Transport Risk Management in the Dairy Industry in the Czech Republic

Romana Heinzova, Kamil Peterek, Katerina Vichova, Jan Jaros

Tomas Bata University in Zlín, Faculty of Logistics and Crisis Management, Studentske nam. 1532, 686 01 Uherske Hradiste, Czech Republic

The Czech food industry is one of the traditional branches of the Czech processing industry and determines the competitiveness of the entire agricultural sector. The food industry represents an essential role as an employer, but it is also crucial for its economic performance. The dairy industry is a specific field. It is confirmed for their whole production and logistics process. A significant part of raw materials and products cannot be stored for a long time, and production processes are affected by several regulations. Transportation is one of the most critical logistics processes. Because dairy products expire quickly, transport emphasizes the speed and efficiency of supply throughout the chain, which carries the risk of burdening transport infrastructure and air pollution. The research aimed to identify the most significant transport risks dairy companies face. Further, evaluate how these risks are managed and the intensity of risk management methods in this field of business. Although the food industry is one of the world's essential industries with necessary implications for the world economy, the authors have encountered a lack of research and expert research to cover this topic and address its specifics and problems. The aim of the research is to identify the most significant transport risks dairy companies face. Further, evaluate how these risks are managed and the intensity of risk management methods in this field of business.

1. Introduction

Food production is one of the critical sectors of the food industry in the European Union and the Czech Republic. The food industry represents a vital role as an employer, but it is also essential for its economic performance. The agro-food supply chain is crucial for all production, as it follows a farm to fork structure. (Mangla et al., 2019) Although the food industry is one of the significant global industries with necessary implications for the world economy. The agri-food supply chain, such as in the dairy sector, is still one of the major subjects which should be examined. (Abdallah et al., 2020) In the Czech Republic, food production is divided into nine groups: processing and canning of meat and production of meat products; processing and canning of fish, crustaceans, and molluscs; processing and canning of fruits and vegetables; production of vegetable and animal oils, and fats; production of dairy products; production of milk products and starch products; bakery, confectionery, and other flour products; other food products; and industrial feeds. According to the share of sales for 2019, their percentage distribution looks as follows.The food chain is relatively complex and involves various processes and economic activities. However, it is a commodity that should show a high level of safety and quality. Risk analysis and risk management are a necessary part of the whole management. Larger companies have experts or even entire departments of experts to analyse potential risks, while for smaller companies and small businesses, the risk management process is difficult to understand. (Bartosova et al., 2021) Higher quality and safer food are still the highest priority in the food industry. (Mangla et al., 2019) The treatment of risks in connection with the production of food products is declared in compliance with legal legislation. Compliance with the HACCP system in food production and transport is also part of the legislation in force in the Czech Republic. Hazard Analysis and Critical Control Point (HACCP) is a food safety management system recognized as essential in securing food safety. Businesses that want to guarantee an even greater guarantee of food production and transport safety are approaching the certification of international standards. In contemporary food supply chains, private food safety standards have become a critical governance mechanism. (Rao et al.,

2021) Standards represent a vital role in promoting food safety, and in many countries, third-party certification bodies carry out audits to determine if food manufacturers comply with a particular standard. (Bar and Zheng, 2018) Companies in the food sector use a Food Safety Management System (FSMS) to ensure the safety of their products and thereby minimize any risk to consumers. (Ballesteros et al., 2019) These systems include certification to standard BRC (British Retail Consortium), IFS (International Food Standard), and ISO 22000.The production of food products is subject to general legal regulations concerning business. At the same time, the production and transport of food are subject to strict food laws to ensure food safety and health. The dairy industry is a crucial field among the production of food products. (Naglova et al., 2017) As the population grows and demand increases, milk is becoming an essential food commodity. (Valsasina et al., 2017) Dairy factories process several products, including milk, cheese, butter, and skim milk. (Wang and Serventi, 2019) Dairy processing is among the most energy-intensive industries in the food processing industry and is typical of high economic importance in many world regions. (Briam et al.,2015)

