THE IMPORTANCE OF RISK MANAGEMENT IN THE COLD SUPPLY CHAIN

Krešimir Buntak
University North, Croatia
E-mail: krbuntak@unin.hr

Nikola Biškup
University North, Croatia
E-mail: nibiskup@unin.hr

Matija Kovačić
University North, Croatia
E-mail: matkovacic@unin.hr

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Abstract

Risk management within the cold supply chain provides an important part of logistics processes. The cold chain has its many specificities, which consist of a series of activities that must be ensured in order to maintain the required set temperature of the product. For the success of the process in the cold supply chain, it is necessary to minimize every possible risk. In this way, the quality of easily perishable products would be maintained. Standardisation (ISO standards) of the cold chain supplies in this context contributes to its quality and functionality. For the purpose of researching this paper, a survey was conducted on 205 respondents. The main goal of the research was to improve that in the trade of frozen products it is necessary to manage the risks of the cold supply chain in order to ensure the quality of products and services. In the research, it is evident that a large number of consumers encountered products that were under an impermissible temperature that is not set by the standards. 55.1% (113 respondents) confirmed that they encountered a product that was thawed and refrozen. Furthermore, the respondents encountered another problem, damaged packaging of frozen products, which can also have major consequences for the product itself, because the packaging itself has the function of maintaining freshness. Therefore, the problem is not always in the set temperature itself. The survey also mentions problems related to finding damaged goods and broken goods due to poor conditions, as well as the risk of open refrigerator doors, which half of the respondents encountered. In this case, it is necessary to manage risks in the cold supply chain using and applying the requirements of the ISO 28000:2022 standard (risk management in supply chains) as well as using certain risk management tools and analysis.

Keywords: management, risks, supply chain, cold products, quality

1. INTRODUCTION

Supply chain management requires constant challenges. There are several types of supply chains and each of them is inherently different from one another. In this paper, the focus will be on the cold supply chain, that is, the supply chain of products that require low temperatures. This is a very demanding supply chain because it is a commodity that is easily perishable if the given conditions are not met. Such conditions must be met during storage, preservation, transportation, manipulation and other activities within the supply chain. This research paper hypothesizes that there are certain shortcomings of cold supply chain management that can have a bad impact on product quality, business operations and consumer health. Through the conducted research, an attempt will be made to obtain information on whether all the given conditions are respected for the mentioned products and whether the given standards are respected. This work is based on secondary sources that were relevant to the research of the cold regime area, while the research itself, carried out through a survey, is based on primary sources where all valid data were analyzed after the information obtained. The paper aims to reveal the possible risks of the cold supply chain by asking questions. The questions are defined according to possible places of occurrence of a certain risk. The paper used an analysis method that investigated the causes of the market situation and defined possible factors influencing them. After the conducted survey, a deductive method was used, through which conclusions could be reached after the conducted analysis. In the first part of the work, secondary sources of different authors are listed. In combination with the method of comparison, the professional literature of different authors on the subject that the paper deals with was studied. Using the method of compilation and description, all the important points of view of the authors of professional literature were summarized and compared with practice. In the second part, the previously mentioned market research with real data and the conclusion of the research was mentioned. The research of this work was carried out at the level of the entire Republic of Croatia. At the end of the paper, the standardisation (ISO) of the cold supply chain was mentioned in the context of risk reduction, and some of the tools for risk management were listed.

2. COLD SUPPLY CHAIN

A supply chain consists of many different links and activities. It all depends on what kind of chain it is. It also depends on the type of goods that pass through that chain. Certain goods require to be treated in a special way, such as goods that require a certain type of temperature during flow and storage. Such a chain is called a cold supply chain.

Cold chain management refers to the creation of an integrated distribution model focused on three key factors, namely product attributes, performance characteristics, distribution channels, and product origin and destination locations. The product property factor refers to their physical characteristics and special requirements for temperature, as well as humidity during transport, handling and storage. The following are the places of origin and destination of products that describe the place

of final production and consumption of products sensitive to temperature fluctuations. Their interaction enables a detailed description of the cold chain by separating its subsequent subdivisions. Industries that use a cold supply chain are fruits and vegetables, meat and seafood, floriculture, dairy products, confectionery and pharmaceuticals. (Brzozowska, et al., 2016.)

