation, the concept of a closed-loop material flow—also known as a cradle-to-cradle system—has been introduced. This model emphasizes the circularity of resources, whereby products are designed for reuse, recycling, or safe reintegration into the environment. As illustrated in Figure 6, the cradle-to-cradle framework promotes a circular economy that minimizes waste, optimizes resource use, and fosters environmental

sustainability by returning materials back into the production cycle rather than disposing of them after consumption (Jensen et al., 2024).

This shift towards circularity plays a crucial role in modern supply chains. It not only reduces dependency on virgin raw materials but also aligns with environmental policies and increasing consumer demands for sustainable products. Integrating circular economy principles is becoming a competitive advantage for manufacturers and exporters, especially in international contexts such as exports from Ukraine to the European Union.

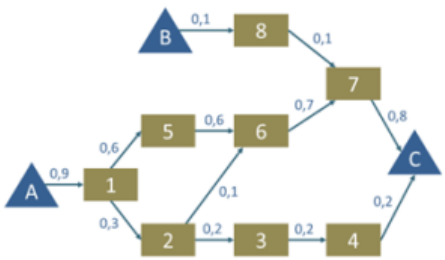
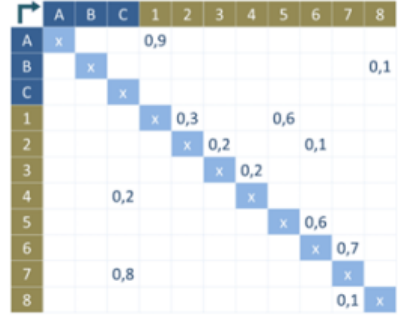
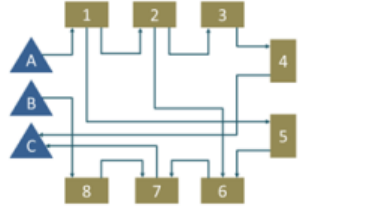
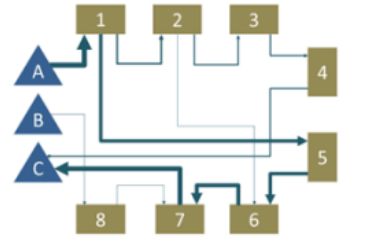
Figure 6: Circular economy and cradle-to-cradle process



Source: Adapted from Jensen et al. (2024).

For a stable and effective material flow, it is necessary to carry out a comprehensive analysis of material flows. The analysis should cover all transport and warehouse processes. Visual representation of material flow is a keyway of successfully understanding the process of flow. There are several options, depending on the task definition, of how to make visualization. The different methods for representing material flow are summarized in Table 3.

Table 3: Representation of the material flow

Name and description of the method	Visual representation of the method
<p>Process Graph</p> <p>A process graph is the simplest way to display the flow of materials. It is usually very quick and easy to perform. If you divide the material flow by-products or production departments, the efficiency of this process graph will be much higher. After all, the main role of the process graph is to present a formal model.</p>	<p>The Process Graph</p> 
<p>Transport matrix</p> <p>The next visualization method is the transport matrix. Representation of material flow using this kind of visualization is more abstract. But from the side of calculation, it is easier to handle. All transports are collected and displayed together. This way of displaying material flows is an ideal opportunity to obtain information from relevant methods for optimization.</p>	<p>The Transport Matrix</p> 
<p>Flow diagram</p> <p>Using a flow diagram to display material flows is much more intuitive. With the help of a flow diagram, you can immediately identify various objects related to material flows throughout the created layout.</p>	<p>The Flow diagram</p> 
<p>Sankey diagram</p> <p>In order to find out where the main material flows are located on the layout (meaning where there are more/less material flows), the Sankey diagram is most suitable for this. The material flows in the Sankey diagram are differentiated by the width of the arrows, which is proportional to the quantity. If a large number of material flows must be applied to the layout, the Sankey diagram and the Flow diagram will not be effective.</p>	<p>The Sankey diagram</p> 

Source: adapted from Vis Table (n.d.).

The effective movement of material flows becomes a key factor in successful logistics, as it directly affects the overall efficiency and profitability of the enterprise. The free movement of materials through the supply chain reduces costs and ensures that customer needs are met with timely delivery (FasterCapital, n.d.).

- Cost optimization: effective movement of material reduces logistics operations costs. Slow or inefficient movement of materials between points leads to excess inventory and the need for additional storage space. This leads to the risk of inventory depreciation and excess storage costs. More efficient movement of materials allows optimize transportation routes, reducing transportation costs and increasing overall productivity.
- On time delivery: A well-organized material flow ensures that materials deliver on schedule, enabling companies to satisfy customer needs and expectations.
- Improvement of productivity: The overall productivity of the company increases if the flow of materials is efficient. Unnecessary delays are eliminated; thus, a smooth transition of materials becomes possible. Production efficiency increases, work execution time decreases, and productivity increases.
- Customer satisfaction: With an efficient flow, customer orders are fulfilled quickly and accurately. It leads to higher customer satisfaction, better relationships, increased loyalty, and more positive feedback.

3.3 Risk and risk management in transportation

The demand for logistics performance is constantly increasing and it can lead to complexity, uncertainty, and potential risk in logistics and supply chain. Risks in logistics and transportation refer to events that have a negative impact or disrupt the movement of goods. This can lead to negative consequences for the company and customers, such as delays, safety issues, or financial losses. These risks can appear from a variety of factors, such as political instability, cyber-attacks, and natural disasters. In addition, technical failures, operational inefficiencies, human error, or breaches of security regulations can also cause risks. For example, supply chain risks in a particular company can be classified into the following categories: company-level or process-level risks. Process-level risks are more technical, operational, and narrower in scope than company-level risks, which are more strategic and broader. Process-level risks are specific to certain individual company operations, such as procurement, production, logistics, or customer service. These risks are more technical and localized (Risk Sciences International, 2023). An example might be inefficient warehouse management, human error in production or equipment failure, delays in the supply chain, or poor inventory management. These types of risks (process-level risks) affect a particular department or operation within a company and do not threaten the entire company. Meanwhile, company-level risks have an impact on the entire company. They usually arise from external factors such as political changes, changes in trade regulations, border crossing processes, and general market dynamics (Indeed, 2025). Thus, it is necessary to understand the risks in logistics and to know what actions should be taken to prevent or solve it, if the risk has already happened.

Risk is a term that means an unwanted and unexpected event. In the supply chain, risks are associated with logistics activities in the flow of information and materials of the company.

Supply chain risks are chain disruptions. Since the goal of logistics can be described by the rule of “4R”, then undesirable events lead to the fact that the company:

- Does not have the right material, or
- Does not provide the right quality of this material, or
- Does not deliver the goods at the right time
- Does not deliver to the right place

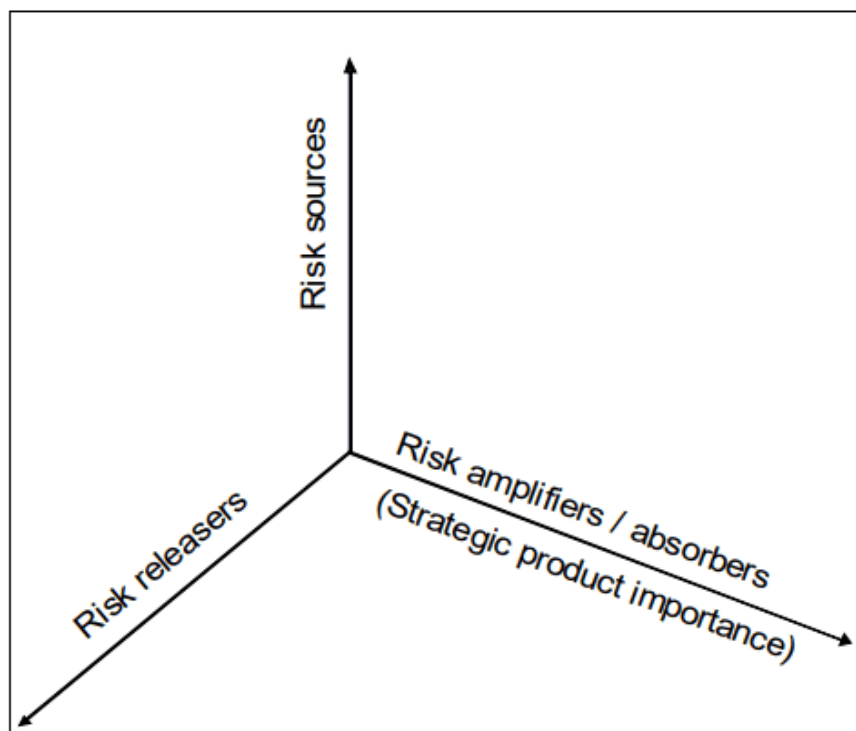
Fuchs and Wohinz (2009), made another definition of logistics risk as a failure of the planned material flow for any reason with negative consequences. Events that are unexpected in logistics processes are associated with the lack of stocks, which means the material flow. The first step in risk management is identifying potential risks, which may be related to customers, suppliers, or the broader environment. As Christopher (2016) pointed out, risks in logistics can come from a variety of sources, like changes in customer demand, issues with suppliers, or unexpected environmental factors that interrupt the flow of materials. By identifying these risks early on, companies can better understand what might disrupt their operations and plan accordingly. Once risks are identified, it's crucial to create a policy and strategy for managing them. This strategy should outline the actions to be taken for each risk, such as how to avoid, minimize, mitigate, monitor, or accept certain risks. Heizer and Render (2017) highlight the importance of having clear risk management strategies that align with the overall objectives of the supply chain and the organization. A well-rounded strategy helps companies be better prepared to deal with risks and make informed decisions. After developing a risk management strategy, companies must take the necessary steps to address the identified risks. These actions could involve contingency planning, keeping buffer stocks, or establishing alternative supply routes to minimize potential disruptions. Pfohl and Gomm (2015) emphasize that proactive risk management measures can greatly reduce the chances of material flow disruptions and strengthen supply chain resilience.

Finally, it is essential to monitor the outcomes of the risk management actions. Ongoing monitoring ensures that the strategy is working as intended and provides opportunities to make adjustments if needed. As Baryannis et al. (2019) point out, continuous monitoring using key performance indicators (KPIs) and performance reviews is crucial for evaluating the effectiveness of risk mitigation strategies and making necessary improvements. Before taking any actions, the company should deeply understand the type of risk that has occurred or can appear. The literature provides many examples of supply chain disruptions and uncertainty. Trkman and McCormack (2009) classified them as endogenous and exogenous uncertainty. They refer to endogenous uncertainty as the origin of risk and uncertainty lies within the supply chain, giving rise to potential alterations in the connections between the local firm and its suppliers. The primary forms of this uncertainty include market fluctuations and technological turbulence. Exogenous uncertainty means that the origin of risk arises outside the supply chain. They proposed categorizing these risks into two significant types: discrete events, such as terrorist attacks, contagious

diseases, or workers' strikes, and ongoing risks like changes in inflation rates and consumer price indices.

The first important step to successfully identify risks is to categorize them. Categorization of risks in logistics can be attributed to 3 directions. The basis is the sources of risks in logistics. The second direction is the importance of strategic products, as absorbers or amplifiers of risk. And the last one is risk releaser in logistics. Figure 7 illustrates this categorization framework, which serves as a practical tool for identifying and assessing realistic risk scenarios in logistics.

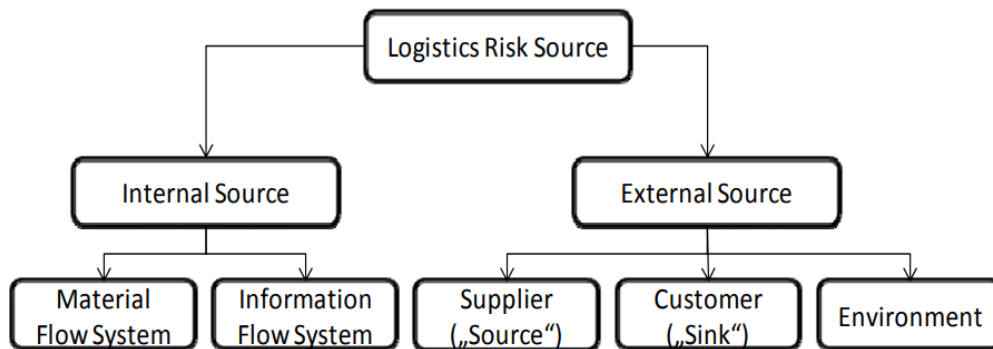
Figure 7: Categorization of risks in logistics



Source: Fuchs and Wohinz (2009).

To identify risks in logistics, it is important to create a structure of the sources of risks. Logistics risk sources consist of external and internal sources. For internal sources, consideration of material and informational flow systems, and for external – suppliers as a source, customer, and environment. Figure 8 provides a visual representation of these risk sources in logistics, and shows a clear framework for their identification and analysis.