The dairy industry is a specific field. It is confirmed for their whole production and logistics process. Most raw materials and products cannot be stored for a long time, and several regulations affect production operations. Numerous problems can arise during the transportation and distribution of dairy products, including people management, product damage, leakage, or spoilage. (Jabbour et al., 2015; Mangla et al.,2019) Indeed logistics and distribution are among the most critical factors in supplying dairy-based food products. (Jabbour and de Sousa Jabbour, 2016) In addition, we encounter the problem of seasonality. Highly seasonal milk supplies have consequences for all aspects of the milk supply chain, including milk transport. (Quinlan et al., 2011) For milk transport operations, a sufficient number of milk tankers must be provided to accommodate peak summer supplies, with consequent spare capacity during the periods of low milk supplies (Quinlan et al., 2005). Milk transport involves the multi-stop collection of a perishable food product ex-farm using bulk milk tankers to dairy factories. The material and construction must accomplish all standards to avoid milk contamination. Several standards exist, such as ČSN 17240, ČSN 17241, AISI 304, W: Nr.1.4301. Keane (1986) broke milk transport into six components: transport driving (driving from the plant to the first farm and from the last farm back to the plant); assembly driving (driving from farm to farm); pumping on the farm; pumping at the plant; non-pumping activities at plant and farm (non-pumping activities). Milk transport is a challenging logistical problem that has long been of interest to operational researchers for many years. (Butler et al., 2004) In all these processes, we may encounter the risk of milk contamination. Next, the milk transport may meet other transportation risks. One of these parameters is the degree of risk associated with possible disruption of the transport process. (Kubanova and Kubasakova, 2021) The aim of the paper is to analyse storage and transport risk in the dairy industry and the tools for the mitigation in the Czech Republic.

2. Methodology

The literature research was prepared based on domestic and foreign professional literature, and the basic terms related to the issue are defined. A questionnaire was sent to companies belonging to the dairy industry in September 2021 in the Czech Republic. Contacts for companies were obtained through the database of the Food Chamber of the Czech Republic. Out of the 72 addressed respondents, 35 completed questionnaires were returned. The return was then 49%. The questionnaire consisted of closed and open questions, and the size of the company according to the number of employees also served as an identifier. In the category of up to 50 employees, 15 completed questionnaires were available; in the category 51-250 employees, it was again 15 respondents. There were five respondents in the size category of more than 250 employees. The research focused mainly on two areas of distribution risk management. Firstly, was to identify the frequency of distributional risks. Secondly, there were tools to deal with distribution risks. The questions and possible answers in the questionnaire were consulted with experts during the telephone pre-research and based on the available literature. At the same time, it was determined whether the company's size affects the responses (frequency of distribution risk or the tool used to manage distribution risk). To what extent are transport and storagerisks in the dairy industry managed differently based on company size?

3. Results and Discussion

The primary statistical sample is relatively small; it was decided to use only descriptive statistical characteristics such as mode, median, and variance. To compare the answers in different size categories, it was necessary to normalize the variance (NOR). Similarly, the primary purpose was to compare the answers in size categories for the median, where the median categories (1-4) were used.

Nine cases (A.-I.) were set and analysed based on the survey regarding the frequency of distribution risks. Statistical dependence of individual answers concerning the size of the company was verified. The research question was formed like:

Whether there are statistically significant differences in the frequency of selected distribution risks in the context of company size? Similarly, in the second area examined, four tools were analysed (J.-M.): whether there are statistically significant differences in the frequency of distribution risk management tools in the context of company size.

The occurrence of individual answers from the survey was evaluated according to a four-scaled evaluation of all thirteen cases Ax, Bx, Cx, Dx, Ex, Fx, Gx, Hx, Ix, Jx, Kx, Lx and Mx where x = 1 determines small-sized companies (up to 50 employees), x = 2 determines medium-sized companies (51-250 employees) and x = 3 determines large-sized companies (over 250 employees). The meaning of the individual grades of the rating scale of frequency is defined as follows: 1 - (Hardly) ever, 2 - Rarely, 3 - Sometimes, and 4 - Often. The category "all" has also been added, which gives statistical characteristics for all responses received.

Respondents selected from nine distribution risks, for which they reported the frequency of occurrence:

A – large stocks
B – non-compliance with storage temperature
C – damage to the packaging during transport
D – spoilage of the product during transport
E – non-compliance with the delivery date to the customer
F – truck accident
G – the risk of the information system
H – cost increases due to incorrect planning
I – non-compliance with INCOTERMS clauses

The results for each research area are presented in the following Table 1.

Table 1: Measures of location and variability of the cases A.-I.

Cases	A.all	A.1	A.2	A.3	B.all	B.1	B.2	B.3	C.all	C.1	C.2	C.3
NOR	.684	.593	.770	.320	.372	.415	.320	.320	.594	.415	.261	.640
Mode	1	3	1	1	1	1	1	1	2	1	2	2
Median	2	2	2	1	1	1	1	1	2	1	2	2
Cases	**D.all**	**D.1**	**D.2**	**D.3**	**E.all**	**E.1**	**E.2**	**E.3**	**F.all**	**F.1**	**F.2**	**F.3**
NOR	.235	.154	.261	.320	.594	.320	.640	.320	.189	.154	.154	.320
Mode	1	1	1	1	2	2	3	1	1	1	1	1
Median	1	1	1	1	2	2	3	1	1	1	1	1
Cases	**G.all**	**G.1**	**G.2**	**G.3**	**H.all**	**H.1**	**H.2**	**H.3**	**I.all**	**I.1**	**I.2**	**I.3**
NOR	.235	.000	.320	.320	.398	.320	.486	.320	.135	.135	.154	.000
Mode	1	1	1	1	2	2	1	2	1	1	1	1
Median	1	1	1	1	2	2	2	2	1	1	1	1

Transport risk management tools and their frequency of use have been examined:

J – insurance of transport risks
K - requiring a quality and safety certificate from the transport company
L - regular inspection of the technical condition of vehicles
M - regular training of workers working in transport and transportation.

