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ORIGINAL PAPER

# FOOD INTEGRITY THROUGHOUT THE CHAIN: THE CASE OF GOOD DISTRIBUTION PRACTICE

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**ABSTRACT**. **Background:** The importance of supply chain management has increased, as consumer concerns about food safety and quality have become more important, along with the demands for large amounts of consistent and reliable products. During distribution, food is exposed to various risks, such as inadequate storage or failure to keep a certain temperature, which consequently affects food integrity. This paper explains the procedures distributors are implementing to guarantee food safety, food quality and overall food integrity in the supply chain.
**Methods:** This paper involves a qualitative study approach. Face to face interviews were conducted in the four (4) leading logistics companies in the cold chain segment, which provide logistics solutions, from delivery of the goods from the manufacturing company to the point of sale.
**Results:** In order to ensure that high quality products are transported properly, and risks are managed effectively, the companies operate in accordance with the principles of different standards. They have work procedures within each activity in the food supply chain to avoid the distortion of food quality and product safety. The whole process of food transport is followed by IT technology, and food categories are divided into nine groups according to the required prescribed temperature. As special requirements need to be respected during the handling of sensitive products, the investigated companies point out the importance of investing in their employees.
**Conclusions:** Food integrity is a holistic concept that relates to food production and distribution, safety and quality. The food supply chain, which tends to be long, global and highly interconnected, leading to greater risk exposure, requires temperature monitoring at every link in the supply chain, particularly in the warehouse and transportation vehicles. Special emphasis on the role of IT and employees is given.

**Key words:** food supply chain, food integrity, food safety, good distribution practice, logistics service providers, Croatia.

## INTRODUCTION

In personalized nutrition, food is a tool for good health, implying an instrumental relationship between food and health [Nordström et al. 2013], where customer trust and confidence are paramount [PwC, 2015]. Nowadays the majority of food products are trustworthy and meet consumer expectations [SGS 2013], but there still are reported cases of consumer-related food incidents, such as razor blades, a sewing needle and other metal objects found in George Weston Foods cakes and a botulism outbreak in Bumblebee Seafoods in 2007 [APEC 2015], a series of food safety incidents in the Chinese food industry in 2008 [Avery 2014, Shears 2010], the horsemeat scandal in the UK in 2013 [Ali et al. 2017], and the Hungarian beef case in 2014 [Donnelley 2014]. For organisations involved in such incidents, it can result in costly product recalls [Whipple et al., 2009], market withdrawals, safety alerts, doubtful reputation of the company and its brands [Hornibrook et al. 2005] and lost consumer trust [Trienekens, Zuurbier 2008]. However, failures in food safety can have serious negative consequences not only for the companies involved, but also for consumers,


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and the worst case scenario occurs when incidents lead to deaths or illness [Trienekens, Zuurbier 2008].

There is undisputed demographic growth with projections that the human population will increase by 50% by 2050 as compared to 7,5 billion people 2017 [United Nations Department of Economic and Social Affairs Population Division 2017, Worldometers, 2017]. This fact demands the modern production-to-consumption food system be capable of feeding few billion people, which on the other hand, has resulted in an extremely complicated food supply chain which over time has evolved into a global system of immense size and complexity. The process of the globalization of the food industry has sparked heightened awareness about the various risks and vulnerabilities that products are exposed to as they move along the supply chain continuum from design and sourcing to manufacturing, transportation, distribution and final sale to the consumer [Marucheck et al., 2011].

The main purpose of this paper is to explore how to ensure that food products are safe, high quality, nutritious, abundant, diverse, convenient, less costly and more readily accessible during the process of distribution in the food supply chain which tends to be long, global and highly interconnected, leading to greater risk exposure [Roth et al., 2008]. Therefore, the paper is structured in a way that it begins with the theoretical background and a definition of the term food integrity and characteristics of the food supply chain and the processes of managing the procurement, movement, storage and handling of food products through the supply chain in order to preserve the safety and quality of food during the distribution phase.

In particular, the paper examines the role of temperature and transport in the food supply chain as the literature [Gustafsson et al., 2009, Hoorfar, Prugger 2011, Smolander et al. 2004] considers temperature monitoring during the transport and storage along the entire food supply chain as key factor to ensure food quality and safety. Despite the noteworthy body of knowledge on the investigated areas, we have also identified a lack in scientific exploration of food integrity from the perspective of the distributor as a member of the supply chain. Therefore, we contribute to the current knowledge by sharing concrete knowledge gained from four leading logistics service providers (LSP) in Croatia.