Figure 8: Risk sources in logistics



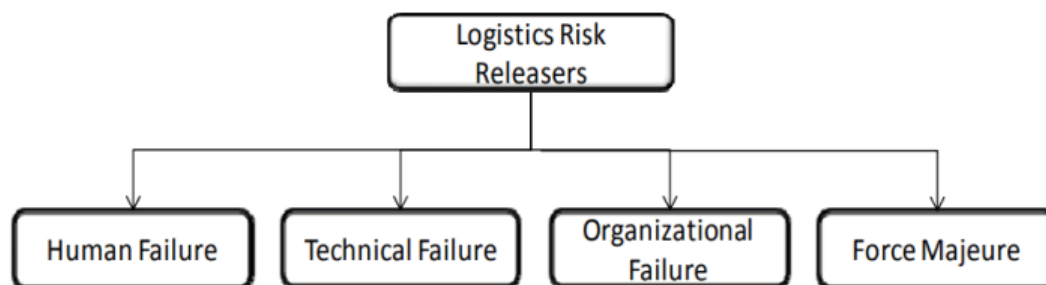
Source: Fuchs and Wohinz (2009).

There are 4 risk releasers that should be considered independently of logistics risk sources. Any cases of occurrence of risks in logistics are related to:

- human error
- malfunction of technical devices
- poor organizational system of the enterprise
- occurrence of a force majeure situation

Figure 9 illustrates these four risk releasers, highlighting their significance in understanding and addressing logistics risks.

Figure 9: The 4 risk releasers

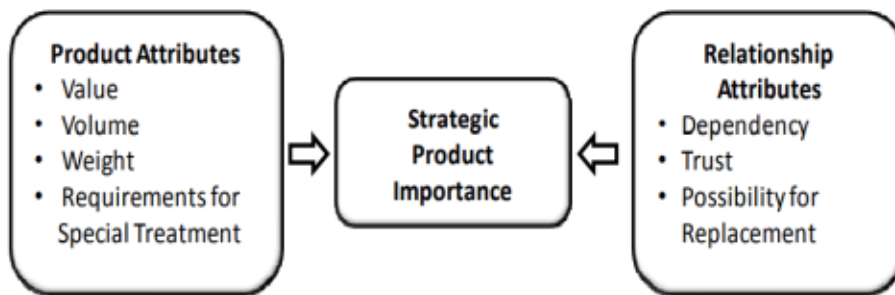


Source: Fuchs and Wohinz (2009).

Human-caused risks can be both unintentional and intentional (for example, terrorist attacks). An example of technical failures can be faulty equipment (for example, warehouse equipment) or software/hardware defects. The risks caused by a bad organization can include a poorly defined work process, unclear responsibilities, or lack of necessary information due to poor documentation. Examples of force majeure circumstances can be bad weather conditions/natural disasters (storm, flood, fire), and social actions (invasion, war, labor strike). The strategic importance of the product has a

great impact on the business. The strategic importance of the product has a strong influence on the relationship between the supplier and the customer. Certain market constellations limit the possible types of relationships that equally affect the strategic importance of products (Fuchs and Wohinz, 2009). Figure 10 shows the key factors that shape the strategic importance of a product and helps explain how these factors influence supply chain relationships — including levels of trust, dependency, and the potential for supplier replacement — as well as broader supply chain dynamics.

Figure 10: Factors that influence the strategic importance of the product



Source: Fuchs and Wohinz (2009).

Fuchs and Wohinz (2009), highlighted that attributes are the most important characteristics of a product that influence the appropriate logistics strategy. Physical attributes such as weight or volume create structure and limit possible logistics strategies that increase logistics risks. For example, limited storage space in combination with bulky items creates an automatic disruption of the flow of materials. Suppose a certain product exists in a large number of different variations. In that case, it often demands a Just in Sequence (JIS) delivery strategy, which significantly increases the risk of disruption of the material flow due to the exclusion of the possibility of safety stock. An example of Just in Sequence can be car seats, which are considered a volumetric module and exist in a large number of variations (Lemay, 2022). The cost of the product is very important in this context. Valuable products pose a greater risk of damage or theft. Therefore, it is necessary to take into account special technical requirements for the process. The supplier-buyer relationship also strongly influences the strategic importance of the product. The intensity of the relationship with the client can be different. Companies can use different types of cooperation. It can be both classic international agreements and full insourcing of the product supplier (Fuchs and Wohinz, 2009).

Business process modeling is a visual method of identifying possible risks that helps a company identify critical areas where risk arises. This modeling allows enterprises to display each step of the process and see how the interaction between different data flows takes place. With the help of a graphical representation of business processes, a company can see interconnected processes, relationships, and critical areas in the entire business or in specific areas that are modeled. This enables companies to identify potential areas for

improvement and enhancement and where risks can be mitigated. Business process modeling reflects the company's current processes and the ability to model future ones (Raiola, 2020). Business process modeling consists of a graphical part and a textual description. The graphical model serves as visual information of the business process, and the textual part helps to understand the created visualization. The modeling shows the specific start and end of the process, the purpose of the process, the company's activities and the order in which they are performed, significant events affecting a particular process or processes, and the links between these events (California Project Management Office, 2021).

Creating a risk map, which is a tool for identifying risk factors that may occur in the organization, is an extremely important step for any business. With the help of a risk map, enterprises can classify the level of damage and divide these risks into a low, medium, or high probability of occurrence. The consideration of creating a risk map can improve company visibility. By mapping the entire supply chain, companies can clarify if they have possible problems with their supplier, transportation routes, or other different factors that may disrupt the supply chain and create a bottleneck. Behind that, a risk map can be functioned as a tool for a proactive approach. A risk map can help identify potential risks proactively and allow the planning of mitigation or contingencies strategies before they cause any damage (Burant and Schneider, 2024). To successfully create a risk map, it is necessary to identify the risks using various data collection methods, like statistical data from the company itself or a specific department, or an interview approach as a method of primary data collection. This will help to identify possible risks and categorize them. Determining the impact of these risks on the company and their likelihood of occurrence is key to the risk map. The impact is categorised from 1 (low impact) to 5 (catastrophic) for the company, and the probability can be measured in percentage terms, for example, a low probability of occurrence 1 (1-20%), or a high probability 5 (81-100%). The risk map helps to visually assess the impact of each identified risk on the company and understand its possible consequences (Actio Software, 2023).

3.4 Risk related to the transportation of goods

As explained by Dorosh et al. (2020), international road transport of goods is a complex logistics process. The implementation of each transportation stage is associated with many unforeseen circumstances. Thus, in international road transport, several risks arise that prevent a company from forecasting and calculating the cost of delivery and its duration. Delivery of goods by road internationally (from a non-EU country to EU countries) consists of the following stages:

- Preparation of cargo for transportation
- Selection of a contractor (transport company) for the carriage
- Preparation of the vehicle for loading

- Preparation of transport documentation
- Loading and securing the cargo in the vehicle
- Customs clearance of cargo in the country of export
- Transportation of the cargo
- Transportation of goods to the border crossing point (Example: Ukrainian-Polish border)
- Passage of customs and border control
- Carriage of goods through the territory of the country of destination (or transit country)
- Delivery of cargo to the destination
- Unloading of cargo

The preparatory phase of transportation is the first stage where a transport risk may arise. During this stage, the cargo is packed and prepared for transportation. According to the legislation of Ukraine, there are requirements and recommendations for packaging and marking cargo during international road transportation, which companies must comply with. The initial stage of transportation involves several risk factors. One of the primary risks is the selection of inappropriate packaging for the cargo. Additionally, employee negligence in packaging or consolidating shipments may lead to cargo damage or loss. Groupage, also known as consolidation, is a logistics practice where multiple small consignments from different shippers are combined into a single shipment for transportation to a shared destination (Mecalux, 2019). If not executed properly, this process can increase the risk of cargo damage or misplacement. An important measure to reduce these risks is to implement a system of preliminary control over the packaging and placement of cargo. Cargo transportation can be carried out in different ways, for example with the participation of the consignor or consignee, or with the help of third-party transport and forwarding companies - outsourcing. In Ukraine, the DELLA TM platform is becoming more popular, because it enables companies that do not have their own fleet to use the services of other companies for international cargo transportation. This causes additional risks associated with the search and selection of a reliable contractor. International road transportation of cargo requires mandatory licensing. This regulation helps protect companies against unreliable carriers. Online transport service platforms such as Della or Lardi Trans help companies find information about the rating of transport companies – carriers. A significant number of open state (Ukrainian) registries allow companies to check the status of the carrier, the presence of court cases or tax debt, information about the qualifications of drivers and the condition of the vehicle. Risks at this stage can be reduced by implementing risk management procedures at an enterprise that uses the services of outsourcing companies for cargo transportation. In the transportation order, which is an integral part of the transport and forwarding service contract, the time and place of delivery of the vehicle for loading must be specified. The causes of this risk may be the irresponsibility of the driver, the delay of the car at the previous place of loading or unloading, traffic jams, or any other force majeure circumstances.

The degree of risk at this stage depends on the reliability of the contractor chosen at the previous stage. For international road transport, it is necessary to have such documents as the (CMR) - Convention on the Contract for the International Carriage of Goods by Road, invoice, packing list, certificate of origin of goods, customs declaration, sanitary certificates, and expert declaration EX-1 - this is a document that officially certifies the exporter's intention to transport goods outside a certain country. The risk of inaccuracies, errors, and lack of necessary data can cause delays in transportation, delays at the border, or even the return of goods. When the truck arrives at the loading location, it is inspected and checked for compliance with the contract, and the vehicle is weighed. At this stage, risks such as technical malfunction of the refrigerator, damage to the awning, and insufficient dimensions of the semi-trailer may arise. These risks can be attributed to the risks associated with the non-compliance of the vehicle with the customer's requirements. The execution of operations related to the loading and unloading of goods and the placement and securing of cargo is regulated by European standards, such as EN 12195-1 or EN 12640, and by the rule of cargo transportation by road transport of Ukraine. The main risks at the stage of loading-unloading are human errors in the execution and the use of equipment and technical means. According to Ukrainian law, the driver is responsible for placing and securing the received cargo. It is also their responsibility to control the loading and unloading process. At this stage, there may be risks associated with the driver's inactivity or incorrect actions, which may lead to damage to the cargo due to the driver's failure to fulfil his or her duties (Dorosh et al., 2020).

Dorosh et al. (2020) specified that customs clearance is the next mandatory step in international cargo transportation. Customs clearance can be performed in two ways, at the customs terminals of regional customs offices and at international automobile checkpoints. Before the cargo is shipped to its destination, a customs declaration and a package of documents for declaration (according to the national legislation of Ukraine) are submitted to the customs in advance. The customs service analyzes the vehicle and the goods according to the submitted documents. At this stage, there is a risk of delaying the vehicle due to a thorough check and customs procedures. If the customs documents are incomplete, or if customs duties have been incorrectly calculated, this causes a risk of delaying the truck. The reason for this is the incompetent action of the broker (declarant) in the preparation of documents. Customs clearance is completed when a stamp called "Under Customs Control" is affixed to the shipping documents and a seal is placed on the vehicle. The longest stage of international cargo delivery is the process of transportation through the territory of the sender (Ukraine) and the territory of the transit country or the country of destination. Risks during transportation may arise due to accidents (partial or complete damage to the cargo), illegal actions of third parties, which may lead to theft of cargo, delays in delivery due to road conditions or force majeure. The events may be caused by the unstable situation in the regions of Ukraine, dangerous road conditions, weather conditions, truck malfunction, poor driver experience on certain transportation routes, and driver incompetence regarding the characteristics of the cargo and the required

temperature of a particular product. In addition, international requirements require that trucks with cargo be parked in certified parking lots, where security personnel must be present and video surveillance must be in place. According to the national legislation of Ukraine and international law, from the moment the goods are accepted by the driver (carrier) until they are delivered to the recipient, the carrier bears all responsibility. The last stage in international transportation is the acceptance of the goods by the recipient and the unloading of the truck. At this stage, all the necessary documents - the quantity of cargo, its weight, condition, and quality of products are checked. During this process, the risk of cargo damage or shortage due to driver inattention, technical malfunction of the truck while in motion (refrigerator malfunction), or technical malfunction of unloading equipment may happen. Ukraine's main trading partner is the European Union (Dorosh et al., 2020). The use of road transport for cargo transportation between these parties is attractive due to its cost-effectiveness, short delivery times, and the possibility of door-to-door delivery. However, international road transportation involves a large number of risks at every stage, from preparing goods for transport and selecting a transport contractor to unloading the cargo at its destination. This makes it difficult for companies to estimate the duration and cost of delivery.

4 MANAGEMENT OF RISK IN ROAD TRANSPORTATION AND LOGISTICS AT RUD UA

In today's dynamic business environment, risk has become an integral part of operational processes. Companies are expected to recognize potential threats and implement suitable measures to maintain the efficiency and stability of their supply chains. RUD UA, as a manufacturing company involved in the distribution of its own products, also faces various logistical challenges that require a structured approach to risk management to ensure reliable and continuous delivery operations.

