The influence of resilience on causes of food waste in retail: a systematic literature review

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Abstract

The purpose of the paper is to understand how the concept of resilience can help reduce the causes of food waste in the retail segment. To do so, a systematic literature review was conducted as a research method. According to the analysis, two theoretical contributions are: redundancy and financial strength are possible negative barriers to reducing the food waste; and most of the resilience elements that help minimize causes of waste are related to anticipation, considering that food has a short shelf life, and if it is not sold it loses the value completely.

Keywords: Resilience elements; Causes of food waste; Systematic Literature Review

Introduction

An issue of sustainability that requires attention in supply chains is food waste. To date, few studies have focused on minimizing waste throughout the supply chains (Cicatiello et al., 2016; Garrone et al., 2014), and those that seek to create strategies in prior links to the consumer (such as distribution) are still scarce (Göbel et al., 2015; Thyberg & Tonjes, 2016). Thus, understanding the causes of food waste from an integrated supply chain perspective is a starting point to find solutions and, consequently, prioritize practices to prevent and/or reduce waste (Derqui et al., 2016; Garrone et al., 2014). One approach that can help reduce the causes of waste, from a managerial point of view, is using resilience elements. Resilience is defined as the adaptive capacity of a supply chain to resist and deal with unexpected events (disruptions), maintaining control over its structure and functions and enabling recovery

and response to such disruptions in order to restore the chain to its original (or better) state of operation (Kamalahmadi & Parast, 2016). In this context, studies that relate resilience to food waste are still underexplored. Additionally, retail is normally the supply chain segment that is most concerned about reducing food waste as it has great power on the market by influencing decisions and actions, both upstream and downstream of the supply chain. To fill this gap, the purpose of the paper is to understand how the concept of resilience can help reduce the causes of food waste in the retail segment. To do so, a systematic literature review was conducted as a research method.

Research Method

A systematic literature review (SLR) was carried out to ensure rigor and data replicability (Tranfield et al., 2003). Three review stages (planning, execution and reporting) were conducted to answer the research questions: Q1) What are the main elements to build resilience in a supply chain? Q2) What are the main causes of food waste in a supply chain? Q3) How do the resilience elements help minimize food waste in a supply chain? These questions were answered by conducting a search in five main databases (Web of Science, Scopus, EBSCO, Scielo and SPELL) between 2000-2017. The selection was performed by title and abstract screening, inclusion/exclusion criteria and quality criteria. The technique for data analyses was the content analysis and the results are presented in a proximity plot graph, of which key elements are associated with the main causes of food waste (see Figure 1). The coefficient of co-occurrence is calculated based on Jaccard's coefficient.

Resilience Elements

Studies on building resilience in organizations and along the supply chains have increased considerably since 2011 (Blackhurst et al., 2011; Pereira et al., 2014; Kamalahmadi & Parast, 2016; Ali et al., 2017). In many of them, concepts related to resilience have been discussed with different nomenclatures, such as principles (Christopher & Peck, 2004; Kamalahmadi & Parast, 2016); enablers (Pereira et al., 2014), factors (Ambulkar et al., 2015), capabilities (Pettit et al., 2010) and elements (Ali et al., 2017). In this study, we chose the term "element", defining it as a fundamental concept that helps develop practices to anticipate, adapt, respond, recover and learn from disruptions, and hence build resilience. Therefore, these elements may be associated with events that precede and occur during or after disruptions (called capabilities as raised by Ali et al., 2017). The resilience elements identified from the SLR were the following:

- **Anticipate**: *Sensing and Interpretation* (Ali et al., 2017); *Knowledge management* (*pre interruption*) (Scholten et al., 2014; Sahu & Mahapatra, 2017); *Security Technologies* (Rajesh & Ravi, 2015); *Visibility (*Blackhurst et al., 2011; Pettit et al., 2013; Kamalahmadi & Parast, 2016; 2017); *Supply Chain Structure* (Blackhurst et al., 2011; Hohenstein et al., 2015); *Communication* (Papadopoulus et al., 2016); *Leadership* (Christopher & Peck, 2004; Scholten et al., 2014; Kamalahmadi & Parast, 2016); *Innovation* (Tukamuhabwa et al., 2015; Kamalahmadi & Parast, 2016).
- **Adapt:** *Redundancy* (Scholten et al., 2014; Soni et al., 2015); Kamalahmadi & Parast, 2016). *Flexibility* (Christopher & Peck, 2004; Kamalahmadi & Parast, 2016).
- **Response:** *Agility* (Kamalahmadi & Parast, 2016; Jüttner & Maklan, 2011). *Collaboration* (Johnson et al., 2013; Papadopoulus et al., 2016).