## LITERATURE REVIEW

Our production-to-consumption food systems are characterized by complexity, shaped by the dynamic interplays of numerous inputs, processes, outputs, and actors that can affect food integrity [Wang et al. 2017]. Food integrity encapsulates the complete supply chain [Ali et al. 2017] as all participants of the supply chain are required to provide certain conditions that food demands as one of the most sensitive products on the market. The literature review shows that both concepts are mutually closely related and therefore in the following explanations, a correlation of some the terms is evident.

### Defining the Concept of Food Integrity

Integrity, as defined in the Webster's New World 3rd Edition, means the quality or state of being complete; entirety, perfect; and wholeness [Zulfakar et al. 2012]. In the context of the food industry, integrity implies consumer confidence in food, i.e. that the food they consume is genuine food, with quality ingredients, and is safe to eat. In his report for the government study, Elliott [2014] defined it as follows: "Food integrity can be seen as ensuring that food which is offered for sale or sold is not only safe and of the nature, substance and quality expected by the purchaser but also captures other aspects of food production, such as the way it has been sourced, procured and distributed and being honest about those elements to consumers". In their exploration of evolving definitions of the term Wang et al. [2017] relied on distinguished quality control experts that observe food integrity from an evolving perspective of the quality corresponding to the changing nature of food production, from conformance to requirements [Crosby 1979], total quality control [Feigenbaum 1983], customer expectations [Ishikawa 1985], to an open-systems view of total quality management

[Deming 1986]. However, food integrity issues include not only food quality and food authenticity. Rather, due to the globalization of the food trade, there is safety as well as origin fraud and quality concerns [Charlebois, Haratifar 2015]. There is an interesting explanation of food integrity by Grunert [2002] and Barnet et al. [2016] who stated that product integrity is a combination of basic and credence requirements and food scandals, like the horsemeat scandal, which challenge consumer confidence. In explaining food integrity Elliott [2014] used a system approach based on eight pillars: (1) consumers first, (2) zero tolerance, (3) intelligence gathering, (4) laboratory services, (5) audit, (6) government support, (7) leadership, and (8) crisis management. Only the supply chain which encompasses food safety, security, traceability, origin authenticity, quality attributes and product information can result in a final food product with integrity [Davidson et al. 2017].

## Integrity throughout the Food Supply Chain

As a network of partners who collectively convert a basic commodity (up-stream) into a finished product (downstream) that is valued by end-customers, and who manage returns at each stage [Harrison, van Hoek 2008] supply chain management is concerned with managing the entire chain of processes, including the raw material supply, manufacture, packaging and distribution to the end-consumer. It can also be defined as the task of integrating organizational units along the supply chain and coordinating material, information and financial flows in order to fulfil (ultimate) customer demands with the aim of improving competitiveness of a supply chain as a whole [Stadtler, Kilger 2008]. Food chain integrity is multi-disciplinary, covering all the aspects of the food chain from producers to consumers [Hoorfar, Prugger 2011]. Each supply chain is unique, showing that there is no single approach to assuring supply chain integrity [Elliot 2014]. Ali et al. [2017] propose several dimensions of food supply chain integrity:

- raw materials integrity – raw materials have always been discussed after any incident involving product recall,
- production integrity - focuses on ensuring processes, management systems, and facilities during the manufacturing process,
- service integrity – not only quality of products but also quality of service is important,
- information integrity - the information given to consumers should uphold the integrity of the processes.

Sowinski [2013] notes that although food safety and security is better today than ever before, there is a big risk with food safety in the global food chain at multiple points of vulnerability directly related to the complexity and length of the supply chain, i.e. lots of food facilities that process or distribute food that are registered with the FDA, food containers moved on trucks, trains and ships every year; and over a million points of sale, such as restaurants, grocery stores and other food service outlets for the distribution of food. The greater the complexity in the supply chain, the greater the chances are the products involved are likely to have issues of authenticity [de Castella, Wheeler 2013] as some processed food products have ingredients from different countries. Ali et al. [2014] point out that chain members that are well equipped in terms of food SC integrity are able to track down possible causes of any incidents. Floros et al. [2010] and SGS [2013] point out the challenge of the large, growing food security gap in certain places around the world, where proper handling, processing, packaging, and distribution methods are lacking. Improving the integrity of the food chain, making certain that food is traceable, safe to eat, high quality and genuine requires communication between all food chain participants. Verbeke [2011] considers effective and efficient communication crucial for active food chains in today's global food market. Techniques based on barcoding are very effective in communication and certifying both the origin and quality of food products [Charlebois, Haratifar 2015]. Technological advancements, such as active RFID tags are the most cutting-edge technology for supply chain integrity and traceability and can automatically capture a range of information concerning product identity, properties, and data (e.g., temperature history), thus providing a supply chain

management system with a complete description of the current state of the product [Dabbene et al. 2014].