4.1 Characteristics of the company and its specification

Company Rud UA is a public joint-stock company specializing in the food industry in the city of Zhytomyr, Ukraine. The company has been on the market since 1981. The company is also called "Zhytomyr Butter Factory" because the main specialization of production is butter, ice cream, and various dairy products, as well as the production of frozen vegetables, fruits, berries, and dough (Company "Rud", 2024). The expansion outside the region began in the 1990s when the biggest competition for the Ukrainian ice cream market was products from Poland. At that time, the entire market of Ukraine was filled with products from Poland. However, there were changes to the import duty, and because of this, the supply of ice cream stopped, which made it possible for Ukrainian producers to fill a large part of the local market. At that time, there were few large local manufacturers. There was even a shortage of ice cream in Ukraine for about 2-3 years in the 1990s. The

resulting situation in the market made it possible for the company to open new sales territories, first in all regions of Ukraine, and then in European countries, the USA, Japan, and Israel (Company "Rud", n.d.). It is noted that the field of dairy production is characterized by rather difficult economic conditions because the main suppliers of the enterprise are private peasant farms and agricultural enterprises, which often do not meet the requirements of technological standards for milk processing. Today, Rud UA is the largest ice cream producer in Ukraine. In addition to its main product, ice cream, the company also produces dairy products and frozen semi-finished products. The company's fully automated production technology allows it to manufacture products of the highest quality. All products manufactured at the enterprise meet international standards (Company "Rud", 2024).

The main activities of the company are:

- Ice cream production
- Milk processing, production of dairy products (butter, cheese, yogurts)
- Wholesale of dairy products, eggs, edible oils and fats
- Other types of processing and preservation of vegetables and fruits
- Retail trade of other food products in specialized stores
- Activities of restaurants, provision of mobile food services

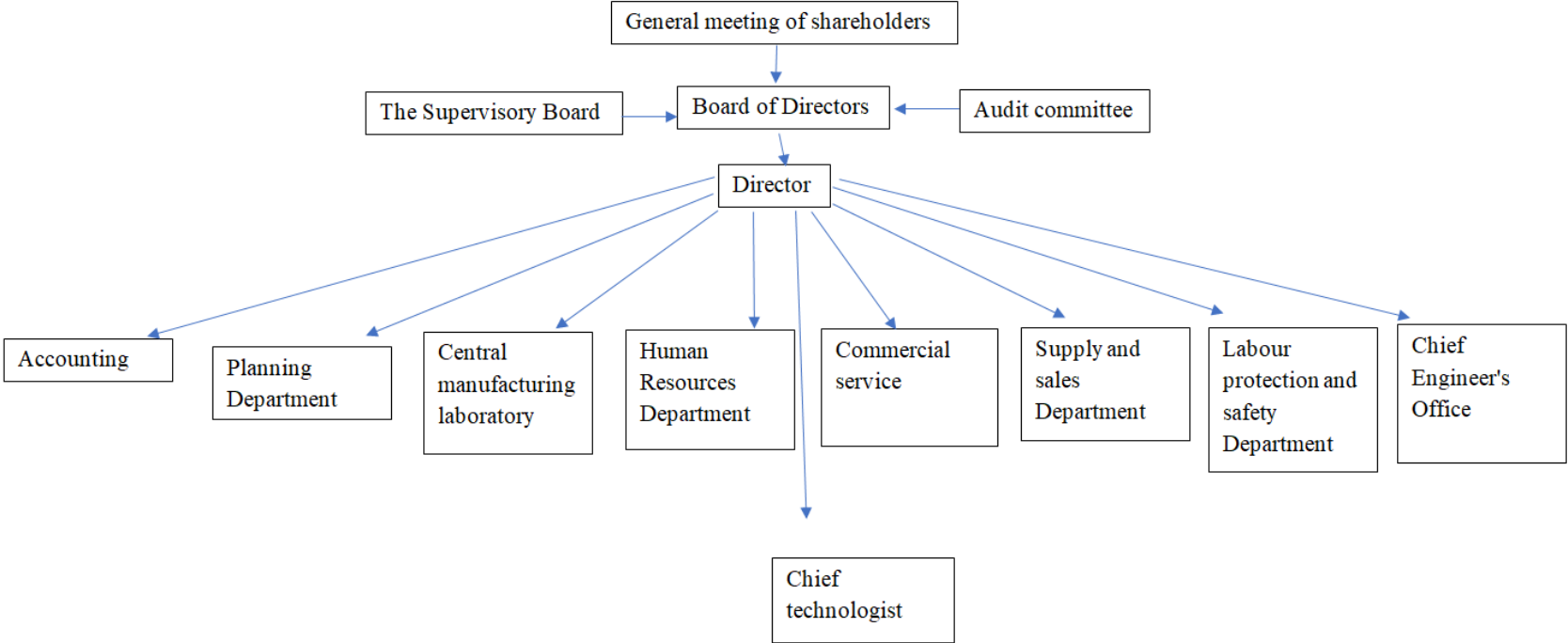
The company currently exports its products to more than 30 countries worldwide, including Lithuania, Latvia, Poland, Germany, the USA, Greece, Israel, Georgia, and many others. The main goal of the company is to manufacture safe products and constantly satisfy the most demanding consumers, improve production processes, and use methods and materials that do not cause pollution to the environment (Company "Rud", 2024). In terms of sales policy, the company most often uses a two-level sales channel (through distributors and retailers). It has official representatives throughout Ukraine as there are distributors in each region. For example, a distributor representative in Kyiv and its region (Company "Rud", n.d.).

4.1.1 The organizational structure of the company

The organizational structure of RUD UA is a linear functional type. In this management structure, all authority is vested in a line manager who leads a certain team. In developing specific issues and preparing relevant decisions, programs, and plans, the manager is assisted by a special apparatus consisting of functional units headed by specialists in the relevant area of work. The heads of functional units implement their decisions through the chief executive officer directly through the relevant managers or directly through the relevant heads of departments.

The governance structure of Zhytomyr Butter Plant consists of a meeting of the founders, a commercial director, an executive director, an audit committee, and a health and safety manager. Figure 11 provides an overview of RUD UA’s organizational structure, and shows the roles and relationships that shape the company.

Figure 11: The organizational structure of the company RUD UA



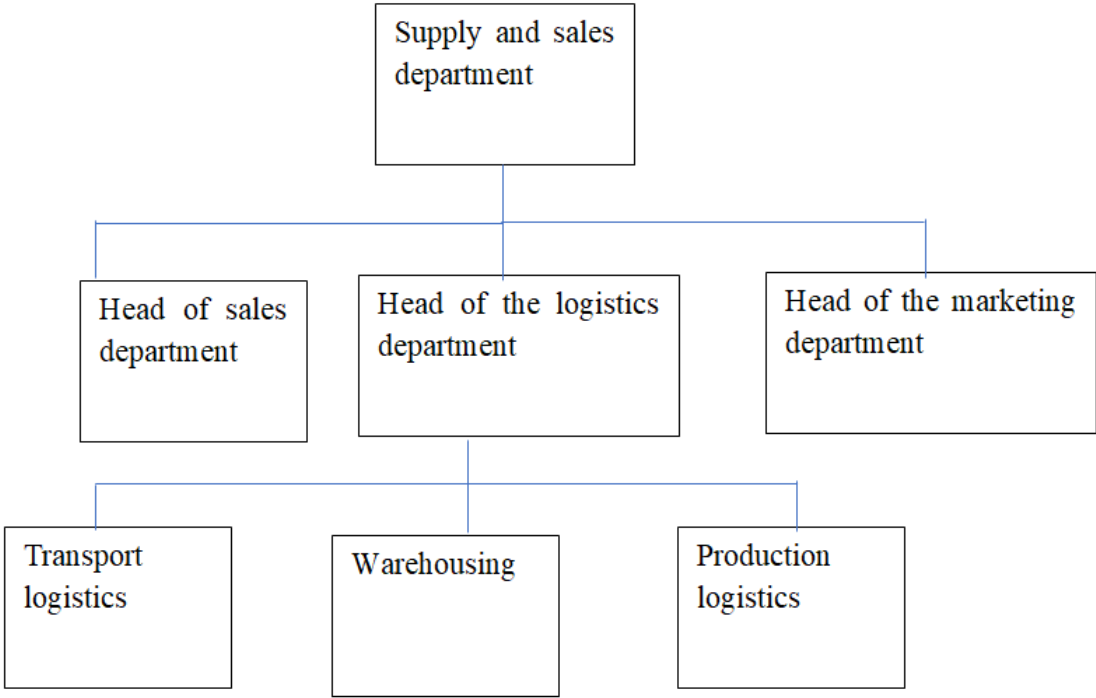
Source: own work based on RUD UA (2024a).

The advantages of the line-functional structure are better preparation of decisions and plans related to the specialization of employees; removal of the chief line manager from a thorough analysis of problems; and the possibility of engaging consultants and experts. The disadvantages of the line-functional structure are a lack of close interconnections and interaction at the horizontal level between all production departments; insufficiently clear responsibilities; a highly developed system of vertical relationships, and a tendency to over-centralization.

4.1.2 The organizational structure of supply and sales department

The company's logistics service consists of several divisions: transport logistics, production logistics, and direct sales as shown in Figure 12.

Figure 12: The organizational structure of the company RUD UA, Supply and sales department structure



Source: own work based on RUD UA (2024a).

The transport logistics department provides transportation of raw materials and supplies to the enterprise and delivery of finished products to the customers. The transport logistics division performs the following functions: ensuring a unified cargo technology, rational choice of transport and determining delivery routes, and ensuring the technological unity of the transport process with warehousing and production processes.

The production logistics division ensures timely and high-quality procurement of raw materials and packaging materials for production and inventory management. The production logistics division provides necessary conditions for the preservation of finished products and raw materials, as well as product maintenance.

The RUD UA warehousing facilities consist of five warehouses: 3 warehouses for ice cream and butter, a warehouse for dairy products, and a warehouse for raw materials. The entire material flow passes through the warehouse. Raw materials, supplies, and spare parts required to ensure continuous production are first delivered to the warehouse and then transferred to the shops and divisions via an internal consignment note. Finished products from the main shops are delivered to the warehouse and then shipped to customers or returned to production as semi-finished products (butter). The timeliness of the shipment of goods and the speed of delivery from the enterprise to the customer at the point of sale also depend on the activities of transport logistics.

The functions of the logistics department are closely linked to the functions of the sales and marketing departments, as marketing ensures the sale of products, logistics directly sells these products, and the sales department analyses demand and organizes sales.

4.2 Identification of the risks

I conducted three semi-structured interviews with the head of the Logistics department, the manager of the Sales department, and the manager of the Production department to identify the risks in the company RUD UA. The interviews aim to explore the processes, challenges, and approaches associated with maintaining the integrity of ice cream products from production to their final export destination.

The first interview was with the head of the logistics department. The purpose of this interview was to understand the entire process of logistics and cold chain management in the company and to discuss and evaluate possible risks. The interview lasted approximately 40 minutes, and the interviewee has 12 years of experience working in this role at RUD UA.

I conducted the second interview with a sales manager. The goal of this interview was to understand the company's sales strategies, demand forecasting, and customer feedback, how these aspects are intertwined with logistics processes, and where possible risks may arise. This interview lasted about 30 minutes, and the interviewee has been working in the company for 8 years.

The third interview aims to understand the production process, quality control measures, and how production activities align with logistics requirements and to analyze the possible risks at the production stage. It lasted approximately 45 minutes, and the production manager has 10 years of experience in the company.

The interview method was chosen to understand the company's cold chain management practices directly from top managers with experience and expertise in logistics and distribution, sales, and production. The interview questions were developed in a way to find the answers to the main research questions of the master's thesis. Before the interview, the permission to record was agreed upon by both sides. The interview was conducted in Ukrainian language and summarized and translated into English for my master's thesis.

The interview guidelines were provided, so the interviewees were familiarized with the following information:

- The interview will be recorded
- The interview participation is voluntary and will be conducted only with permission
- The result of the interview will be used only for research purposes of this master's thesis
- The results will be a part of this thesis and will be available later on at the library of the University of Ljubljana, School of Economics and Business

The interviewees – the Head of the logistics department, the sales manager, and the production manager at the company RUD UA agreed with the interview guidelines.

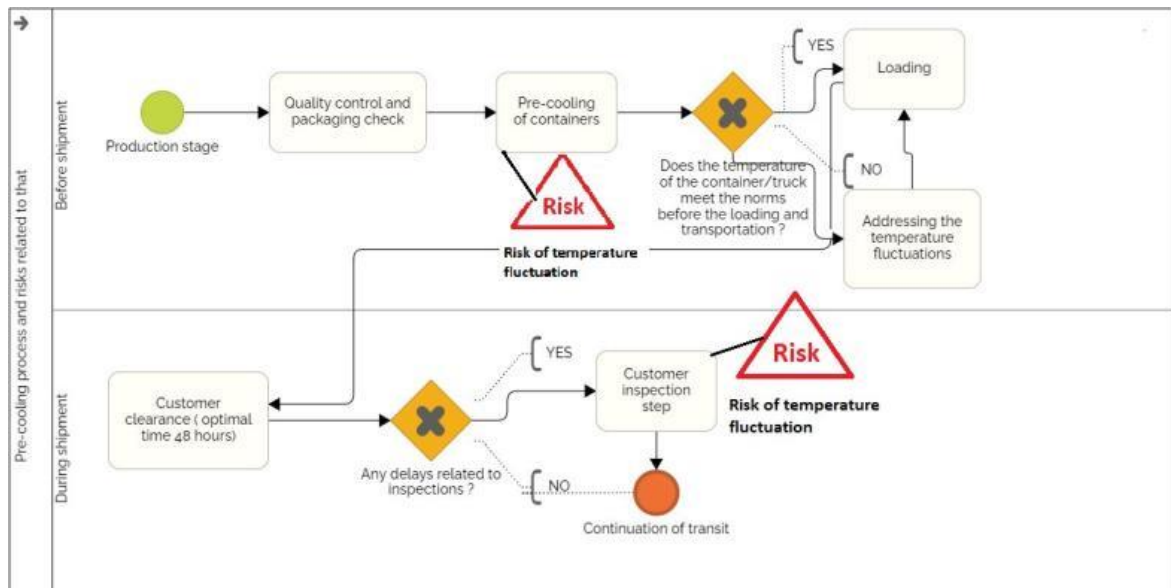
The head of the logistics department first focused on the typical journey of ice cream products, from production to reaching the final customer (export). According to him, the supply chain at the RUD UA can be divided into 3 stages. It's pre-production logistics, production, and post-production. Logistics and distribution work closely with sales and procurement departments. They are responsible for ingredients and packaging materials. They coordinate with internal suppliers and Ukrainian vendors. When ingredients are available, the manufacturing starts. The ice cream is produced according to all specifications with strict quality control measures.