- **Recover**: *Risk management* (Christopher & Peck, 2004; Tukamuhabwa et al., 2015; Kamalahmadi & Parast, 2016). *Financial strength* (Hohenstein et al., 2015; Tukamuhabwa et al., 2015; Pettit et al., 2010).
- **Learn:** *Trust* (Christopher & Lee, 2004; Kamalahmadi & Parast, 2016); *Knowledge management (post-interruption)* (Scholten et al., 2014; Sahu & Mahapatra, 2017).

Causes of Food Waste in the Retail Segment

Following the idea of Ishikawa´s diagram (also based on Bilska et al. 2016), the causes of food waste were classified into six different groups: 1) **Machines** - involves aspects related to equipment; 2) **Method -** includes aspects about procedures; 3) **People** - encompasses problems with the people involved in the process; 4) **Material** - involves problems with the materials used in the process; 5) **Environment** - includes issues external to the organization; 6) **Measurement** - includes evaluations made in the process. Table 1 summarizes the causes of food waste identified in the SLR.

Influence of Resilience Elements on the Causes of Food Waste

In this section, the relationships between the resilience elements and the causes of food waste identified by the cause groups (Table 1) are explored. Given the large set of relationships identified in the analysis, the discussion was carried out only with elements that represented 60-80% of the total relationships (Pareto Principle), as well as the causes that have the same representativeness in each element. Additionally, elements that have negatively influenced the reduction of food waste (referred to as barriers) were also highlighted in each cause group.

Machines

Technology (14%) is the resilience element that mainly has an impact on causes related to cold chain breaking in storage and the lack of refrigerated transport, such as real-time tracking, temperature, humidity and pressure control (Grunow & Piramuthu, 2013). These technologies can monitor food temperatures during transportation and storage (Canali et al., 2017), such as individualized sensors that further increase the accuracy of information (Raak et al., 2017). In terms of **supply chain structure** (11%), waste can be generated due to failures in transportation or refrigeration structure, especially considering long distances (Girotto et al., 2015). Srivastava et al. (2015) highlight that the complexity of the supply chain may increase due to the number of companies and links among them.

Innovation (10%) has also shown a positive impact on the causes related to machines, considering the creation, adoption or improvement of products and/or processes, such as technologies for temperature control, trucks and refrigeration structures (Garrone et al., 2014). In this regard, the use of Radio Frequency Identification (RFID) systems - sensors and smart tags - can be an opportunity (Aiello et al., 2015). **Visibility** (8%) helps to monitor problems related to storage and transportation in the cold chain (Bilska et al., 2016). In turn, the influence of **flexibility** (7.4%) can help solve problems in machines and processes, such as the use of transport and equipment of alternative handling and storage, and changes in sequencing (Canali et al, 2017; Derqui et al., 2016).