Feinman [2013] adds that implementing preventive and proactive controls built on actionable intelligence to protect the food supply chain is significantly more effective than reacting to an adulteration event after it happens. Ratiu and Mortan [2013] believe that in this context, a proper functioning of the food supply chain should take into consideration the ethical issues in the relationships with a wide diversity of stakeholders like farmers, food processors, traders, consumers, employees, community and last but not least the environment. Hong et al. [2011] consider regulations or standards, obtaining the certifications necessary in managing food chain integrity and building customer confidence.

Arevalo Chavez and Seow [2012], Aung and Chang [2014], and Trienekens and Zuurbier [2008] expect that quality assurance will dominate the process of production and distribution in food supply chains in the future. Today`s food supply chain ensures „from farm to fork" integrity without unnecessary costs in order to improve the trust in food.

## The Importance of Temperature Tracking

As food is a temperature-sensitive product, it can be damaged when not kept within a specific temperature range, and supply chain integrity includes the additional requirements of proper packaging, temperature protection, and monitoring. Smith [2006] and Jol et al. [2006] warn that bacterial growth can be out of control without the appropriate temperature and humidity in managing food throughout the supply chain. A temperature-controlled supply chain or a cold chain provides the essential facilities and methods required to maintain the quality of food [Aung, Chang 2014] as temperature is the most important factor in prolonging or maintaining the food product characteristics and shelf life [Bogataj et al. 2005, Montanari 2008, Sahin et al. 2007]. This is in line with the work of Zhang et al. [2003] who linked quality degradation of products to time and temperature during production, transportation, and storage. In the literature [Rivigo 2017, Wedding 2016] it is also known as temperature integrity that must be preserved from the point of production, processing, through each of the transport stages – handling, loading, unloading, and storage – and extends to storage at the consuming household [Salin, Nayga 2003]. This concept has been evolving since the 1980s [Fernie, Sparks 2004], because earlier, chains simply meant storing at a specific temperature in warehouses and refrigerated vehicles [Bharti 2016]. The changes started taking place with the advent of chambers capable of storing at different temperature ranges [Duiven, Binard 2002], advanced transportation system [James et al. 2006] and the shortening of ordering and replenishment cycles [McKinnon, Campbell 1998].

Moureh and Flick [2004] particularly consider transport as an important link in the chain as temperature maintenance is critical in order to preserve, safety and shelf life of food. Moreover, some warehouses can have poor temperature maintenance and control, while others do not have different temperature storage facilities so all the freight is stored at the same temperature [Hofstra 2018].

Chatzopoulou [2015] warned that food products that are transported in long distance for long periods of time before reaching retailers or processing factories require special refrigerators and temperature conditions. The situation is more complex if we take into account that due to cheaper operational costs and the need to deliver food products to all parts of the world almost all food companies have outsourced their transportation activities to the third party logistics (3PL) service providers [Elmuti, Kathawala 2000]. As the same temperature should be ensured during transportation and storage in the supply chain, the logistics service providers (LSP) have the greatest responsibility [Zulfakar et al. 2014] and have already implemented some technologies for temperature tracking [Raab et al. 2011]. There is a certain amount of literature regarding the significance of technological progress made in the field of temperature monitoring systems [Raab et al., 2011], from conventional thermometry [Taoukis, Labuza 1989], electronic data loggers [Bharti 2016], time–temperature

indicators (TTIs) [Bharti 2016, Kumar, Budin 2006, Sahin et al. 2007], to wireless communications systems like wireless wide area networks (WWAN), wireless local area networks (WLAN), and wireless sensor networks (WSN) systems [Wang et al. 2006, Ruiz-Garcia et al. 2009]. Moreover, some works [e.g. Amador et al. 2009, Ruiz-Garcia et al. 2009] discuss increasing the application of Radio frequency identification technology (RFID) combined with temperature sensors can monitor temperature conditions within the supply chain during recent years. Advantages from using technology solutions in temperature tracking include the reduction of costs for logistical operations, minimization of product value losses, decision-making support, meeting food safety requirements and improved communication within the chain [Sahin et al. 2007, Kang et al. 2012].

**Regulation Issues**

In order to ensure food integrity and to have safe foods, there is a wide range of different standards, regulations and certifications in the food sector [Rehber 2012]. They are based on domestic law and practice and also operate within an international framework of rules and agreements. Increased globalisation has led to food safety hazards [Manning, Baines 2004] and resulted in a complex network of public and private incentives to implement enhanced food safety controls [Martinez, Poole 2004]. Spink and Moyer [2011] discuss about changes in food safety approaches which ranged from reactive tactics to proactive strategy with preventative measures such as the Good Manufacturing Practices (GMPs) regulations, the Hazard Analysis Critical Control Points (HACCP), and Good Hygienic Practices (GHPs).