Depending on the type of cold products, certain temperatures are required that vary from -30 °C to +14 °C and these are the following types:

- Banana (12 °C to 14 °C), a group characterized by temperature range enabling to monitor ripening of fruit,
- Pharmaceutical (2 °C to 8 °C), for most specialty pharmaceuticals including vaccines,
- Chill (2 °C to 4 °C), products for which the average storage temperature includes fresh fruits and vegetables, dairy products, meat products and similar,
- Frozen (-16 °C to -20 °C), category for frozen products including meat,
- Deep freeze (-28 °C to -30 °C), group with the lowest achievable temperature, designed to transport seafood. (Wojciechowski, 2014.)

We can see that the temperature required to keep cold products varies. Temperatures that exceed accepted standards may cause damage to products or loss of their required value. In cold supply chains, it is important to minimize transport costs and ensure the safety of transported products. Otherwise, there may be a loss of their physical and chemical properties, which leads to irrational material losses. (Brzozowska, et al., 2016.)

Farms and markets are highly fragmented, leading to an increasing number of intermediate products in the chain, resulting in high delivery times, costs, waste, order returns, complaints and customer dissatisfaction (Shashi, et al., 2018.). Such a thing should not be associated with cold products because they are the most sensitive in that part. Time, which is constantly mentioned, is, along with temperature, the most important component of the cold chain. The delivery time of cold products should be minimized with as few waits and stops as possible to the end point of the supply chain.

In the delivery of products to consumers using a cold chain delivery system, the characteristics of the product determine the evaluation and control systems necessary to maintain the freshness and quality of the product during its delivery to the end user. It is also important to monitor the temperature during the entire cold chain process in order to ensure the safety and quality of the cold chain products, and it is also important to know the nature and characteristics of the product for the construction of the cold chain. With products having a short shelf life and requiring special facilities for storage, distribution and sales, the development of cold chain management (CCM) was a natural progression in supply chain management. (Danso, 2021.)

Storage of such products under consistently recommended conditions is essential for their quality. Storage is done by keeping it using pallets, crates, cartons, glass/plastic bottles and other suitable containers. Such preservation extends their life and ensures that their quality is maintained over long shipping periods, while the

chances of waste, waste disposal costs and associated emissions are minimized. (Sharma, et al., 2021.) However, it is not enough just to properly store cold products, it is necessary to pack them properly, and only in this combination can we say that such products are properly stored (Ndukwu, 2017.).

Research in Pakistan in 2011 revealed that 32% of food produced in that country is thrown away due to risks related to cold supply chain management (Khan, et al., 2022.). In this segment, it is important to recognize the risks that affect the management of the cold supply chain. They are the reason for possible losses in that chain. Proper risk management reduces their negative impact. Below is a research of the risks that may appear in the cold chain. After that, the ways in which they can be detected and managed will be listed.

3. COLD SUPPLY CHAIN MARKET RESEARCH

In this part of the paper, the research of the market of cold products will be mentioned. The research is based on secondary sources that were relevant to the research of the cold regime area, while the research itself, carried out through a survey, is based on primary sources where all valid data were analyzed after the information obtained. The paper used an analysis method that investigated the causes of the market situation and defined possible factors influencing them. After the conducted survey, a deductive method was used, through which conclusions could be reached after the conducted analysis.

3.1 Research method

Research on the topic of this paper was conducted using the sample method through a survey questionnaire. The necessary data for the research was obtained by conducting an anonymous survey in digital form. 205 respondents (n=205) were surveyed. The respondents are buyers of cold products in stores in the territory of the Republic of Croatia. This questionnaire included the collection of quantitative data. Questions are precisely defined in advance that will serve as a source of information and are necessary for this research and their graphic arrangement. Such research used sampling, which, based on a smaller and carefully selected group of people, tried to estimate the percentage parameter or the real average value of the population, i.e. to determine the framework within which the wider community's opinion on the quality of keeping cold products is likely to move. On the basis of the above, the goal of the research is to be realized, which is to detect possible risks by surveying the citizens of the Republic of Croatia. It should be noted that the questions in the survey were determined in such a way that possible places and ways of occurrence of risks from practice were taken into account. All questions were multiple-choice with the question asked and the answer offered, next to which respondents should put a mark if they agree with any of the answers offered. The questions in the survey were simple, mainly for the reason that the respondents would not get confused and that they could give as concrete an answer as possible in accordance with the hypotheses set in the paper. The research was conducted during the first half of 2022.