The following step is packaging and labeling. They ensure all labels comply with European regulations, including ingredient lists in the appropriate languages. Regarding post-production logistics, the finished product is moved to the warehouse, which is located close to the production facility. It is beneficial that the warehouse is located close, so the risk that the product might change its temperature standard is low. The temperature at the warehouse is -20 degrees. The logistics team prepares all the necessary documentation for export customs clearance in Ukraine and import customs clearance in the European destination country. This includes commercial invoices, packing lists, certificates of origin, and health certificates. The ice cream is shipped to Europe by trusted partners (third-party providers and by usage of their trucks/services). The trucks have a temperature control system, which is required by the EU regulations for that type of product from non-EU countries. The company RUD UA has and uses its fleet for shipment only in Ukraine. Depending on customers, the final destination might be the distribution center, cross-docking, or direct supermarket warehouse (For example – Auchan Polska). As the head of

logistics explained, the most important risk is the loss of the product because it did not comply with the temperature regime. With other risks – reverse logistics is possible, but if the temperature of the product has changed, this is the most critical for the company. In second place is the delay at the border. They usually expect 48 hours for this. If this time is exceeded, the risk increases. The third is the customs clearance risk due to the lack of electricity (electricity cuts due to constant attacks on electrical stations in Ukraine) or air sirens (it is forbidden to work at that time). These are the main and most critical risks for the company at the moment.

The head of logistics stressed that customs delays are a crucial issue. Any delays at the border disrupt the cold chain. Even a few hours outside optimal temperatures can affect the quality and safety of the ice cream. This is a critical step, especially for their product. The optimal time for customs clearance is 48 hours. Customs inspections are necessary for exporting goods to the EU, but opening refrigerated containers for checks can disrupt the product. This procedure can cause temperature fluctuations, especially if the inspection takes time. They mitigate this by pre-cooling containers to a lower temperature and using proper packing materials to minimize temperature swings. They work closely with customs brokers and carriers to prioritize their shipments and minimize non-refrigerated storage time. Figure 13 illustrates the pre-cooling process used to maintain product quality during transportation.

Figure 13: Pre-cooling process



Source: own work.

A detailed identification and assessment of these risks, based on the interview with the head of the logistics department, is presented in Table 4. Each risk was evaluated using a 1 to 5 impact scale, where 1 indicates a very low impact and 5 indicates a very high impact on three dimensions: Product Quality, Delivery Timelines, and Overall Costs. These scores

were assigned based on the expert judgment of the interviewee, supported by examples and contextual explanations provided during the interview. The average value represents the overall criticality of the risk.

Table 4: Identification and assessment of risks in the transportation process based on the interview with the head of the logistics department

Identified risk	Risk assessment (Impact level)			
	Impact on Product Quality	Impact on Delivery Timelines	Impact on Overall Costs	An average value
The change in the temperature of the product	5	5	5	5
Border delay process	4	4	4	4
Air sirens/lack of electricity	4	4	4	4
Lack of compliance data ordered	2	4	4	3.3
Missing or errors in documents regarding transport arrangement	2	3	2	2.3
The inappropriate fulfilment of the certificate of packaging	2	3	2	2.3
Improper marking of the vehicle	2	3	2	2.3
Inadequate protection of goods	4	4	4	4
Theft	5	5	5	5
Driver/operator's inebriety	2	4	3	3
Employees who do not come to work or are late to work (strikes)	3	4	4	3.6
Non-compliance with the driver's working time	2	4	3	3
Lack of driver competence	2	4	3	3
Accident at work	3	5	5	4.3
Vehicle malfunction	4	4	4	4
Accident on the road	3	5	5	4.3

Source: own work.

The average value of the Impact level was calculated as it is needed for further analysis of the Identification and assessment of each risk and the risk map creation. In the interview, the head of logistics said that to mitigate risks and ensure product integrity throughout the supply chain, they choose larger companies that can provide comprehensive services for them. He pointed out that the carrier company provides them with the latest trucks, all trucks accredited (refrigerated condition), in addition to the fact that each truck must have European (FCR) - Forwarder's Cargo Receipt certification. Drivers are more qualified in large transportation companies. That is why cooperating and using the service of a big transportation companies are in priority for the RUD UA. The main strategy to mitigate risk is that RUD UA pays on average 15 percent higher than the market price for delivery. The company pays utmost attention to find the best possible partners in the supply chain to reduce the risk. They pay more, but they require certification, the latest refrigerated trucks,

and an experienced driver. In terms of the specific technologies or monitoring systems that the company uses to track temperature and ensure cold chain compliance, the head of logistics elaborated that, as mandated by, the carrier itself should insure its risks (from a legal point of view). With some carriers, RUD UA also uses and has access to a general system of its carrier for the temperature screening in the vehicle. The driver must accept goods at a certain temperature in their warehouse. An acceptance certificate is signed between the carrier and the company. The controller must be present to measure the temperature of the goods before shipment and to sign the acceptance certificate between both parties.

In terms of the areas that are potential opportunities for further improvement in their cold chain risk management, the head of logistics emphasized that given the current situation with the war in Ukraine, the company has to invest even more in generators and other backup power sources in their warehouses and production to maintain operations, in the event of power outages to ensure the product quality and supply chain resilience on the stage of production and warehousing". Regarding the customer clearance, the head of logistics mentioned that this procedure can be automated. If RUD UA implements a system to automate customs procedures, it will reduce the time of crossing the border. In addition, they must conduct regular risk assessments and update the contingency plans. Currently, the company does not have a separate Risk Management department, but given the situation in recent years, Covid and the war, this area is seen as a potential area for implementation and improvement.

At the beginning of the second interview with the sales manager, she explained that the Sales department receives orders through an online platform (website of the RUD UA), where customers can send a specific request or via email to the Sales department. When orders are received, they are entered into the (ERP) - Enterprise resource planning system, where the sales manager can see the availability of the requested product. If additional production is needed, the Sales department notifies the production department to prioritize the required quantities. There are minimal delays at this stage, as the sales department closely cooperates with the production team. When the stock is confirmed, the order is sent to the warehouse and logistics team. Then logistics team schedules the shipment based on the delivery deadlines. The manager pointed out that they use third-party logistics providers to ensure the flexibility and reliability of the delivery. "As any other manufacturing company, the RUD UA faces order fluctuations from time to time. But it motivates us to adjust our demand forecasts", the sales manager explained. The manager noted that the company actively uses available online resources to collect information and analyze market trends. For example, sites like echerha.gov.ua, with data on customs queues and border crossings, and della.com.ua, which provides information on transportation and logistics, are very helpful in forecasting demand and determining order volumes. Based on this data, Rud compares the received information with the production plan and thus develops forecasts by using formulas. Employees take into account historical

data, seasonal fluctuations, and the current market situation, which makes it possible to predict possible delays in supply and choose optimal strategies to meet demand. With their type of product, they have seasonal increases in demand (during the spring-summer period) which is why the demand forecasting and production for safety stock start in the autumn-winter period.

The sales manager pointed out that for forecasting the demand for ice cream products in different markets, historical sales data is crucial. They pay attention to past sales volume in each country, including market growth rates. She stressed that they constantly provide surveys to their customers, to understand preferences, market dynamics, and consumer behavior in different regions in Europe. As the manager mentioned, the ice cream sales are highly seasonal, so they adjust the forecast to the peak summer season. They pay detailed attention to the market segmentation as purchasing behaviour and geographical location. They collect detailed sales and inventory data from retailers. As the manager said: “Each market has its characteristics and preferences. What sells well in one country may not be in demand in another due to differences in tastes, traditions, and consumer habits”. This requires a deep understanding of each market. Since RUD UA works with a product (ice cream) that requires special storage and transportation conditions, unpredictable changes in weather conditions can affect demand. For example, prolonged warm weather can increase demand, while cold periods can decrease it. Behind that, the manager mentioned that accurate forecasting requires accurate and timely market data, which is not always available or may be unreliable. This is especially true in new markets without accumulated statistics and sales history, for example, Germany and Greece. She concluded that changes in customs regulations or tariffs can affect delivery times and product availability on the market, making it difficult to forecast demand.

Based on the information provided by the sales manager, the list of risks associated with logistics and road transportation for RUD UA was created in Table 5. Each risk was evaluated using a 1 to 5 impact scale, where 1 indicates a very low impact and 5 indicates a very high impact on three dimensions: Product Quality, Delivery Timelines, and Overall Costs. These scores were assigned based on the expert judgment of the interviewee, supported by examples and contextual explanations provided during the interview. The average value represents the overall criticality of the risk.

Table 5: Identification and assessment of risks based on the interview with the sales manager

Identified risk	Risk assessment (Impact level)			
	Impact on Product Quality	Impact on Delivery Timelines	Impact on Overall Costs	An average value
Order fluctuations	2	4	3	3
Demand forecasting challenges	2	3	4	3
Unreliable market data	1	3	3	2.3
Limited market data in new markets (Germany & Greece):	2	3	4	3
Unpredictable weather during the summer season	1	3	3	2.3
Changes in customs regulations or tariffs	1	4	4	3

Source: own work.

“We implement various risk management strategies. We maintain buffer stock, have reliable agreements with our logistics providers, and use historical data to prepare for demand shifts”, the manager replied to my question about the measurement which they take to mitigate the risks associated with logistics and transportation delays. According to the sales manager, they share sales forecasts and demand data with the production and logistics departments to ensure that production schedules and logistics plans are aligned with market demand. They use comprehensive cargo insurance against the main risks (loss, damage, delay in transit), as well as third-party liability insurance. In case of any problems with delivery, they immediately inform the client and offer alternative solutions (For example, delivery of the available quantity of the order - Less-than-truckload, discount on next order). The manager pointed out that they conduct regular analysis of European ice cream markets to identify new trends and consumer needs, so they can develop new products or modify the existing ones.

In this third interview, the manager of the production department provided insights into the key challenges affecting production and logistics. One of the most critical factors, according to the manager, is the seasonality of ice cream demand, which influences all aspects of production and supply chain operations. During peak seasons (spring-summer), they significantly increase production volumes to meet the demand. The RUD UA normal production capacity is 600,000 pcs/day and > 27,000 pcs / hour, which means 150 tons per day. The maximum capacity is up to 200 tons of ice cream production per day. The manager said that they produce more than 100 types of ice cream, like paper cups/waffle cups, and ice cream cakes. The production operates in 3 shifts during the high season and 2 shifts during the low. During the high season, the company has 800 employees, and in the low season 500 employees. The manager stressed that they must be ready to quickly adapt

to changes in demand by changing the product range and increasing or decreasing the production of certain types of ice cream. They strengthen quality control at all stages of production during peak seasons. During periods of low demand, they accumulate stocks of finished products to ensure uninterrupted supplies during peak seasons. The manager pointed out that during the peak season, there may be a risk of raw material shortages due to high demand. From a logistical point of view, there is a risk of delivery delays and damage to products during transportation. During the low season, the cost of maintaining a warehouse with finished goods increases. Due to the large volume of products in warehouses during the high season, the risk of damage to ice cream due to mechanical damage increases. In the low season, Rud produces products with a long shelf life to create stocks that are later used in the high season. The manager noted that the company has flexible production lines that can be quickly reconfigured for different types of products, which allows it to respond more quickly to changes in demand. They are constantly expanding their assortment because they develop and promote new products that can be attractive in the low season. Rud has a diversified market and exports its products to more than 30 countries around the world, where seasonal fluctuations may differ from the European market, which helps to balance the overall demand. They are constantly expanding their target audience to include products for children, adults, and people with dietary needs. Product quality risk is one of the most critical risks in production at RUD UA. The manager said that a few years ago there was a case when a batch of milk received from a farmer supplier was of poor quality. This led to some of the ice cream produced did not meet the company's standards. As a result, the company strengthened quality control at all stages of the production process, introduced additional laboratory tests for incoming raw materials, and established a feedback system with suppliers to resolve problems promptly.