Verbruggen [2016] made a significant contribution to understand the actors involved in the regulatory governance of food safety clasifying them into public or private actors at the national or transnational level. He was discussing about co-regulation between public and private regulatory activities, at national and international sphere as a regulatory strategy to ensure the safety of food supply. It can help to reduce the administrative burden of regulation on business and promote more efficient approaches to regulatory inspections and the management of food safety, particularly in relation to enforcement and monitoring activities [Martinez et al. 2013]. At a global level, there are the international trade agreements developed by the World Trade Organisation (WTO). The United Nations Food and Agriculture Organization (FAO) and World Health Organization (WHO) established Codex which adopted one of the key standards related to food safety - the Hazard Analysis and Critical Control Points (HACCP) standard [Verbruggen 2016]. The measures cover „all stages after primary production, during preparation, processing, manufacturing, packaging, storing, transportation, distribution, handling and offering for sale or supply to the consumer" [Manning, Baines 2004]. There is the Agreement on the International Carriage of Perishable Foodstuffs and on the Special Equipment to be used for such Carriage which establishes standards for the international transport of perishable foodstuffs between the states that ratify the treaty ECE/TRANS/271. [2017].

With the rise of non-state food safety standards a group of globally leading retailers established the Global Food Safety Initiative (GFSI) which can be considered as a transnational meta-regulator in the field of private food safety governance [Verbruggen and Havinga]. The European Commission is the key institutional actor on the public level, at a regional sphere. The quantity of European legislation regarding food is overwhelming [van der Meulen 2013]. The EU's General Food Law has objectives to facilitate the free trading of food across all EU countries by ensuring the same high level of consumer protection in all Member States. It covers all parts of the food chain from animal feed and food production to processing, storage, transport, import and export, as well as retail sales. European Food Safety Authority (EFSA) provides scientific advice to the European Commission and EU countries, to help them take effective decisions to protect consumers. It also plays an essential role in helping the EU respond swiftly to food safety crises [European Union Explained, 2014].

At a national level, many ministries and departments are involved in food safety

regulations. The Food Act (Official Gazette No. 46/07) is the basic framework law on food safety in Croatia. The Food Act transposes the provisions of Regulation (EC) No 178/2002 and provides the basis for the assurance of a high level of protection of human health and consumers' interest in relation to food [Miškulin et al. 2013].

## RESEARCH METHODOLOGY

For the purpose of this research, a qualitative study was applied. Face to face interviews were conducted in the four (4) leading logistics companies in the cold chain segment, which provide logistics solutions, from taking delivery of the goods from the manufacturing company to the point of sale. The companies were chosen due to the growing importance of this industry in Croatia and in the European Union, as well. The Croatian road transport industry is marked by small companies, most of which own a fleet of under 5 freight vehicles. The concerning fact is that the average age of the road transport companies' fleets in Croatia has been growing, especially for the reason of higher road charges for older vehicles in most of the EU member states. One of the key issues for the Croatian road transport industry is its fragmentation [Žibret, Čorak 2012] and there is no such company that could significantly influence the profitability of this industry [Naletina 2016]. In 2015, there were 3 222 active companies that registered their activities in the road transport industry [Companies Registry 2017]. It is important to point out that most of the Croatian transport companies deal with general and bulk transport, while those specialized in dangerous goods transport, food products transport or special freight, are rare. It is for these reasons and for the purpose of conducting this research, that the sample comprises the largest companies which deal with road transport of food products. Relating to that, most of the food industry companies transport the goods using their own fleet of vehicles.

Interviews were conducted from July to September 2017 and lasted approximately one hour. The research instrument was structured as an interview remainder, which consisted of 21 questions altogether. The questions related to the number of freight vehicles in the fleet, the number of employees, the importance of the preservation of food quality and safety, and the certifications they possess. Furthermore, the research focused on the way companies ensure food safety, i.e. providing cold chain integrity, and the education of employees on the prescriptive regulations on hygienic practices. Then, the respondents answered questions about food storage; storage equipment for different temperature regimes for preserving different types of foods, as well as how they are equipped with refrigerated vehicles, cold refrigerators and storage. The respondents also commented on the critical phases in the food handling process; the way they enable control and the listing of the achieved temperatures in the transport vehicles during transport; and the anticipated challenges in the future related to maintaining food safety and quality. Companies' and respondents' characteristics are listed below (Table 1).