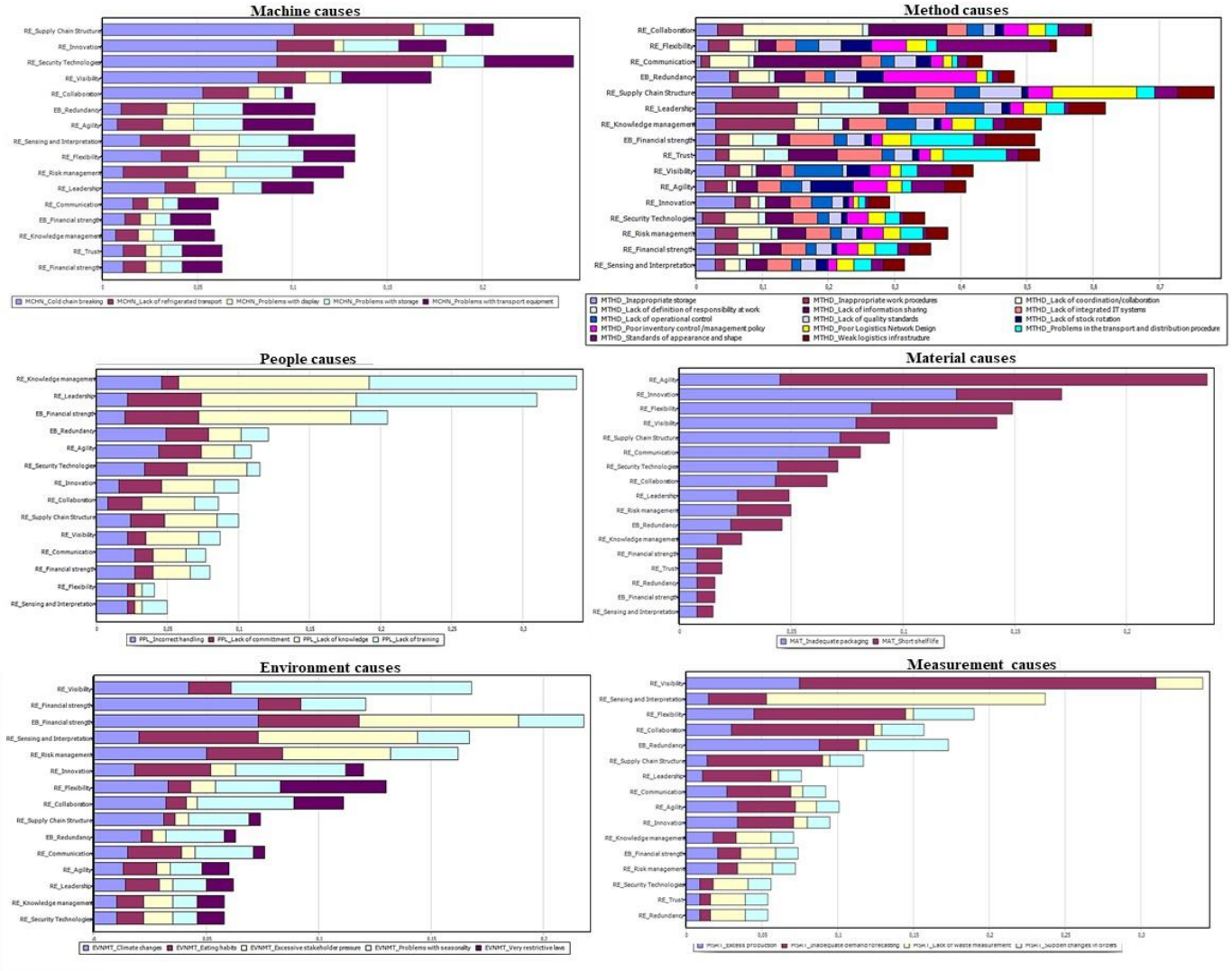
Sensing (7.4%) identifies and interprets problems with equipment, planning, storage and establishment of response and control strategies (Derqui et al., 2016).

Table 1 – Causes of waste

Group	Causes of food waste	Authors
Machines	Cold chain breaking	Girotto et al. (2015); Mena et al. (2014).
	Problems with transport equipment	Cicatiello et al. (2016), Garrone et al. (2014); Mena et al. (2011).
	Problems with display	Girotto et al. (2015); Thyberg and Tonjes (2016).
	Lack of refrigerated transport	Bilska et al. (2016); Mena et al. (2014); Raak et al. (2017).
	Problems with storage	Bilska et al. (2016); Canali et al. (2017).
Method	Inappropriate storage	Balaji and Arshinder (2016); Tromp et al. (2016).
	Standards of appearance and shape	Canali et al. (2017); Göbel et al. (2015); Thyberg and Tonjes (2016); Mena et al. (2011).
	Lack of work accountability	Gruber et al. (2015); Mena et al. (2011).
	Lack of operational control	Balaji and Arshinder (2016); Mena et al. (2014)
	Lack of quality standards	Balaji and Arshinder (2016).
	Lack of stock rotation	Canali et al. (2017); Derqui et al. (2016); Tromp et al. (2016).
	Poor inventory control /policy	Balaji and Arshinder (2016); Gruber et al. (2015); Holweg et al. (2016).
	Lack of coordination/collaboration	Aiello et al. (2015); Balaji and Arshinder (2016); Derqui et al. (2016).
	Lack of information sharing	Balaji and Arshinder (2016); Kaipia et al. (2013); Raak et al. (2017).
	Problems in transport procedures	Mena et al. (2011); Raak et al. (2017).
	Weak logistics infrastructure	Holweg et al. (2016).
	Poor Logistics Network Design	Balaji and Arshinder (2016); Brancoli et al. (2017).
	Inappropriate work procedures	Balaji and Arshinder (2016); Bilska et al. (2016); Mena et al. (2011)
	Lack of integrated IT systems	Balaji and Arshinder (2016)
People	Lack of training	Balaji and Arshinder (2016); Girotto et al. (2015).
	Lack of knowledge	Balaji and Arshinder (2016); Bilska et al. (2016); Gruber et al. (2015).
	Lack of commitment	Gruber et al. (2015).
	Incorrect handling	Balaji and Arshinder (2016); Mena et al. (2011).
Material	Inadequate packaging	Balaji and Arshinder (2016); Mena et al. (2014); Tromp et al. (2016).
	Short shelf life	Garrone et al. (2014); Kaipia et al. (2013); Tromp et al. (2016).
Environment	Climate changes	Mena et al. (2011); Shafiee-Jood and Cai (2016).
	Eating habits	Göbel et al. (2015); Gruber et al. (2015).
	Very restrictive laws	Gruber et al. (2015).
	Excessive stakeholder pressure	Canali et al. (2017); Derqui et al. (2016).
	Problems with seasonality	Mena et al. (2011); Mena et al. (2014).
Measurement	Inadequate demand forecasting	Balaji and Arshinder (2016); Mena et al. (2011); Tromp et al. (2016).
	Sudden changes in orders	Mena et al. (2014).
	Excess production	Bilska et al. (2016); Mena et al. (2011).
	Lack of waste measurement	Derqui et al. (2016); Ghosh et al. (2016).