Based on the interview with the manager of the production department, a list of risks has been identified and evaluated. The results of this assessment are shown in Table 6. Each risk was evaluated using a 1 to 5 impact scale, where 1 indicates a very low impact and 5 indicates a very high impact on three dimensions: Product Quality, Delivery Timelines, and Overall Costs. These scores were assigned based on the expert judgment of the interviewee, supported by examples and contextual explanations provided during the interview. The average value represents the overall criticality of the risk.

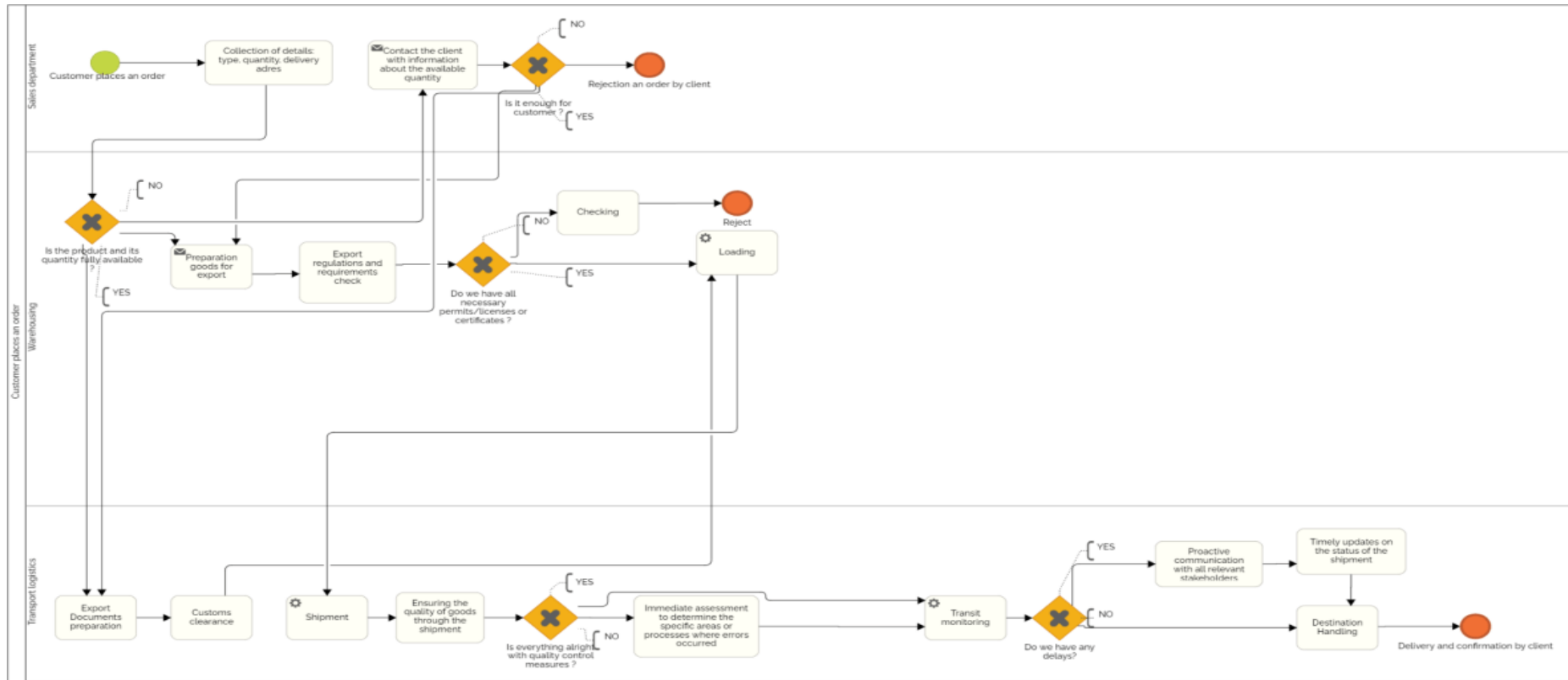
Table 6: Identification and assessment of risks based on the interview with the manager of the production department

Identified risk	Risk assessment (Impact level)			
	Impact on Product Quality	Impact on Delivery Timelines	Impact on Overall Costs	An average value
Raw material shortage (peak season)	3	4	4	3.6
Delivery delays/damage (peak season)	2	5	3	3.3
Warehouse storage costs (low season)	1	1	5	2.3
Ice cream damage (high volume, peak season)	4	2	3	3
Equipment Failures	5	4	5	4.6

Source: own work.

Understanding and documenting the process of a customer placing an order for goods to be exported by RUD UA is a critical step in ensuring operational efficiency in identifying risks and further mitigation. These discussions provided a comprehensive understanding of the roles, interactions, and dependencies within the process. In addition, during my internship at RUD UA, in the logistics department, I had the opportunity to observe daily operations and this allowed me to understand the real-time interaction between different departments, such as sales, logistics, and finance. Based on the gathered information, I developed a business process model to represent the sequence of activities and decision points involved in the workflow. The primary objective was to create a comprehensive model that illustrates the workflow when a customer places an order for export at RUD UA. This model captures all critical stages, including order receipt, processing, document verification and preparation, and final shipment. I used the standardized Business Process Model and Notation (BPMN) to create a visual representation of the process. To ensure the accuracy and reliability of the business process model, I validated the collected data. This was achieved by comparing the insights gained during the interviews with the observed practices and data obtained from the company's systems. In addition, the draft model was thoroughly reviewed with key stakeholders to gather their feedback and confirm the accuracy of the depicted processes. Figure 14 provides a visual representation of the process, showing how customer orders are handled and exported by RUD UA.

Figure 14: The modeling of the process when a customer places an order for goods to be exported by RUD UA



Source: own work.

The created business process model fully reflects the workflow of placing orders and exporting at RUD UA. It describes the sequential stages, from order initiation to shipment, and highlights the key roles and responsibilities in different departments. In addition, the model captures critical system interactions and decision points in the process. The model serves as a valuable tool for identifying potential areas for improvement and increasing the efficiency of a company's export operations.

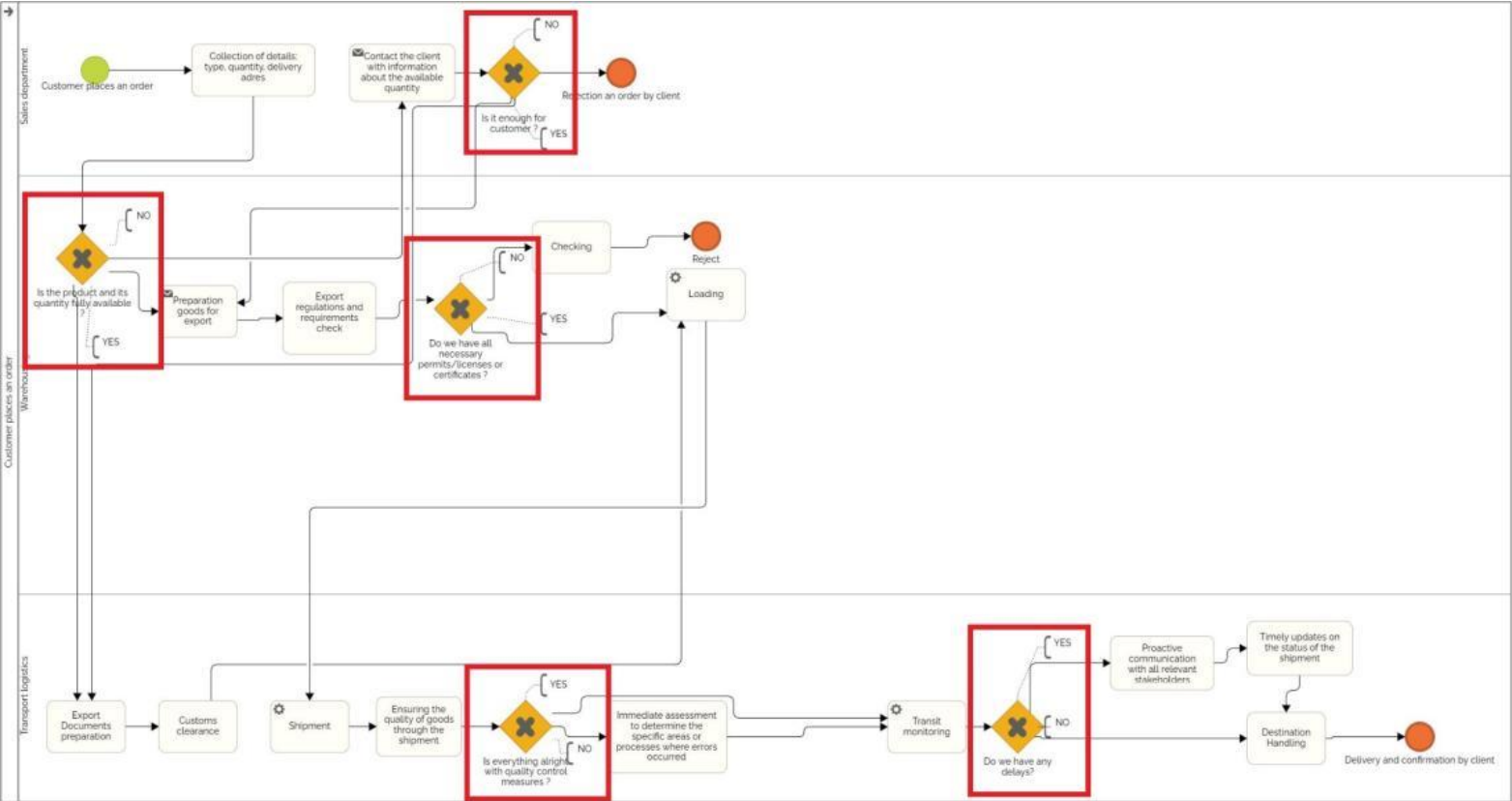
The modeling of the process, when a customer places an order for goods to be exported by RUD UA, involves two distinct execution options. Each option reflects different outcomes based on the availability of the product and customer preferences. These two execution options describe the steps that follow depending on the product's availability and the decision made by the customer.

Execution option 1: the process starts in a sales department, which receives an order from a customer. The first action that the sales department takes is the collection of details about the necessary product required by the client; type of product, its quantity, delivery address, etc. After that, the Sales department sends a request to the warehouse about the availability of the specific type of product and its amount. If the Warehouse informs the Sales department that this type of product is currently unavailable in the required quantity or required type of product, the Sales department should contact the client about that and ask if the other available product or the same product, but in another quantity is suitable for the customer. If it is not appropriate for the client, the client may reject an order, and the process is finished.

Execution option 2: if the suggested quantity by the warehouse is suitable for the client, the Sales department contacts the warehouse again to prepare goods for export. At the same time, the Sales department contacts the logistics department for export documents preparation. All the departments cooperate to fulfil an order. Preparation of goods for export by warehouse requires an additional step which is checking export regulations and requirements. This step is critical for the company as if the RUD UA does not have all the necessary permits, licenses, or certificates on time, it may lead to delays in customer clearance and the rejection of shipment. When documents for export and customer clearance are ready by the logistics department, goods are ready to be shipped by the warehouse - the loading process begins, then shipment is organized. Figure 16 shows that Shipment is another critical step. It requires ensuring the quality of the goods through the entire process of shipment. If something is wrong with quality control measures, the immediate assessment of the determination of specific areas or processes where errors occur is needed. Another step by the logistics department is transit monitoring and destination handling. The important sub-action is to ensure that the company knows how to reduce the impact of the delay if it occurs. If a delay happens, proactive communication with all relevant stakeholders is essential. Timely updates on the status of the shipment are a key step for successful destination handling. The process is completed when the client sends a confirmation.

To sum it up, in a process when a customer places an order for goods to be exported by RUD UA, there are 5 steps, where the risk may happen. It is product availability, quantity availability, regulations, and requirements check, when preparation for goods is proceeding, quality control measures in a shipment, and delays while goods are in transit. The process model in Figure 15 helped visually determine the risks in a company.

Figure 15: The critical steps where the risk may happen



Source: own work.

4.3 Analysis and evaluation of each risk

For the company Rud UA (Zhytomyr Butter Plant), risk management in road transport is critical to ensuring the safe and efficient transportation of products. One of the key elements of risk management is their timely identification. The risk assessment procedure at RUD UA includes the collection of important information about possible threats that may affect the performance of transportation tasks. The risk identification process involves identifying potential hazards, defining and classifying different types of risks, and describing risks that may interfere with organizational and transportation goals. Risks can both hinder the achievement of goals and cause damage to the company. Since it plays an important role in the management and decision-making process, the risk identification process should take into account all possible events that could lead to their occurrence. This includes both new and already known risks.

Risks in companies or transportation processes can arise for a variety of reasons, including:

- Making wrong decisions due to erroneous, inaccurate, insufficient, or misinterpreted information.
- Non-compliance, misunderstanding, or failure to comply with the rules and procedures related to the required documents and obligations of the carrier.
- Human factors, technical problems, or accidental circumstances.
- External factors beyond the direct control of the company

Table 7 provides a detailed analysis of each risk, including the risk symbol, its cause, and possible consequences. It also shows the level of the impact, likelihood, and significance of the risk. The symbols for the types of risks were chosen based on the nature of each risk identified during the risk assessment process at RUD UA. Each symbol was selected to clearly represent a specific category of risk.