Table 1. Characteristics of Logistics Service Providers and Socio-demographic Characteristics of the Respondents

| Name of the company | No of freight vehicles in the fleet | No of employees | Function | Gender | Age | Professional qualification | Years in the company | Quality certificates |
|---|---|---|---|---|---|---|---|---|
| *LSP1* | 150 | from 50 to 250 employees | Transport organization and logistics specialist | M | from 26 to 35 | SSS | 2 years | HACCAP<br>ISO 9001<br>ISO 14001 |
| *LSP2* | 50 | from 50 to 250 employees | Vehicle fleet manager | W | from 26 to 35 | VSS | 10 years | FRC |
| *LSP3* | 10 | from 50 to 250 employees | Head manager | M | over 56 | VSS | 25 years | HACCP<br>IFS |
| *LSP4* | 200 | more than 250 employees | Dispatcher | M | from 26 to 35 | VSS | 5 years | ISO<br>HACCP<br>IFS |

Source: own work

## Research Results

Companies base their business on the quality of their services in order to completely satisfy their customers. Therefore, in order to ensure that high quality products are transported properly, the companies operate in accordance with the principles of HACCP, ISO 9001, ISO 14 001, IFS, FRC standards.

## Ensuring the Integrity of the Cold Chain

Companies state that they offer a high degree of security and assure that what clients produce reach the consumer without affecting the quality of the product. Therefore, they put special emphasis on the traceability in the cold chain because a break in the traceability of temperature leads to food spoilage and as such, can cause health hazards. In order to avoid the distortion of food quality and product safety, companies mention they have work procedures in place and they have work procedures within each activity. The whole process of food transport in the cold chain is followed by IT technology, meaning that at any time temperature in the chamber can be read. Due to the WMS system for warehouse management, companies can follow product traceability, the location of the product in a retail store as well as the transport vehicle in which the product was delivered, in order to be able to react promptly and in necessary cases, withdraw the product.

In order to operate successfully, it is important to invest in employees, so as to better perform their duties in the hiring of employees depending on the function to be performed passing the definition of training and familiarization with the work of the LS company. So, during the employment phase, the company has made special manuals to help their employees carry out their functions and meet special requirements that need to be respected during the handling of sensitive products. For instance, the company has a special manual which consists of all the information that drivers need to know to do their job safely and in accordance with the rules and principles. All employees have the necessary sanitary booklets.

As certain food groups require special temperature regimes, companies divide the food categories into separate food groups. There is the example of temperature conditions, which has divided food categories into nine groups according to the required prescribed temperature. Table II shows the transport temperature conditions according to the type of the food and the operation of the chiller machine. Normally, retail companies, as well as transport companies, divide the food category into the subcategories FOOD I and FOOD II. The required temperature conditions for meat and meat products, fish and fish products, eggs, milk and milk products, fruit and vegetables, bakery and cereal products, combined products, oils and fats and dried products are shown in the Table (Table 2). Permanent work means that aggregates are constantly working and maintaining the same temperature, while the start-stop indicates that the aggregates are on or off.

Table 2. Transport Temperature Conditions according to the Type of Food and the Working Mode of the Chiller Machine

| Product category | type of food | temperature | working model |
|---|---|---|---|
| ***Meat and meat products*** | fresh meat<br>deep frozen meet<br>minced meat<br>poultry meat<br>offal of domestic ungulates<br>meat products<br>canned meat products | +2°C to +4°C<br>-18°C<br>max. +2°C<br>max. +4°C<br>+4°C<br>+4°C to +8°C<br>+10°C to +25°C | permanent<br>start-stop<br>permanent<br>permanent<br>permanent<br>start-stop<br>start-stop |
| ***Fish and fish products*** | fresh fish<br>frozen fish<br>fish products<br>canned fish | 0°C to +2°C<br>-18°C<br>+4°C to +8°C<br>+10°C to +25°C | permanent<br>start-stop<br>start-stop<br>start-stop |
| ***Eggs*** | fresh eggs<br>egg powder<br>pasteurized eggs in the bag<br>frozen eggs | +4°C to + 8°C<br>+10°C to<br>+25°C<br>+ 2 °C to +4 °C<br>-18°C | permanent<br>start-stop<br>permanent<br>start-stop |
| ***Milk and milk products*** | UHT milk<br>fresh milk<br>cheeses and cheese spreads<br>yoghurt, sour cream and related products<br>butter<br>frozen dairy desserts | +10°C to +25°C<br>+4°C to +8°C<br>+2°C to +6°C<br>+2°C to +6°C<br>+2°C to +6°C<br>-18°C | start-stop<br>start-stop<br>start-stop<br>start-stop<br>start-stop<br>start-stop |
| ***Fruit and vegetables*** | frozen fruits and vegetables in containers<br>fresh fruit and vegetables<br>compotes and preserves<br>pickled vegetables in containers<br>marmalades and jams | +4°C to +12°C<br>-18°C<br>+10°C to +25°C<br>+10°C to +25°C<br>+10°C to +25°C | permanent<br>start-stop<br>start-stop<br>start-stop<br>start-stop |
| ***Bakery and cereal products*** | transportation of deep frozen raw pasta products<br>start-stop<br>finished products made of dough – dry products<br>bread and pastry products – products for consumption without heat treatment | -18°C to -25°C<br>+15°C to +20°C<br>+10°C to +15°C | start-stop<br>start-stop |
| ***Combined products*** | chocolate<br>candy<br>biscuits and related products | +15°C to+20°C<br>+15°C to +20°C<br>+15°C to +20°C | start-stop<br>start-stop<br>start-stop |
| ***Oils and fats*** | oils<br>fats | +10°C to +<br>20°C<br>+5°C to +10°C | start-stop<br>start-stop |
| ***Dried products*** | dried fruits and vegetables in containers<br>dried nuts in packaging<br>dried seeds in the package | +10°C to +25°C<br>+10°C to +25°C<br>+10°C to +25°C | start-stop<br>start-stop<br>start-stop |