The results for each research area are presented in the following Table 2.

Table 2: Measures of location and variability of the cases J.-M.

Cases	J.all	J.1	J.2	J.3	K.all	K.1	K.2	K.3
NOR	.821	.652	.545	.320	.721	.735	.450	.640
Mode	3	3	4	1	3	1	3	1
Median	3	2	4	1	2	2	3	1
Cases	**L.all**	**L.1**	**L.2**	**L.3**	**M.all**	**M.1**	**M.2**	**M.3**
NOR	.660	.320	.581	.960	.507	.320	.711	.000
Mode	3	3	2	1	3	3	3	3
Median	3	3	3	1	3	3	3	3

The same data set can also be represented as boxplots shown in figures 1-4. These figures were used to analyse all thirteen cases' location and variability measures.
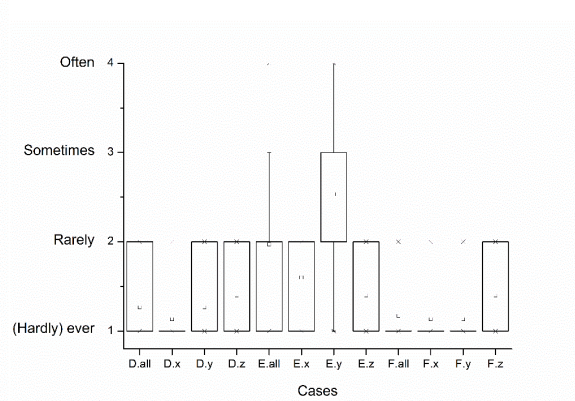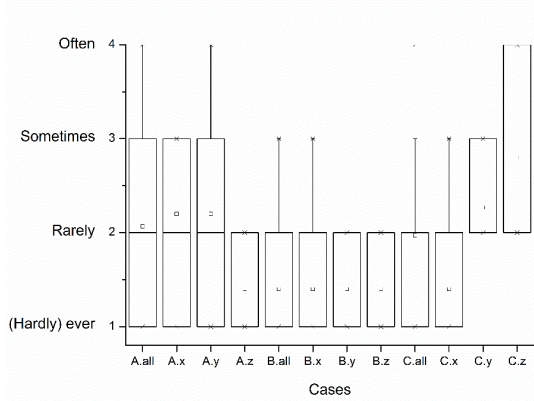
Figure 1: Boxplots of answers on identified cases A.-C.

Figure 2: Boxplots of answers on identified cases D.-F.
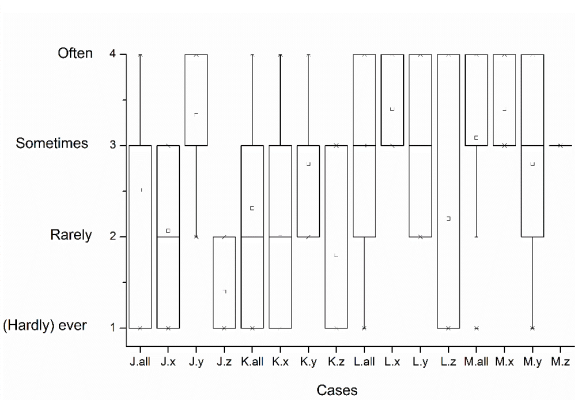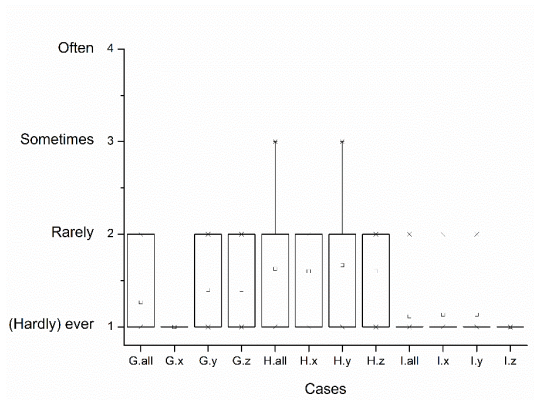

Figure 3: Boxplots of answers on identified cases G.-I.