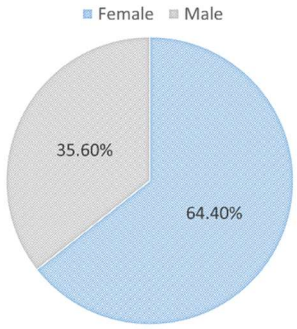
3.2 Research results

The purpose of this research, which was conducted through a survey, is to provide us with answers to the assumptions stated in the paper, and in this way to gain an insight into how the cold chain works in practice, primarily from the consumer's point of view. With the aim of reviewing the conditions and problems in the trade of chilled and frozen products and to obtain a customer rating with the quality of the cold supply chain through product quality assurance.

3.3.1 Graphic display of data

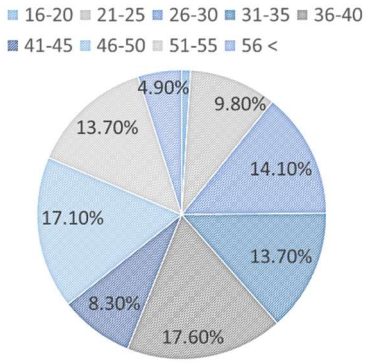
In this part, a graphic presentation of the data obtained by the previously defined survey questionnaire follows. With each graphic representation there is an additional explanation of the results. The information from the obtained data is defined.

Figure 6 Ratio of male and female samples



Source: Authors

Figure 7 Age group of samples

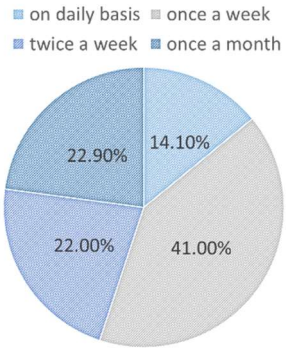


Source: Authors

In Figure 1 one can see the ratio of female and male respondents. In this research, we have a higher proportion of female (64.40%) compared to male (35.60%)

respondents. The graph from Figure 2 shows the age groups of the samples. It can be seen that the age group from 16 to 20 years is in the smallest percentage of only 2 respondents, which is 1%. While the age group from 36 to 40 has the highest percentage of 17.6% (36 respondents).

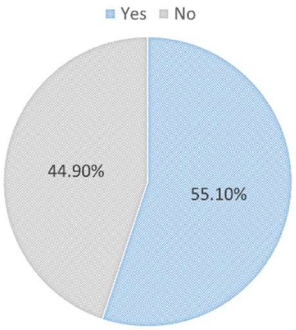
Figure 8 Frequency of purchase of chilled and frozen products



Source: Authors

Further questions in the survey were specified in order to gain an insight into which link is the weakest when the product from the cold regime is already placed on the market. When asked how often they buy chilled and frozen products, the largest percentage (41%) answered once a week, 22.9% answered once a month, which is almost equal to respondents who buy twice a week. 14.1% buy products on a daily basis. The above shows us that people have different habits when it comes to buying products from the cold regime. The obtained data can be seen in Figure 3. When looking at the broader picture, it is evident that the vast majority buy chilled or frozen products almost regularly on a daily, weekly or biweekly basis, which speaks volumes about the important function of such a supply chain.

Figure 9 Temperature changes on products observed by customers



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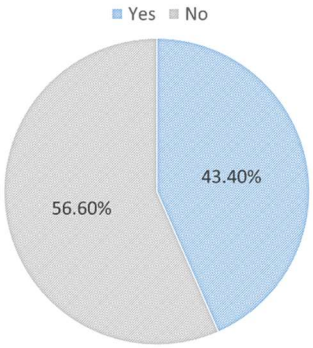
The next question was about whether the customers came across products that were previously thawed and then frozen again. It can be seen in the graph from Figure 4 that out of 205 respondents, 113 of them responded with an affirmative answer, which is 55.1%, while 92 of them (44.9%) responded with a negative answer. Most respondents can recognize if the product has been improperly handled during transport. Such an obtained result is a consequence of an emerging risk in case of inadequate handling, which damaged the quality of the product. Visible signs on the product that indicate changes in the temperature of frozen products are a change in the shape of the product (for example indentations on the product), further wet spots on the packaging (especially on cardboard and paper packaging it is easy to see signs of thawing), the formation of ice crystals inside the closed packaging, stuck to the contents in packaging, product color change (if it is visible through the packaging), etc. A little more than half of consumers have encountered a temperature risk in the cold supply chain, if the temperature of the product is regularly monitored in real time, it is easy to see where the link in the chain has weakened.