Source: own work

Storages are fully equipped with the appropriate cooling systems that maintain the temperature. There are three types of temperature regimes: (1) frozen (-18°C to -

25°C), (2) cold (0°C to +8°C) and (3) ambient (10°C to +25°C). In order to ensure an adequate temperature, storage areas are equipped with measuring devices, and all the measuring devices that are found in the warehouses are connected to the associated program by which employees can monitor and regulate the temperature on the computer. The person responsible for setting up the temperature can, at any given moment, control the temperature level in each warehouse. For example, in a storage area, there are three sensors at different locations, at the entrance, in the middle and at the end of the warehouse, and based on these temperatures, the program shows the average storage temperature. In addition, besides the proper temperature, storages should be disinfected after storing certain types of food in order to prevent contamination. The storage space has a specific market spot for food manipulation and a space in which employees can walk.

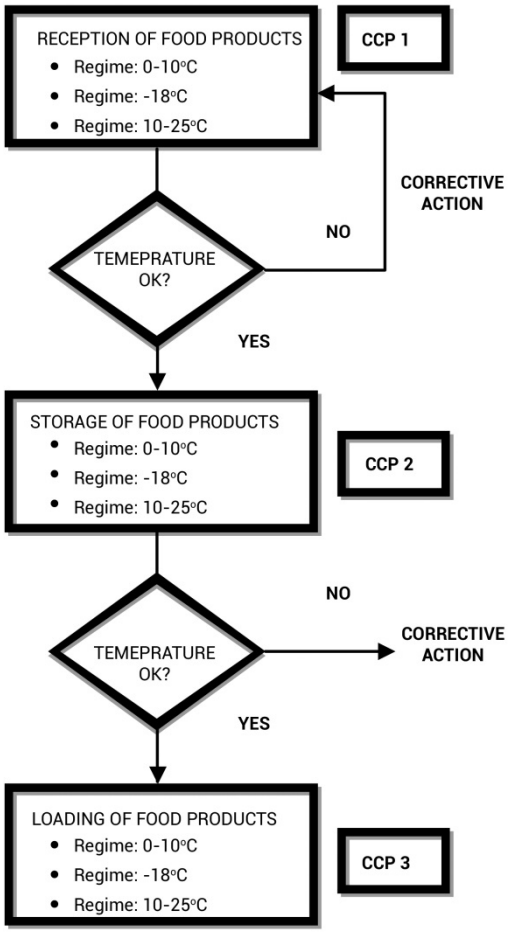
The process of transporting food from manufacturers to retail stores is temperature-controlled. The process can be described as follows: the company receives a food transport order from the manufacturer, in which the manufacturer specifies the type of food transported, the amount, the date and the addresses for loading and unloading and the temperature regime that the food requires. The company then issues an order for shipping with all the necessary information: the number of vehicles, the type of vehicle, the time and address for loading, the type of goods, weight, temperature, note on the loading, the number of pallets, the unloading time and address and the name of the driver. The entire process of the collection and delivery of goods must be accompanied by a specific form as prescribed under HACCP principles. After the driver receives the order, he takes the food over to the pre-determined address. On the order, the driver writes the data, such as: the date, time and place of loading, the type and quantity of goods and the temperature at which the goods were taken. The form must be confirmed by the manufacturer that the food was taken from. When the vehicle reaches the destination for unloading the form shall contain the following information: the date, time and place of unloading, information about damage, if any, the type and quantity of goods and the temperature at which the food is unloaded. To finish the procedure, the signature and seal of the person who took over the goods is needed. The form must include the number and licence plate, also the way of cleaning the vehicle before loading (swept, washed with water, disinfected) should be indicated. Together with this form, a temperature form obtained from the printers that are located on the vehicle and connected to a cooling device if the vehicle has to be attached. The printed pages show the temperature level for every hour during the transport of goods. With this form, the company ensures that the transportation service was provided as well as the delivery of goods, respecting the prescribed temperature regime and food safety during transport.