Symbol A was assigned to risks related to decision-making errors caused by inaccurate or incomplete information. These types of risks can lead to significant disruptions in operations. The letter "A" was chosen because it represents the beginning of a sequence, highlighting the foundational nature of this risk in the overall process.

Symbol B represents risks associated with non-compliance or misunderstanding of rules and procedures, especially regarding the necessary documents and obligations of the carrier. The letter "B" was selected as it follows "A" in the sequence and denotes a secondary but equally important risk category related to legal and regulatory compliance.

Symbol C is used for risks arising from human factors, technical problems, or accidental circumstances. The letter "C" was chosen to reflect the unpredictable nature of these risks, which often result from human error, equipment failure, or unforeseen events.

Symbol D represents external factors that are beyond the company's control. These include weather conditions or geopolitical events that can affect the transportation process. The letter "D" was used to clearly separate these external risks from those that are internal and more directly manageable by the company.

To classify the risks more effectively, I divided them by the level of occurs into two categories. The first one is the Process-Level Risks also known as the Operational-Risks – these risks are standard for the general functioning of a business. They usually manifest themselves in some of the flows of the RUD UA logistics, for instance in transportation or warehousing. The second category is Company-Level Risks (Strategic Risks) - They are more extensive risks and can influence the enlisted RUD UA Company's overall performance and its strategy or operation, in general.

The level of impact (cost of losses or disruption to operations) evaluated in the range from 1 to 5 with the following meaning:

- 5 - catastrophic
- 4 - serious
- 3 - middle
- 2 - small
- 1 – minor

The level of probability of occurrence evaluated in the range from 1 to 5 with the following meaning:

- 5 - (probability from 81-100%). The highest probability range of 81-100% belongs to frequent risks. These are events that occur regularly, every month, or more frequently. The risks in this category are predictable and well-known in the industry, like small disruptions in supply chains, routine equipment maintenance issues.
- 4 - (probability from 61-80%). This level is for risks that are likely to happen multiple times a year. The 61-80% range was chosen to show events that are common in the logistics operations of the RUD UA and can be expected to occur at least a couple of times per year. These are risks like moderate delays, regular fluctuations in demand, or equipment failures. Those risks are predictable and require consistent management attention.
- 3 - (probability from 41-60%). The probability of occurrence is medium, it will occur more than once a year. In some cases, such an event may occur; this applies to some cases. The range of 41-60% represents risks with a medium chance of happening at RUD UA. This level represents risks that occur occasionally, such as once a year or in some cases more than once a year. These events are related to already-known issues within the company, for example, seasonal fluctuations or occasional delays at customs.

- 2 - (probability from 21-40%). The range of 21-40% was chosen to show that the event might occur once every few years, for example, once every two years. These are risks at the RUD UA that could arise because of occasional external factors, for example, rare regulatory changes or unusual market conditions, but remain uncommon in the day-to-day operations of the company.
- 1 – (probability from 1-20%). The probability range of 1-20% was selected to show the minimal chance of occurrence at the company. Such risks are usually rare and occur only under very specific conditions. This level applies to risks that are infrequent and have almost no historical data within the RUD UA logistics process.

The percentages were derived using a combination of consultation with logistics professionals, mainly with the head of the logistics department mr Serhii Muravytski, and his team, to determine the likelihood of various risks based on their experience as well as the reviewing the frequency of past events in RUD UA’s transportation process.

When the level of impact and the probability of occurrence are known, the next step is to identify the significance of those risks. According to the following formula in (Guevara, 2024), which is based on the Risk Assessment Matrix:

$$\text{Risk significance} = \text{Probability of Risk} \times \text{Consequences of Risk}$$

Determining the Risk Significance Coefficient allows the establishment of the weight of the risk assessment and prioritizes the list of identified hazards. Grouped risk types represent real threats to the company and indicate the direction of corrective actions.

In this way, by establishing the probability and impact of each risk category, I simultaneously prioritize each of them according to the degree of significance: low (1-6), medium (8-12), and high (15-25). After determining the degree of significance, it is possible to assign each threat to the appropriate field according to the risk assessment map method, which will be given after the Table 7. Table 7 presents a detailed analysis of the identified risks, categorizing them based on their probability and potential impact on the transportation process.

Table 7: Identification and assessment of risks in the transportation process of RUD UA

Symbol	Identified risk	Classification of Risks	The reason	Risk evaluation		
				Impact (Consequences), based on an average value	Probability of occurrence	Significance
A1	Lack of conformity of the ordered data	Company-Level Risk	Incorrect date of loading/unloading with the bill of lading	3 - middle	3 – more than once a year	9 - medium
A2	Demand forecast challenges	Company-Level Risk	Difficulties in predicting future demand based on available data	3 - middle	3 – more than once a year	9 - medium

table continues

Table 7: Identification and assessment of risks in the transportation process of RUD UA
(cont.)

Symbol	Identified risk	Classification of Risks	The reason	Risk evaluation		
				Impact (Consequences), based on an average value	Probability of occurrence	Significance
A3	Unreliable market data	Company-Level Risk	Inaccurate information affecting decision-making	2 - small	2 - once every two years	4 - low
A4	Limited market data in new markets (Germany & Greece)	Company-Level Risk	Insufficient information for market analysis	3 - middle	2 - once every two years	6 - low
B1	Lack of permission to transport certain goods	Process-Level Risks	Permission was not submitted on time or incorrect data was entered	4 - serious	2 - once every two years	8 - medium
B2	A packing certificate that is improperly filled out	Process-Level Risks	Omissions or errors in the packing certificate that was provided to the driver	2 - small	2 – once every two years	4 - low
B3	Absence or errors in transportation documents	Process-Level Risks	Improperly completed transport documentation. Lost documents	2 - small	2 – once every two years	4 - low
B4	Improper marking of the vehicle	Process-Level Risks	Mistake in marking the vehicle	2 - small	1 – occurred rarely	2 - low
B5	Changes in customs regulations or tariffs	Process-Level Risks	Modifications in rules affecting compliance	3 - middle	4 - occurs regularly	12 - medium
B6	Non-compliance with the driver's working time	Process-Level Risks	External factors: weather conditions, strikes, transport disruptions. Driver haste, working too slow	3 - middle	3 – more than once a year	9 - medium
C1	Inadequate protection of goods	Process-Level Risks	Poor technical security conditions	4 - serious	2 – once every two years	8 - medium
C2	Theft of the goods	Process-Level Risks	Stopping at dangerous and inappropriate parking lots	5 - catastrophic	1 – occurred rarely	5 - low
C3	Driver/operator's inebriety	Process-Level Risks	Inappropriate behavior of staff	3 - middle	1 – occurred rarely	3 - low
C4	Employees who do not come to work or are late to work (strikes)	Company-Level Risk	External factors: weather, strike	4 - serious	2 – once every two years	8 - medium
C5	Lack of driver competence	Process-Level Risks	Expiration of the document	3 - middle	1 – occurred rarely	3 - low

table continues

Table 7: Identification and assessment of risks in the transportation process of RUD UA
(cont.)

Symbol	Identified risk	Classification of Risks	The reason	Risk evaluation		
				Impact (Consequences), based on an average value	Probability of occurrence	Significance
C6	Accident at work	Process-Level Risks	Employee illness. Failure to comply with health and safety rules	4 - serious	2 – once every two years	8 - medium
C7	Vehicle malfunction	Process-Level Risks	Improper operation of the vehicle	4 - serious	2 – once every two years	8 - medium
C8	Accident on the road	Process-Level Risks	Driver fatigue. Distractions (using phones, eating while driving). Speeding	4 - serious	2 – once every two years	8 - medium
C9	The change in the temperature of the product	Process-Level Risks	Failures within the lorry's refrigeration unit. Unforeseen delays at the border. Frequent door openings	5 – catastrophic	3 – more than once a year	15 – high
C10	Delivery delays/damage (peak season)	Process-Level Risks	Issues related to transportation and handling	3 - middle	3 – more than once a year	9 - medium
C11	Ice cream damage (high volume, peak season)	Process-Level Risks	Accidental damage during handling or storage	3 - middle	3 – more than once a year	9 - medium
C12	Equipment failures	Process-Level Risks	Technical problems that affect production or operations	5 - catastrophic	2 – once every two years	10 - medium
D1	Air sirens/lack of electricity	Process-Level Risks	Military activity. Infrastructure damage (power grids)	4 - serious	5 – occur regularly	20 – high
D2	Order fluctuation	Company-Level Risk	An external factor that influences demand	3 - middle	3 – more than once a year	9 - medium
D3	Unpredictable weather during the summer season	Company-Level Risk	An external factor that impacts demand and operations	2 - small	3 – more than once a year	6 - low
D4	Raw material shortage (peak season)	Company-Level Risk	External factors influencing the supply chain	4 - serious	2 – once every two years	8 - medium
D5	Warehouse storage costs (low season)	Company-Level Risk	Operational cost related to demand fluctuations	2 - small	3 – more than once a year	6 - low

table continues

Table 7: Identification and assessment of risks in the transportation process of RUD UA
(cont.)

Symbol	Identified risk	Classification of Risks	The reason	Risk evaluation		
				Impact (Consequences), based on an average value	Probability of occurrence	Significance
D6	Border delay process	Process-Level Risks	Missing or inaccurate documents (commercial invoices, certificates of origin, or health certificates). Extra checks of perishable goods (ice cream) - physical inspections of trucks and cargo	4 - serious	4 - a couple of times a year	16 - high

Source: own work.

Following the analysis of the four risk categories (A, B, C, D), a list of 28 detailed risks was generated, for which their significance was determined. Based on the consequences/impact and probability of a given risk, it is possible to decide on its location in the risk map. Table 8 illustrates the distribution of these risks according to their severity and likelihood, providing a visual representation of their relative significance.

Table 8: Risk map

Impact	Probability of occurrence				
	1 – (1-20%)	2 - (21-40%)	3 – (41-60%)	4 – (61-80%)	5 – (81-100%)
5 - catastrophic	C2	C12	C9		
4 - serious		B1, C1, C4, C6, C7, C8, D4		D6	D1
3 - middle	C3, C5	A4	A1, A2, B6, C10, C11, D2	B5	
2 - small	B4	A3, B2, B3	D3, D5		
1 - minor					

Source: own work.

The significance of each risk is represented in the Risk Map analysis. The green color represents the low significance level (1-6), the yellow one is medium (8-12), and the red one is the high level (15-25). Every risk has a specific impact on the performance of freight tasks or financial and legal consequences. Risks with low significance usually do not affect the reputation of the RUD UA or the safety of employees. However, those risks can occur under exceptional conditions. 10 risk factors were assigned to the category with low

impact, C2, C3, C5, A4, B4, A3, B2, B3, D3, and D5. Three risks fall under the category of human factors, technical problems, or accidental circumstances (C2, C3, and C5). Non-compliance with regulations and documentation errors are frequent with the low-significance level (B2, B3, and B4).

15 potential risks (C12, B1, C1, C4, C6, C7, C8, D4, A1, A2, B6, C10, C11, D2, and B5) showed medium materiality level. The medium materiality of the risk poses a threat to the goals and task performance of the company. In most cases, the level of risk requires continuous monitoring, checking and carefully taking appropriate action every time. The majority of risks belong to medium-level of significance. This means that RUD UA does not face catastrophic threats, however, it operates in an environment where the potential for disruptions is significant.

The risks C9 (The change in the temperature of the product), D6 (Border delay process), and D1 (Air sirens/lack of electricity) have a high level of significance to the company. All the classified risks in this category are at the Process- Level (Operational level) of the company. These events can cause high financial losses (lost revenue), legal damages (potential fines), and sometimes loss of a good shipping image. The risk C9 directly impacts product quality and safety, as spoiled ice cream is not saleable and can damage the company's reputation. Two external factors (Air sirens/lack of electricity, and Border delay process) are risks beyond the direct control of the company that impact operations or the supply chain on a significant level.

4.4 Case Study Analysis

I have analysed the risk C9 (The change in the temperature of the product), which is on a Process- Level (Operational level) in detail, as this risk has a high level of significance to the company and in the Risk map was detected in a red zone of the impact and probability of occurrence. The decision to analyze this event is based on the significant impact on the company's core business and the overall value it provides.

As the company works with temperature-sensitive products, any deviation from the required temperature conditions can lead to significant financial losses, damage the company's reputation, lead to non-compliance with regulatory standards and reduce customer satisfaction.

A real-life example demonstrating this risk is the shipment of ice cream products on March 19, 2024, under contract No. 07-07/17-PL dated July 7, 2017, between Zhytomyr Butter Plant JSC (RUD UA) and PURA VIDA spolka ograniczona odpowiedzialnoscia sp. k (Poland), as per invoice No. 16 dated January 23, 2024. JSC "Zhytomyr Butter Plant (RUD UA)" products were shipped:

- "Children's Desire" ice cream, waffle cup, 70g. (256 boxes),

- Ice cream "Super Chocolate" waffle cup, 70g. (256 boxes),
- "Helado" ice cream, waffle cup, 70g. (1728 boxes),
- "Helado chocolate" ice cream, waffle cup, 70g. (1047 boxes),
- "Helado cherry" ice cream, waffle cup, 70g. (1269 boxes),
- Eskimo ice cream "Eskimos", 80g. (144 boxes).