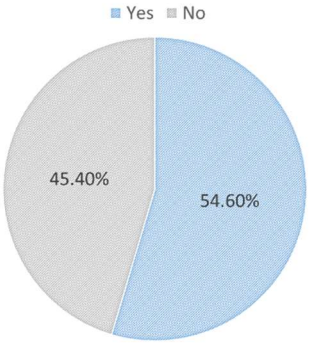
Figure 10 Consumer experiences with damaged packaging of frozen products



Source: Authors

The next question shown in Figure 5 refers to whether consumers had a situation where they bought a product that was damaged (eg its packaging). 56.6% gave a negative answer, while the remaining 43.4% answered that they had encountered the stated condition of the product. This gave us the information that the majority of respondents did not have a negative experience with a damaged product, but still the remaining 43.4% encountered such a situation, and it is certainly not a negligible problem that occurs on the market. Product packaging has a much greater function than that packaging looks nice and attracts the customer. Any damage to the packaging creates the possibility that the customer buys a defective product, which in the extreme case can harm health. It is evident from the research that this problem is present, and when it comes to the fact that this problem is in the cold chain, then there is a double risk. Damaged packaging and the possibility of temperature changes can seriously damage the quality of the product itself.

Figure 11 Opened doors of refrigerated shelves



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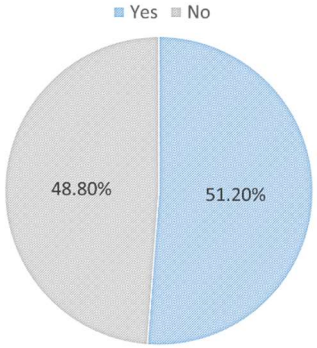
The next question shown in Figure 6 refers to risks that do not occur within the process, but occur after the products have been placed on the market due to the consequences of human carelessness (trader or customer). According to Figure 6, we see that the majority of respondents (54.60%) had experience with an open refrigerator, while the rest (45.40%) did not have this experience. Due to such cases, it often happens that the door of the refrigerated display case remains open/semi-open, which can also damage the quality of temperature-sensitive products. If the door of the display case on the refrigerator is left open or half-open, the temperature in the refrigerator increases, and the situation occurs where the refrigerated products release rarefied air, and on the other hand, the product becomes hotter. By mixing warm and cold air, moisture is created on the product and the packaging becomes wet, which may indicate problems during storage, improper loading or unloading, but in fact the problem arose in stores due to the human factor. For this reason, it is important to record the temperature at every step in order to accurately determine the place of origin of the mentioned problem.

Figure 12 Buying spoiled product



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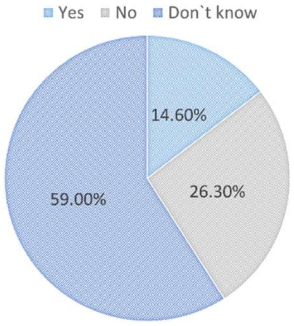
There are products such as meat, fish, milk or eggs that you should definitely pay attention to in their condition because they can dangerously harm the customer's health. The declaration of the expiration date is not the only guarantee that the product is healthy. A problem with the product can also arise when the expiration date is correct, and some part of the process within the cold chain is not respected according to rules, standards and other. Most often this happens in the summer months when the change in temperature easily affects all links of the cold chain from loading, unloading, storage, etc. Some of the solutions can be giving importance to temperature oscillations in warmer months in all stages of the process. On the graph in Figure 7, we can see the worrying fact that almost 51% of the respondents had an encounter with the purchase of a damaged product that had passed its use-by date or was the result of a risk that was not observed within the development of the cold supply chain process. So, it is about the majority of those surveyed. In order to avoid health problems, it is important that customers are careful when buying this type of product despite the expiration date being correct, but on the other hand, it sometimes happens that the expiration date is 'deceptive', which results in unnecessary food waste even though it is still safe for consumption. From this research, data was obtained that the cold chain does not function perfectly and that risks have been observed.