During the processes of storage and transportation, the food is going through critical phases. The following figures show the warehouse and transport processes by flow diagrams. Flow diagrams capture all the phases of storage (Figure 1) and distribution of the food products.

**Food Storage Process**

The first activity is the receipt of the food products, which represents the first critical control point (CCP1) of the process. If the temperature is not appropriate, corrective actions are needed, otherwise the process continues. The next process is food storage at an adequate temperature, which represents second critical control point (CPP2). If the temperature is not appropriate, corrective actions are needed, otherwise the process continues. The third critical control point (CCP3) is checking the temperature during loading the food into the transport vehicle.

Every step in the warehouse process, together with the list of activities which are taken care of during that process and the temperature limits are shown in Table 3.




Source: own work

Fig. 1. Storage Flow Chart

Table 3. Description of Storage Process

| Step | Description of activities | Temperature limits |
|---|---|---|
| *Reception* | • measuring the temperature of the goods<br>• damage control<br>• thermographic picture of the vehicle<br>• supporting documents for the goods<br>• control of the agreement of the documentation with the facts | regime: 0-10⁰C<br>regime: -18⁰C<br>regime: 10-25⁰C |
| *Warehousing* | • temperature control in the warehouse<br>• thermographic printing<br>• correctly and neatly stacking of goods under a pre-arranged schedule<br>• control of WMS system | regime: 0-10⁰C<br>regime: -18⁰C<br>regime: 10-25⁰C |
| *Loading* | • temperature measurement<br>• thermographic printing of chamber before loading | regime: 0-10⁰C<br>regime: -18⁰C<br>regime: 10-25⁰C |

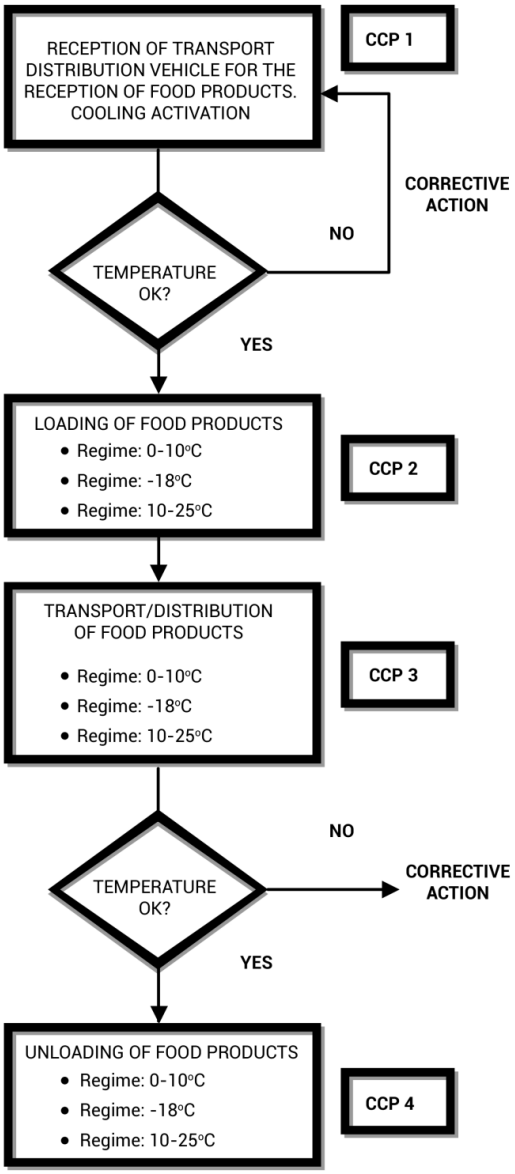
Source: own work

## Process of Food Transportation and Distribution

Figure 2 shows the flow chart of the transportation and distribution process for food products. As can be seen from the diagram, this process has four (4) critical control points. The first critical control spot is preparing the vehicle for the transport of a certain type of food. The temperature should be appropriate for the prescribed type of food being transported, and if this is not the case, the process is stopped in order to prepare the vehicle for transport in the appropriate

conditions. The second critical control spot is the loading of the goods into the vehicle, where employees are checking that the conditions are according to the prescribed ones. The third critical control spot is the transport and distribution of the food at the given temperature regime. Here, employees are checking whether the temperature is matching the regime, otherwise, the corrective actions are in place. If everything is satisfactory, the process continues. The last critical control point is unloading the food in the prescribed conditions.