Since ice cream requires strict temperature control, even a minor deviation could affect the product's quality and lead to potential losses. This event highlights the real-world implications of temperature-related risks and underscores the importance of effective risk management in ensuring product integrity and business sustainability.

Before loading the product into the refrigerator semi-trailer, the temperature inside was +4.5°C, and the temperature of the product was (- 19°C). At the time of customs clearance of products on March 19, 2024, the temperature in the refrigerator semi-trailer was (- 22°C).

On April 6, 2024, the products were returned to Ukraine due to non-compliance with the temperature regime of product storage by State standards of Ukraine 4735:2007 "Ice cream with a combined composition of raw materials. Technical conditions", State standards of Ukraine 4733:2007 "Ice cream, milk, cream, filling. Technical conditions" which led to partial deterioration (deformation) of the ice cream.

During the inspection and counting of the products, it was found that the ice cream was packaged in cardboard boxes, stacked on pallets, and wrapped in stretch film. The total number of pallets was 33 pcs. (11 pallets along the length of the semi-trailer and 3 pallets in a row each width of the trailer).

At the moment of opening the door, the electronic thermometer of the refrigerated semi-trailer indicated a temperature of (- 26°C). After opening the door of the refrigerator semi-trailer, the temperature was recorded as (- 1,4°C).

An expert of the Zhytomyr Chamber of Commerce and Industry with the participation of representatives of JSC "RUD UA" conducted a sample to check the product quality by measuring the temperature of the samples. The selection of ice cream samples was carried out by opening cardboard boxes with ice cream of the same type, which were taken from different pallets.

The temperature was measured using 2 electronic thermometers model TFA 30.1018. The detailed findings of this inspection are summarized in Table 9. Upon unloading the refrigerated semi-trailer, the following products were found:

Table 9: Inspection Report of Ice Creams - Packaging, Labeling, Temperature, and Product Condition

Product	Quantity of inspection	Packaging	Labeling	Temperature of selected samples	Condition of the ice cream
"Children's Desire" ice cream, waffle cup, 70g.	256 cardboard boxes, each containing 30 servings of ice cream	The boxes were placed on 2 pallets, with 128 boxes per pallet, arranged in 8 rows of 16 boxes. The pallets were wrapped in stretch film.	Each pallet had a label with a barcode indicating the product name and the number of boxes. The labels on the boxes provided the following details: <ul style="list-style-type: none"> - Manufacturer and address of production facilities - Product name (ice cream) - Net weight of each package - Number of packaging units - Net weight of the ice cream in the transport container - Storage conditions (temperature not exceeding -18°C) - Batch number - Production date - State standards of Ukraine 4733:2007 certification - Barcode 	+0.5°C, -6.2°C, -8.1°C, - 12.3°C.	<input type="checkbox"/> Visible deformation and shrinkage of the ice cream <input type="checkbox"/> Separation of the ice cream from the waffle cup walls <input type="checkbox"/> Waffle cups were moist to the touch and had a flattened shape <input type="checkbox"/> Ice cream was soft
"Super Chocolate" ice cream, waffle cup, 70g.	256 cardboard boxes, each containing 30 servings of ice cream.	The boxes were placed on 2 pallets, with 128 boxes per pallet, arranged in 8 rows of 16 boxes. The pallets were wrapped in stretch film.	Each pallet had a label with a barcode indicating the product name and the number of boxes. The labels on the boxes provided the same details as were mentioned in the description of "Children's Desire" ice cream	-10.6°C, -11.2°C, -13.5°C, -14.0°C, -16.3°C	<input type="checkbox"/> Visible deformation and shrinkage of the ice cream <input type="checkbox"/> Separation of the ice cream from the waffle cup walls <input type="checkbox"/> Waffle cups were moist to the touch and had a flattened shape <input type="checkbox"/> Ice cream was soft
"Helado" ice cream, waffle cup, 70g.	17 cardboard boxes, each containing 30 servings of ice cream.	The boxes were placed on 12 pallets, with 144 boxes on each pallet, arranged in 9 rows of 16 boxes. The pallets were wrapped in stretch film.	Each pallet had a label with a barcode indicating the product name and the number of boxes. The labels on the boxes provided the same details as were mentioned in the description of "Children's Desire" ice cream	-9.7°C, -12.1°C, -12.2°C, -12.3°C, -12.5°C, -15.0°C, -16.0°C, -17.0°C, -19.6°C, -20.8°C, -25.1°C.	<input type="checkbox"/> Visible deformation and shrinkage of the ice cream <input type="checkbox"/> Separation of the ice cream from the waffle cup walls <input type="checkbox"/> Waffle cups were moist to the touch and had a flattened shape <input type="checkbox"/> Ice cream was soft

table continues

Table 9: Inspection Report of Ice Creams - Packaging, Labeling, Temperature, and Product Condition (cont.)

Product	Quantity of inspection	Packaging	Labeling	Temperature of selected samples	Condition of the ice cream
“Helado chocolate” ice cream, waffle cup, 70g.	1,047 cardboard boxes, each containing 30 servings of ice cream.	The boxes were placed on 7 pallets, with 144 boxes on each pallet, arranged in 9 rows of 16 boxes. The pallets were wrapped in stretch film.	Each pallet had a label with a barcode indicating the product name and the number of boxes. The labels on the boxes provided the same details as were mentioned in the description of "Children's Desire" ice cream	-4.6°C, -6.1°C, -14.7°C, -18.1°C, -24.3°C, -26.0°C.	<input type="checkbox"/> Visible deformation and shrinkage of the ice cream <input type="checkbox"/> Separation of the ice cream from the waffle cup walls <input type="checkbox"/> Waffle cups were moist to the touch and had a flattened shape <input type="checkbox"/> Ice cream was soft
“Helado cherry” ice cream, waffle cup, 70g.	1,269 cardboard boxes, each containing 30 servings of ice cream.	The boxes were placed on 9 pallets, with 144 boxes on each pallet, arranged in 9 rows of 16 boxes. The pallets were wrapped in stretch film.	Each pallet had a label with a barcode indicating the product name and the number of boxes. The labels on the boxes provided the same details as were mentioned in the description of "Children's Desire" ice cream	-8.1°C, -9.2°C, -9.8°C, -10.8°C, -11.0°C, -12.4°C, -12.6°C, -12.1°C, -15.0°C, -17.4°C.	<input type="checkbox"/> Visible deformation and shrinkage of the ice cream <input type="checkbox"/> Separation of the ice cream from the waffle cup walls <input type="checkbox"/> Waffle cups were moist to the touch and had a flattened shape <input type="checkbox"/> Ice cream was soft
Eskimo ice cream "Eskimos," 80g.	144 cardboard boxes, each containing 30 servings of ice cream.	The boxes were placed on 1 pallet, with 144 boxes arranged in 9 rows of 16 boxes. The pallet was wrapped in stretch film.	Each pallet had a label with a barcode indicating the product name and the number of boxes. The labels on the boxes provided the same details as were mentioned in the description of "Children's Desire" ice cream	-19.0°C -19.2°C.	

Source: own work.

The specified defects are the result of non-compliance with the temperature requirements for product storage in the refrigerated semi-trailer, leading to the damage (spoilage) of the ice cream. Figure 16 features the “Super Chocolate” ice cream.

Figure 16: Ice cream "Super Chocolate"



Source: RUD UA (2024b).

Figure 17 showcases the “Children's Desire” ice cream. It illustrates the impact of improper temperature control.

Figure 17: Ice cream "Children's Desire"



Source: RUD UA (2024b).

The (FRC) - Refrigerated – Reinforced – Class C certificate ensures that the vehicle used by RUD UA for shipping ice cream to their customer, PURA VIDA in Poland, on the day of delivery complied with international standards for refrigerated transport. The FRC document shows that this certification was issued by the Latvijas Autotransporta Līdzekļu Sertifikācijas Centrs (Latvian Vehicle Certification Center), and confirms that a refrigerated vehicle has been tested and meets the standards required for transporting perishable goods according to the (ATP) - Agreement on the International Carriage of Perishable Foodstuffs. The following document provides the vehicle information such as

registration number, vehicle identification number, manufacturer, and the refrigeration unit. Figure 18 presents the FRC certificate.

Figure 18: The FRC certificate

LATVIJAS AUTOTRANSPORTA LĪDZEKĻU SERTIFIKĀCIJAS CENTRS

LV UTN 40003375495-02-2003-F3

IEKĀRTA / EQUIPMENT							
LV	40003375495	IZOLĀCIJAS INSULATED	SALDĒŠANAS REFRIGERATED	MEHĀNISKĀ SALDĒŠANAS MECHANICALLY REFRIGERATED	SILDĪŠANAS HEATED	MEHĀNISKĀ SALDĒŠANAS UN SILDĪŠANAS MECHANICALLY REFRIGERATED AND HEATED	DAUDZTĒRŠŅU MULTI- TEMPERATURE

SERTIFIKĀTS / CERTIFICATE **ATP 71991023**

Izdots saskaņā ar Nolīgumu par ātri bojājošos pārtikas produktu starptautiskajiem pārvadījumiem un par speciālām iekārtām, kas izmantojamas šo pārvadījumu veikšanai / Issued pursuant to the Agreement on the International Carriage of Perishable Foodstuffs and on the Special Equipment to be Used for such Carriage (ATP)

- Izdevēja iestāde / Issuing authority: **LATVIJAS AUTOTRANSPORTA LĪDZEKĻU SERTIFIKĀCIJAS CENTRS
LALSC SIA
PUSPIEKABE FURGONS**
- Iekārta / Equipment: **AM3085XF**
- Reģistrācijas numurs / Registration number*: **AM3085XF** Transportlīdzekļa identifikācijas numurs / Vehicle identification number*: **WKESD00000647357**
- Piešķirta / allotted by: **KRONE** Izolētās virsmašāve / Insulated box: **KRONE, SD/TKS, 026692, 02/2015**
- Īpašnieks vai lietotājs / Owner or operated by: **LLC WINGS TRANS, Zhytomyrska obl., Zhytomyrskiy r-n, Zhytomyrska grom., m. Zhytomyr, vul. Granitna, 16C, Ukraine**
- Iesniedzējs / Submitted by: **LLC WINGS TRANS**
- Ir apstiprināta kā / Is approved as: **C- KLASES MEHĀNISKĀ SALDĒŠANAS IEKĀRTA FRC**
- Ar vienu vai vairākiem termoteriētiem, kas ir / With one or more thermal appliances which is (are): **CARRIER, VECTOR 1550-11 INSONO, R404A, ZC502151/2015**
- 6.1.1 Autonom(-as) / Independent;
- 6.1.2 Nav autonom(-as) / Dependent;
- 6.1.3 Noņemama(-as) / Removable;
- 6.1.4 Nav noņemama(-as) / Not removable.
7. Sertifikāta izdošanas pamatojums / Basis of issue of certificate:
 - Šis sertifikāts ir izdots, pamatojoties uz / This certificate is issued on the basis of:
 - Iekārta pārbaudēm / Tests of the equipment;
 - Atbilstību paraugizstrādājumam – conformance with a reference item of equipment;
 - Regulāro apskati / A periodic inspection;
 - Norādīti / Specify:
 - Pārbaudes staciju / The testing station: **LALSC**
 - Pārbaudu veidu / The nature of the tests: **Izolācijas spēju pārbaude
Termoteriētu darbības efektivitātes atbilstības noteikšana**
- 7.2.3 Pārbaudes protokola(-u) numuru(-us) / The number(s) of the report(s): **71991023, LALSC, 2023/10/23**
- 7.2.4 Koeficients K / The K coefficient: **0,400 W/m²·°C**
- 7.2.5 Lietderīgā salīdzināšanas jauda, ja ir +30 °C ārējā temperatūrā un šīs iekārtas temperatūrā / The effective refrigerating capacity at an outside temperature of 30 °C and an inside temperature of:

	Nominal capacity	Evap.1	Evap.2	Evap.3
°C	14995 W	XXXXX W	XXXXX W	XXXXX W
°C	11641 W	XXXXX W	XXXXX W	XXXXX W
°C	8287 W	XXXXX W	XXXXX W	XXXXX W
- 7.3 Atveru un īpašā aprīkojuma skaits / Number of openings and special equipment: **2**
- 7.3.1 Durvju skaits / Number of doors: **2** aizmugures durvis / rear door 2 sānu durvis / side door(s)
- 7.3.2 Ventilācijas atveru skaits / Number of vents:
- 7.3.3 Aprīkojums gaiss ķāršanai / Hanging meat equipment:
- 7.4 Cits aprīkojums / Others: **10 - 2026**
8. Šis sertifikāts ir derīgs līdz / This certificate is valid until: **10 - 2026**
- 8.1 Ar nosacījumu, ka / Provided that:
 - Izolētā virsma un attiecīgā gadījumā termoteriēti tiek uzturēti labā stāvoklī, un / The insulated body and, where applicable, the thermal appliance is maintained in good condition; and
 - Termoteriēti netiek būtiski mainīti / No material alteration is made to the thermal appliances;
9. Apstiprināja / Done by: **RIGA**
10. Datums / On: **2023/10/23**

Kompetentā iestāde / The competent authority
LALSC
Atbildīgais par ATP / Responsible for the ATP
(Amatpersonas Vārds, Uzvārds/Officer name)
Vadims Pintāns

* Nav obligāts / Not mandatory

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Source: RUD UA (2023).