Figure 4: Boxplots of answers on identified cases J-M.

Excess stocks are perceived as a potentially high risk, especially for small businesses where the mode is 3. For medium-sized companies, a high degree of dispersion is identified; although the mode is 1 and the median is 2, respondents in this size category used all the options offered. Thus, the nature of the excess stock risk cannot be determined with certainty, but it is clear that this risk is perceived as less "risky" than for small businesses. Conversely, for larger companies, excess stocks are considered less significant as a risk or are managed so well (planning, cooperation with customers, demand monitoring) that the occurrence of risk is very sporadic.

Unambiguous outputs were achieved with the characteristic of non-compliance with the temperature in the warehouse. All monitored size categories have a mode and a median of 1. The individual variances are also relatively low. Therefore, we can conclude that there is no difference between the monitored size categories. The risk of non-compliance with the temperature is rarely addressed—relationship with food transport standards, local legislation, and the ever-improving quality of means of transport. Damage to packaging during transport is not considered a small risk by small businesses; according to the respondents, this risk is rarely addressed (mode and median at 1). However, the incidence is more frequent (mode and median at 2). It is probably related to the share of own trucks, the share of the external transport company, and the possibility to address this risk in the form of insurance. Product spoilage does not pose a significant risk to any size category of business. The relatively low variance and the lowest mode and median values are telling. Again, this is related to the high quality of transport, the effort to minimize handling and transport over shorter distances. Failure to meet the delivery date to the customer is less likely for large companies (mode and median at 1), while as the company's size decreases, this risk increases with its frequency. For small enterprises, the mode and median are at 2, for medium-sized enterprises even at 3. However, for medium-sized enterprises, a significant variance is evident. Conformity across size categories can be identified at the risk of a truck accident. The occurrence of risk can be marked as less probable; the Mode and median in all monitored categories are equal to 1. After "INCOTERMS", this is the second-lowest frequency of selected risks ever.

Significant variations in individual categories are noted regarding the requirements for a quality certificate at shipping companies. They do not attach much significance to this topic for smaller and larger companies, as they mostly use their fleet. The change in perception and frequency is evident in medium-sized enterprises. The

low dispersion value of medium-sized enterprises and the mode equal to 3 show a greater dependence on external carriers, i.e., especially for medium-sized enterprises, quality certificates of transport companies are essential. There is also a similar trend in using the insurance instrument to reduce the incidence and impact of transport risks. As in the previous indicator, insurance is widely used by medium-sized enterprises, where even the mode is at 4, and the standardized variance reaches a relatively small value. Large enterprises achieve far smaller variance values, but the mode and median are one. The variance for smaller enterprises is relatively high. Roughly half of the smaller companies contacted use insurance "sometimes" (value 3), while another 40%, on the contrary, "very rarely" (value 1). It is not easy to draw a clear conclusion. Regular inspection of the technical condition of vehicles and maintenance of the vehicle fleet is perceived very differently across size categories. It is more critical for smaller companies than the other size categories monitored. For larger companies, the mode and median are even two values lower than for the category of smaller companies. The standardized variance for larger companies also shows differences in the perception of the role of regular inspections of individual respondents. This is due to whether they use their means of transport or use the services of an external carrier, which is obliged to check the technical condition of the vehicles. Respondents perceive regular staff training as an essential tool for risk prevention in transport and distribution. This is evidenced by the mode in all monitored size categories at 3 and the low variance value, especially for small and large enterprises.

Conclusions

The food sector is one of the key sectors in the Czech Republic. It contributes significantly to employment and other economic aggregates. The dairy industry is a specific field. It is confirmed for their whole production and logistics process. Most raw materials and products cannot be stored for a long time, and several regulations affect production operations. Numerous problems can arise during the transportation and distribution of dairy products, including people management, product damage, leakage, or spoilage. Milk transport is a challenging logistical problem that has long been of interest to operational researchers for many years. The process of transporting dairy products is subject to a number of risks.

The aim of the research was to identify the most significant transport risks faced by dairy companies. Further, evaluate how these risks are managed and the intensity of risk management methods in this field of business. Excess stocks in the warehouse and non-compliance with the temperature in the warehouse can be considered the most significant transport risks. Another significant risk is failure to meet the deadline for the customer. This risk has been reported for Small and Medium Enterprises. The most used tools for transport risk management are quality certificates and risk insurance. These tools are typical for medium-sized businesses. Regular staff training is perceived by respondents as an important tool for risk prevention in the area of transport and distribution However, the food industry is one of the world's significant industries with essential implications for the world economy. The authors have encountered a lack of research and expert research to cover this topic and address its specifics and problems. Therefore, this research also contributed to the expansion of theoretical aspects in the field of logistics of the dairy industry in the Czech Republic.

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