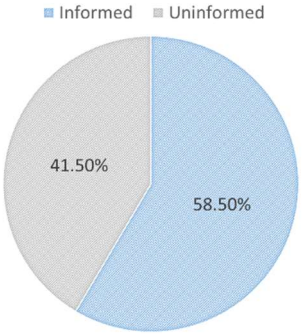
Figure 13 Purchase of products that have subsequently removed from sale



Source: Author

The next question from Figure 8 refers exclusively to products from the cold chain such as meat, fish and other, although the situation with the remove of products from stores for the sake of consumer safety is much more extensive. The situation of removed products from all food categories, not only frozen and semi-frozen products, is becoming more and more frequent. What is worrying is that the vast majority of consumers do not know or are not sure if they have bought and consumed products that were subsequently removed from the market. If we look back at the data obtained through the survey, out of the total number of participants in the survey, even 59% of them responded with *I don't know*, while 14.6% of them responded with an affirmative answer. Only 26.3% of them answered with a negative answer.

Figure 14 Informing customers about the risks of the cold supply chain



Source: Authors

When asked whether consumers are informed about all the risks of improperly stored products from the cold chain, in a survey of 205 respondents, 58.80% answered that they were informed, while 41.50% answered negatively. This indicates to us that there is still a large percentage of consumers who do not take care and are not aware of the risks when buying perishable products.

3.3.2. Research analysis

The research showed that Croatian customers often buy cold products, whether on a daily, weekly or monthly basis. Many respondents encountered products that were thawed and refrozen, which created a risk of product defrosting. This leads to further risks related to the poor quality of the purchased product, and in some cases there are risks related to the health of consumers if such products have been exposed to higher temperatures for too long. If the temperature of the product is regularly monitored in real time, it is easy to see which link in the chain has weakened. The reason can also be various malfunctions in cooling devices, carelessness when monitoring the temperature, etc. In addition to temperature changes, the respondents also had experience with damaged packaging, which leads to risks such as reduced product freshness, reduced shelf life (mostly in the case of fruits and vegetables), microbiological risks, etc. Any damage represents a risk that the customer will buy a defective product. Problems must not only appear in the process of storage, loading or unloading, but also in the part of the supply chain when the product is already available to the customer. For example, respondents in the survey mostly confirmed that they encountered open doors of refrigerated display cases in stores. This leads to an increase in temperature in refrigerated display cases and refrigerators, and the products begin to change their properties, which can affect health safety. Mixing warm and cold air creates moisture on the product. The cause of such problems are malfunctioning display cases or human carelessness, which is the reason in most cases. These are just some of the risks that can occur, and this problem can also lead to risks related to the failure of parts (e.g. the compressor). A good solution can be sound sensors that will warn of the mentioned problem, which can significantly reduce

the risks. Half of the respondents encountered defective products, which shows that the risks are active. The most common reason for this may be the expiration date of the product, but the expiration date does not have to be a guarantee of the correctness of the product, as some other problems may arise in the management of the cold supply chain. We asked the respondents if they had encountered a situation where they bought a cold product that was subsequently withdrawn from sale after their purchase. The vast majority of respondents do not know if such a situation has happened to them (probably due to poor consumer information), while the fewest answered that they have (14.6%). This figure should not be neglected because the risks in this case can be dangerous for the health of consumers. That is why good and timely consumer information is important if such a product was available for purchase. This leads to a reduction of further possible risks. Although the majority of respondents answered that they were informed, almost half of the respondents were still not informed about the risks that may arise. Then the risks become even greater and more uncertain.

On the basis of this research, it is concluded that it is necessary to manage risks in the cold supply chain, which will ensure consumer safety, business credibility and ensure a competitive advantage on the market.

4. COLD SUPPLY CHAIN RISK MANAGEMENT

We saw in the previous chapter of this work that the risks in managing the cold supply chain are very present. In order to reduce the mentioned risks, it is necessary to ensure quality management of such a chain. This should be the responsibility of everyone within the chain, and mostly risk or quality managers.

Standard ISO 28000:2022 talks about risk management in the cold supply chain. It is the basis of quality management of such a chain, which reduces numerous risks as well as those mentioned in the previous research. ISO 28000:2022 is an international standard that requires specific qualifications in the safety management system and includes some critical aspects related to the assurance of safety in the supply chain (Huei Ing, et al., 2019.). Safety is ensured by minimizing risk in every segment and link of the supply chain. In this case, the risks of the cold chain must be specifically detected in order to avoid problems for the organization and for the consumer himself. As stated by certain authors (Huei Ing, et al., 2019.), supply chain security management is important for every industry in any field. This is because the level of market demand for products and services must be fully in line with the requirements of the ISO 28000:2022 standard. This standard must help in continuous improvement to achieve a high level of standards, not just small improvements in the company. The characteristics of ISO 28000:2022 are that it has a pragmatic and business-oriented approach to risk management and promotes risk management as a central component of effective management. The standard also ensures that key decisions are made based on an effective risk assessment process, supports overall compliance management and protects the company from liability issues and third-party claims. (Franke, 2013.) Ultimately, this provides greater consumer satisfaction.