The case of RUD UA shows the critical importance of following all norms related to temperature regime during the transportation of goods over a long distance. The temperature fluctuation led to damage and deformation of the product. This case demonstrates the need for reliable process control and compliance with international standards such as the Agreement on the International Carriage of Perishable Foodstuffs to ensure the integrity of goods during transportation and prevent losses for both the supplier and the customer. As was mentioned in Chapter 2.4 Risk related to the transportation of goods, “According to the national legislation of Ukraine and international law, from the moment the goods are accepted by the driver (carrier) until they are delivered to the recipient, the carrier bears all responsibility”. In the case of RUD UA, the carrier assumed full responsibility for the damaged goods.

5 SUGGESTIONS FOR RISK REDUCTION AND THEIR CRITICAL EVALUATION

An analysis of the current situation at RUD UA has shown how significantly the risk factor affects the operations of the enterprise. The impact of risk influences various aspects of the company, deteriorating its financial stability, production capabilities, marketing potential, ability to meet obligations, and other areas. Additionally, after studying the operations of different departments (conducted interviews, observation during internship), the following key issue was identified: functional specialists focus specifically on local tasks within their departments, and achieving departmental goals does not always align with or lead to achieving the organization's overall objectives.

This shows the importance and necessity of an effective risk management system within the enterprise. To improve the implementation of the risk management system at the RUD UA, it is proposed to create and calculate the following: create a separate risk management department consisting of 3 people, or hire one person who will perform all functions, such as risk identification, risk analysis and assessment, and development of measures to reduce risks. This person will function as a "one-person unit". This should ensure a more effective approach to managing risks.

The most effective way to implement the risk management function at an enterprise is to create a specialized unit or subsystem within the existing enterprise management system that integrates seamlessly with other traditionally independent functional subsystems of the company. Considering the recommendations of the risk management literature and the identified shortcomings at the RUD UA, the risk management department should include the following key groups: assessment of internal and external threats, risk analysis, development of a risk countermeasure strategy, and crisis management. All of these groups should be integrated into the risk management process and linked through information flows (in the case of hiring 3 employees). If the company hires only one employee, this

person should be responsible for all of the above information. Therefore, in this case, it should be a person with a senior position.

Based on the above information, I will calculate 2 variants for the company. Variant 1 – to hire 3 people, and Variant 2 – only one person with the senior position who will take all responsibility. I will calculate the break-even point of risk-related losses for both variants to find if it is profitable to create a department, and will make the comparison at the end.

Variant 1 (Hiring 3 people for (RMD) – Risk management department)

Table 10 shows the calculation of the required staff to start the department and the planned salary based on the competence of the employee and the current economic situation in Ukraine.

Table 10: The calculation of the required staff and the planned salary

Specialist position	Quantity	Monthly payment in UAH
Head of the Department	1	40 000 UAH
Risk manager	1	30 000 UAH
Economist	1	20 000 UAH
In total	3	90 000 UAH

Source: own work.

Table 10 outlines a suggested team structure proposed in this thesis as part of the risk management recommendations. While it is not currently included in RUD UA’s official strategy, it reflects a realistic and forward-looking approach based on identified challenges and the company’s current exposure to risk. The salary figures are aligned with typical market rates in Ukraine and correspond to the expected qualifications of the proposed roles.

The estimated monthly payment is based on the average salary situation in the Zhytomyr region, where the RUD UA office is located, for highly educated experienced employees. To set up a department, the company must allocate 90,000 UAH per month to implement the new department (only salaries are included). The effectiveness of these implementations will be calculated below. First, I will calculate the Total Annual Cost and for this, I will use the following information: annual labour costs, social deductions, and additional expenses (equipment).

Annual labour costs for the department are $90,000 \text{ UAH} \times 12 \text{ months} = 1,080,000 \text{ UAH}$.

Social deductions in Ukraine are 22%, $1,080,000 \text{ UAH} \times 0.22 = 237,600 \text{ UAH}$.

Additional expenses like PC, equipment, and training are estimated at 90,000 UAH annually (relevant only for the first year of the department's establishment).

The Total Annual Costs are 1,080,000 UAH (Annual labour costs) + 237,600 UAH (Social deductions in Ukraine) + 90,000 UAH (Additional expenses—first year) = 1,407,600 UAH.

The second step would be to find the break-even point to determine the number of risk-related losses required for the strategy to be profitable. In that case Economic effect \geq Total costs.

Risk-related losses \times by the percentages that we want to achieve, I estimated that a team of 3 employees can reduce risk-related losses by 80 %, so Risk-related losses \times 0,8 = 1,407,600 UAH.

This estimation is based on case studies from the manufacturing sector, specifically focusing on operational risk reduction. Case studies, including Vysus Group, suggest that dedicated teams with appropriate expertise can achieve risk reductions in the range of 70-90% (Vysus Group, n.d.). I have estimated an 80% reduction as an average.

Risk-related losses = 1,407,600 UAH / 0.8 = 1,759,500 UAH.

In the suggested Variant 1, risk-related losses of the year 2024 of at least 1,759,500 UAH are required to break even, otherwise, the strategy is not profitable for the company.

Variant 2 (Hiring 1 person – senior position)

The company must allocate 40,000 UAH per month to hire the risk manager. The effectiveness of these implementations will be calculated below.

Annual labour costs = 40,000 UAH \times 12 months = 480,000 UAH

Social deductions in Ukraine = 40,000 UAH \times 0.22 = 105,600 UAH

Additional expenses—first year = 30 000 UAH

The Total Annual Costs are 480,000 UAH (Annual labour costs) + 105,600 UAH (Social deductions in Ukraine) + 30 000 UAH (Additional expenses—first year) = 615,600 UAH

The second step would be to find the break-even point to determine the number of risk-related losses required for the strategy to be profitable. In that case Economic effect \geq Total costs.

Risk-related losses \times by the percentages that we want to achieve, I estimated that one person can reduce risk-related losses by 50 %, so Risk-related losses \times 0,5 = 615,600 UAH.

Risk related losses = 615,600 UAH / 0.5 = 1,231,200 UAH.

In the suggested Variant 2, risk-related losses of the year 2024 of at least 1,231,200 UAH are required to break even, otherwise, the strategy is not profitable for the company.

My calculations allow the company to evaluate the proposed options for creating a separate Risk Management Department consisting of three people or only one person. If their expenses for 2024 amounted to more than UAH 1,759,500, then it will be beneficial to create a separate department of 3 people to improve costs by 80 percent. If their expenses for 2024 were less than UAH 1,759,500 but more than UAH 1,231,200, then it will be beneficial for the company to hire a person with a senior level to reduce expenses by 50 percent. If the company had much lower risk-related costs, then the above proposals would not be economically viable for RUD UA. In this case, I suggest another alternative strategy to reduce the risks.

To start with, Rud can implement low-cost risk management software or even platforms with free tariffs for each department. For example, Zoho Inventory, RiskWatch, or Trello. These platforms offer many features that can help reduce risks. With the help of these platforms, the company can monitor supply chain disruptions, track temperature indicators, and automate risk assessment. This will allow the company to start improving risk management without the need for additional staff costs. Among the advantages, it can be noted that these tools are easy to use and can be quickly integrated into work processes, which helps to achieve results faster. Also, the company can test these tools without significant investment. These platforms are easy to understand and this makes it easy to train employees. In addition, a big advantage is that the software can be adapted to the needs of different departments of the company, which allows it to cover a wide range of risks (logistics, finance, quality control, or production). If the implementation of one of the free or low-cost tools proves to be effective, the company can gradually move to paid tariffs or more comprehensive solutions. The implementation of free risk management software should be a reasonable step for the RUD UA if they have a limited budget.

6 CONCLUSION

This study aimed to analyze the risk factors in RUD UA's logistics operations and develop effective strategies to mitigate them. The work was aimed at finding answers to three key research questions: (1) What risk factors have a significant impact on logistics and road transportation at RUD UA? (2) What is the level of impact of these risks? (3) What are the possible ways to reduce the identified risks? The answers to these research questions provide practical conclusions and a structured approach to risk management in large companies in the food industry.

In response to the first question, the study identified key risk factors that significantly affect the logistics and road transportation of RUD UA. These include delays at the border, air raids or power shortages, changes in tariffs and customs regulations, and changes in

product temperature. These factors were identified through semi-structured interviews and data analysis, which showed their prevalence and impact on the company's daily operations.

For the second research question, the paper assessed the level of impact of these risks. The results showed that a change in product temperature has a catastrophic financial impact and that other risks mentioned above, such as border delays and changes in customs regulations, also have a significant operational and financial impact. By combining qualitative analysis and quantitative data, a risk assessment map was created, which allowed to assess the impact on the company's operations.

In response to the third research question, three key risk mitigation strategies were proposed: the creation of a specialized risk management team consisting of 3 people, or hiring one person responsible for all functions. I calculated monthly salaries, the amount of tax in Ukraine, and the necessary funds to provide equipment. These data were used to provide the company with calculations of whether this or another proposed option would be economically viable.

An alternative to the recommendations is the implementation of free or low-cost risk management software. This software can be used in different departments of the company to improve the functioning and interaction when a certain risk occurs. These strategies have been critically evaluated and their implementation has shown the potential to reduce operational vulnerabilities and increase overall resilience.

Although the study focused on RUD UA, the findings are relevant to similar organizations facing similar challenges. However, the findings of this study should be interpreted with some limitations in mind. The study focused on only one company, which may limit the generalizability of the results. In addition, the use of qualitative data, such as interviews, may be subjective. The estimation of savings due to the dedicated risk management function are only approximate. Future research could expand on this work by including additional case studies or analyzing the long-term outcomes of the proposed strategies.

To summarize, this research has answered three key research questions by identifying the main risk factors, assessing their impact, and proposing practical mitigation strategies. These findings provide practical recommendations for industry professionals. The implementation of the proposed measures will allow RUD UA to create a more resilient operational structure, ensuring stability and efficiency in an increasingly dynamic environment.

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APPENDICES

Appendix 1: Summary in Slovene

Učinkovito obvladovanje tveganj je ključnega pomena za stabilnost in učinkovitost logističnih dejavnosti, zlasti v logistiki hladne verige, kjer je potreben strog nadzor temperaturno občutljivih izdelkov. Motnje v dobavni verigi lahko povzročijo finančne izgube, poslabšanje kakovosti in škodo ugledu podjetja. V tej magistrski nalogi so analizirani dejavniki tveganja v logistiki in cestnem prevozu v podjetju RUD UA, ki je vodilni proizvajalec sladoleda v Ukrajini. Glavni poudarek te diplomske naloge je opredelitev ključnih tveganj, preučitev njihovega vpliva in predlog strategij za njihovo zmanjševanje. V raziskavi sta uporabljena analiza študije primera in polstrukturirani intervjuji s ključnimi zaposlenimi v podjetju, vključno z vodjo logističnega oddelka, vodjo prodaje in vodjo proizvodnje, z namenom opredelitve kritičnih področij tveganja. Ugotovitve kažejo, da so med najpomembnejšimi tveganji spremembe temperature izdelkov, spremembe carinskih predpisov in tarif, zamude na meji ter letalski napadi ali pomanjkanje električne energije. Analiza študije primera je bila izbrana, ker omogoča vpogled v specifične značilnosti podjetja, ki jih ni mogoče zajeti zgolj s širšo, kvantitativno raziskavo. Za oceno resnosti in verjetnosti teh tveganj je bila uporabljena matrika za ocenjevanje tveganj, ki je pomagala določiti sistematično prednostno razvrstitev strategij za njihovo zmanjševanje. Rezultati matrike za oceno tveganja kažejo, da so napake pri nadzoru temperature in zamude na meji največje tveganje zaradi neposrednega vpliva na kakovost izdelkov in finančno stabilnost.

Za reševanje teh izzivov magistrsko delo predlaga ustanovitev skupine za obvladovanje tveganj, izračun potreb po osebju in plačah ter preučitev izvajanja poceni orodij za obvladovanje tveganj kot alternativne rešitve. Namen teh priporočil je izboljšati operativno odpornost in zagotoviti skladnost z vsemi industrijskimi standardi, v katerih deluje podjetje RUD UA. Ta raziskava prispeva k področju obvladovanja tveganj v dobavni verigi, saj zagotavlja strukturiran okvir za prepoznavanje in zmanjševanje tveganj v logistiki hladne verige. Študija se osredotoča zlasti na podjetje RUD UA, vendar se ugotovitve in priporočila lahko uporabijo za podobna podjetja, ki delujejo v živilski industriji ali v temperaturno občutljivih dobavnih verigah. Morebitne prihodnje raziskave bi lahko raziskale dolgoročni učinek teh predlaganih strategij in preučile, kako nove tehnologije (programska oprema za obvladovanje tveganj) prispevajo k učinkovitejšim praksam obvladovanja tveganj.