Table 4 describes every step which must be taken during the transport and food distribution process.




Source: own work

Fig. 2. Transportation and Distribution Flow Chart

Table 4. Description of the Transport and Distribution Process

| Step | Description of activities | Temperature limits |
|---|---|---|
| ***Vehicle preparation*** | • measuring the temperature of the goods<br>• damage control<br>• thermographic picture of the vehicle<br>• supporting documentation on the goods<br>• control of the agreement of the documentation with the facts | regime: 0-10$^0$C<br>regime: -18$^0$C<br>regime: 10-25$^0$C |
| ***Loading of the vehicle*** | • temperature control of the goods<br>• thermographic printout<br>• correctly and neatly stacking of goods according to pre-existing practices | regime: 0-10$^0$C<br>regime: -18$^0$C<br>regime: 10-25$^0$C |
| ***Transport / Distribution*** | • thermographic printout<br>• HACCP form for the transport<br>• ensuring the goods against damage | regime: 0-10$^0$C<br>regime: -18$^0$C<br>regime: 10-25$^0$C |
| ***Unloading*** | • measuring the temperature of the goods<br>• damage control<br>• thermographic picture of the vehicle<br>• supporting documentation on the goods<br>• control of the agreement of the documentation with the facts | regime: 0-10$^0$C<br>regime: -18$^0$C<br>regime: 10-25$^0$C |

Source: own work

## CONCLUSIONS

If, during food distribution food changes its biological, chemical or other characteristics, its quality, safety and healthiness could be challenged. Accordingly, food integrity is questioned. It is therefore important to stress and emphasize the importance of temperature monitoring at every link in the supply chain. The value of this paper is in elaborating on the food conditions needed in the warehouse and transportation vehicles in order to maintain the integrity of the temperature-controlled supply chain and food quality during distribution from the production to the consumption phase of the supply chain. The research results are of both, academic and industrial value, as they show how to accomplish food security and preserve food quality during the distribution phase in food supply chain management. The main limitation of the conducted study is that it is case-based, on the sample of four logistics service providers. Preferably, future studies should stress the whole food supply chain and give the perspective of all chain members, not only the logistics service providers as the focal companies.

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# INTEGRALNOŚĆ ŻYWNOŚCI W ŁAŃCUCHU DOTAW: DOBRA PRAKTYKA DYSTRUBUCYJNA

**STRESZCZENIE**. **Wstęp:** Obserwuje się wzrastającą rolę zarządzania łańcuchem dostaw ze względu na fakt, że klienci coraz bardziej zwracają uwagę na bezpieczeństwo żywności i jego, jakość, co wywołuje popyt na produkty o odpowiedniej i stabilnej, jakości. W trakcie dystrybucji żywność jest narażona na różnego rodzaju ryzyka, takie jak nieodpowiednie przechowywanie lub niedotrzymanie wymaganej temperatury. W pracy omówiono procedury stosowane przez dystrybutorów dla zapewnienia bezpieczeństwa żywności oraz jej, jakości w całym łańcuchu dostaw.
**Metody:** W pracy zastosowano jakościowe podejście do problem. Zostały przeprowadzone bezpośrednie wywiady w czterech wiodących przedsiębiorstwach logistycznych z obszaru chłodniczego, które oferują usługi dostawy produktów od producenta do punktu sprzedaży.

**Wyniki:** W celu zapewnienia wysokiej jakości transportu produktów, ryzyka są zarządzane efektywnie. Przedsiębiorstwa pracują w zgodzie z różnymi standardami, po wypracowaniu procedur odpowiednich dla poszczególnych obszarów łańcucha dostaw w celu uniknięcia pogorszenia jakości i bezpieczeństwa żywności. Cały proces transportu żywności jest nadzorowany przez narzędzia IT, poszczególne grupy żywności są podzielone w dziewięć grup w zależności w wymaganej temperatury przechowywania. Ze względu na specyficzne wymagania obchodzenia się z wrażliwymi produktami, przedsiębiorstwa kładą istotny nacisk na inwestycje w pracowników.
**Wnioski:** Integralność żywności jest koncepcją holistyczną, powiązaną z produkcją żywności, jej dystrybucją, bezpieczeństwem i jakością. Łańcuch dostaw żywności, długi ze swojej natury, globalny i nieciągły, naraża żywność na różne ryzyka i wymaga monitorowania temperatury na każdym etapie łańcucha, szczególnie w magazynach oraz w środkach transportu. Specjalny nacisk jest położony na narzędzia IT oraz na pracowników.

**Słowa kluczowe:** łańcuch dostaw żywności, integralność żywności, bezpieczeństwo żywności, dobra praktyka dystrybucyjna, dostawcy usług logistycznych, Chorwacja

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