The authors (Prasad & Baker, 2020.) state that risk management must have its own strategy. It must be specialized in perceiving and analyzing the possibilities and outcomes of threats and in selecting appropriate strategies to reduce the likelihood of episodes associated with hostile events. It must be aimed at reducing the effect of the observed risk event. For a better risk management process, 4 steps are carried out:

1. Identify the Risk,
2. Assess the Risk,
3. Control risk,
4. Review controls. (Mahmood, 2021.)

Certain tools can be used in risk management, such as BowTie, which represents the basis for ensuring business continuity. Then SWIFT analysis (Structured What-If Checklist Technique) and HAZOP (Hazard and Operability Analysis) can be used, which is a qualitative tool, and the input to the tool is brainstorming. FMEA (Failure Mode and Effects Analysis) is most often used, which, in addition to risk analysis, also serves to define measures. The authors (Kardos, et al., 2021.) state that the FMEA method belongs to the group of basic analytical methods used in the process of risk management, quality management, reliability and safety, and is one of the basic methods used in the risk assessment process. They also state that it applies not only to production processes but also to financial and social processes. The main goal of the FMEA method is to recognize the possibility of failures as soon as possible, identify their possible causes, consequences, assess risks and safely prevent them.

The most common quality management systems are ISO 9001:2015, Six Sigma, LEAN management and Total Quality Management. In addition to the mentioned standard, there is also the ISO 9001:2015 standard that talks about quality management. These two standards can be closely linked in cold supply chain management. The principles of quality management can be defined as a series of fundamental beliefs, standards, rules and values that are accepted as true and serve as a basis for quality management. The key principles mentioned are customer focus, leadership, involvement of all employees, process approach, continuous improvement, fact-based decision making and relationship management. There are three levels at which quality can be observed:

- quality management systems and models,
- quality tools and techniques,
- quality principles and values. (Buntak, et al., 2021.)

During quality management, it is possible and recommended to use certain tools such as the cause/effect diagram - Ishikawa diagram, Pareto diagram, flow diagram - flowchart, test sheet - check sheet, histogram, scatter diagram and control charts.

In this section, we clearly see that there are ways to properly manage risks at all times. All the above tools, standards, methods and risk management strategies are necessary if we want our cold supply chain to function with quality and without problems. Without such risk management and compliance with standards, we cannot ensure the quality of cold products that are available to consumers every day.

5. CONCLUSION

The cold supply chain is one of the riskier chains. It must meet the numerous requirements of the products that pass through it. Frozen or cold products require a certain temperature that preserves them, otherwise their properties change. In addition to transport under special conditions, it is also important to store cold products, which extends their life and ensures the maintenance of their quality during a longer period of shipment, while the chances of waste, waste disposal costs and related emissions are minimized. One of the measures to preserve product quality is constant temperature measurement and record keeping. In order to determine that there are risks in the cold supply chain, a survey was conducted of Croatian customers of cold products who buy them every day. The scientific research showed that risks are present in certain segments. These risks can be affected by a number of situations from defrosting the products to their refreezing, and it has also been established that there is a problem when customers carelessly leave the cooling devices open and thus increase the temperature of the products. Such problems also affect the health of consumers who cannot know if they have bought a defective product. Some products were later withdrawn from sale, but there is a problem of poor information, which creates additional risks. This confirms the hypothesis of the work set out in the introduction, because the mentioned problems revealed by the research can affect the quality of the product, the business of the company and the health of consumers. In order to reduce the mentioned risks, this work recommends quality risk management through the implementation of a clear strategy. Such a strategy must be in accordance with standards (at most ISO 28000:2022 and ISO 9001:2015), certain risk management tools (eg FMEA) and quality management tools must be used. With this, we can ensure better business operations, a more functional cold supply chain and better customer satisfaction. After the research carried out in this paper, an open question arises as to whether this survey of customers can detect risks and see the actual state of their management, or whether other research is needed. Therefore, future research should go in the direction of risk detection by research conducted on other stakeholders of the supply chain who are responsible for the storage and handling of cold products. This would reveal whether there are any deviations from the survey conducted on customers and the one conducted on other responsible stakeholders.

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