Source: created by the authors.

Figure 1 – Relation of resilience elements and causes of food waste



Source: created by the authors

Risk management (7%) helps monitor possible problems in the equipment of the cold chain, improving the ability of recovery in case of equipment breakdown or failure (Derqui et al., 2016; Kamalahmadi & Parast, 2016). On the other hand, it has been observed that two resilience elements act as barriers. **Redundancy** acts as a barrier because excess routes and use of equipment to handle, transport or store can make it difficult to control operations and lead to food deterioration. **Financial strength** proved to be a barrier due to the existence of trade-offs related to investing in machines (Heising et al., 2017).

Method

The **supply chain structure** (12%) can contribute to reducing waste related to poor logistics network design, lack of coordination/collaboration, lack of information sharing, lack of integrated IT systems and quality standards, inadequate storage and weak logistics infrastructure. The longer the distances between the supply chain links, the worse this situation can become (Balaji & Arshinder, 2016; Cicatiello et al., 2016). **Leadership** (9.7%) influences managers' commitment to developing and implementing a quality policy, setting appropriate measurable targets for the whole organization, conducting regular management reviews and ensuring adequate resources for waste reduction and prevention (Bilska et al., 2016). The influence of **collaboration** (9.3%) is rooted in the fact that actions of a supply link can contribute positively or negatively to the other links (Aiello et al., 2015; Derqui et al., 2016). **Flexibility** (8.5%) has the greatest impact on the causes: standard of appearance, poor inventory control/management policy, a lack of coordination/collaboration and a lack of stock rotation and may alter and/or impose new procedures to choose the appearance and distribution of food, reducing its waste as a consequence (Cicatiello et al., 2016).

Knowledge management (8.2%) has been shown to influence the causes: lack of operational control, lack of integrated IT systems, weak logistics infrastructure and inadequate work procedures. This element is strongly related to **Communication** (8.1%) as knowledge tends to be retained in some individuals´ minds (Canali et al., 2017; Halloran et al., 2014). Sharing ideas and knowledge among supply chain partners can encourage waste reduction initiatives for the entire supply chain (Derqui et al., 2016). **Trust** (6.8%) can influence the relationships between retailers and suppliers, as the optimization of the whole supply chain requires coordinating diverse interests, in which a level of trust and commitment is required among its actors (Willersinn et al., 2015). According to Mena et al. (2011), the lack of communication generates waste and undermines trust.

Two barriers have been identified in this group of causes. **Redundancy** is mainly related to the cause "poor inventory control/management policy", which includes the culture of keeping stock in case of any need (Mena et al., 2014); it consequently increases the waste probability. **Financial strength** acts as a barrier because economic efficiency is the major decision of companies. For instance, cheaper transportation modals can lead to longer distances and more handling, increasing the risk of food damage and waste (Mena et al., 2011).

People

Knowledge management (22.3%) had a greater emphasis on the causes: lack of knowledge and lack of training. Training should be carried out regularly to update information and knowledge (Bilska et al., 2016). **Leadership** (20.5%) influences the same causes. Managers need to encourage waste prevention on a daily basis, as well as educate employees on food safety policies and waste prevention practices in their

workplaces (Bilska et al., 2016). Using **security technologies** (7.6%) can help reduce human errors, such as incorrect food handling, labelling errors and even production planning. Greater **visibility** (7.2%) identifies where errors are occurring and then focuses on the training processes in these places. Finally, **agility** is related to the causes: lack of commitment and incorrect handling. Managers and employees must be committed to their tasks and relationships, as well as make adaptations when a process is incorrectly handled (Balaji & Arshinder, 2016; Holweg et al., 2016). In this group of causes, two elements acts as barriers. **Financial strength** can impact the lack of investment in training and benefits for the workforce (Gruber et al., 2015). **Redundancy** can impact negatively considering that assigning the same tasks to a large number of employees can lead to incorrect handling or a lack of commitment (Canali et al., 2017).

Materials

Due to the short shelf life of fresh food, time management is essential to reduce waste (Kaipia et al., 2013). In this case, agility (18.6%) enables decision-making and necessary adaptations so that food arrives fresh in retail stores (Garrone et al., 2014). **Innovation** (13.5%) allows the creation or improvement of packaging to better monitor food quality, better ventilation and temperature control, and increased shelf life of fresh food (Shafiee-Jood & Cai; 2016); and better package designs can reduce transportation and handling damage, as well as consumer waste (appropriate portion sizes and clearer labels for content and shelf life) (Verghese et al., 2015). **Flexibility** (11.7%) allows the retailer to adapt and change some of their processes (such as routes) so that food with a short shelf life can arrive in stores fresh and having good quality (Göbel et al., 2015). **Visibility** (11.2%) leads to greater understanding of the supply chain, helping to understand at what point in the process food is spoiling and at what time food with a short shelf life must be withdrawn from the store and considered for donation (Derqui et al., 2016). Finally, the **supply chain structure** (7.4%) allows the retailer to organize its chain and analyse the distance of its suppliers, producers and distribution centres, and the type of transport and storage necessary when dealing with perishable products, as these issues are fundamental to maintain the quality and food safety with a short shelf life (Lijestrand, 2017). On the contrary, redundancy can act negatively in reducing this cause by considering the excess of inefficient materials, such as inadequate packaging, because in addition to decreasing the shelf life of fruit and vegetables, it can end up causing waste even before the food reaches the expiration date.

Environment

Sensing (12.3%) and **visibility** (9%) are interrelated, as the company's understanding of its chain and the ability to interpret events increase the capability to anticipate external changes (Liljestrand, 2017). The scope of **risk management** (12%) in the food supply chain are related to climate change issues, such as natural disasters, climate change, floods, fires, crop losses, yield reductions and disease outbreaks (Manning & Soon, 2016). **Flexibility** (10%), in turn, influences the causes of very restrictive laws (Holweg et al. (2016). Regarding climate change, Osei-Kwarteng et al. (2017) suggest the need to flexibilize processes to avoid possible waste caused by seasonalities. **Innovation** (9%) can create new products and processes to meet, for example, new demands due to consumers' eating habits or even when there is some climate change that makes it difficult to access and purchase a particular type of food (Salihoglu et al., 2017; Willersinn et al., 2015). **Collaboration** (8%) helps to ensure that unsold but still consumable food can be redistributed to other members of the chain or donated to

NGOs (Derqui et al., 2016) – which should be coordinated with government and political mediators – and needs flexibilization of food safety rules (Canali et al., 2017; Göbel et al., 2015). On the other hand, two barriers were found. **Financial strength** is detrimental regarding meeting consumer requirements (and their eating habits) and restrictive laws, which require fresh products (with restricted expiration) and good visual quality (Göbel et al., 2015). **Redundancy** can influence the acquisition of products from other regions to meet needs (due to changing orders, seasonality or some climatic change) (Warshwsky, 2015). Besides being more expensive, they can deteriorate until arriving at the point of sale (Mena et al., 2014).

Measurement

Sensing (14.6%) can influence the measurement, interpretation and analysis of sales and production forecasts, as well as help monitor and observe changes in demand (Raak et al., 2016). **Visibility** (14%) has been shown to have an impact, since the retailer's understanding of the chain allows for a more accurate demand forecasting, which generates less surplus food with excessive purchase orders (Bilska et al., 2016). Canali et al. (2017) highlight that the visibility of causes (such as variation in demand or supply) can help reduce the need for overproduction. **Flexibility** (11.7%) can help in locating secondary channels for marketing surplus products, whether they are generated by inadequate demand forecasting or by excess production (Canali et. al; 2017; Tromp et al., 2016). **Collaboration** (9.7%) showed that close collaboration between retailers and suppliers leads to an initial step, improving information sharing, accuracy of demand and production forecasting and improving the management of sales promotions (Mena et al., 2011; Kaipia et al., 2013). **Supply chain structure** (6.3%) has great influence considering that the longer distances are between suppliers and retailers, the more waste it might cause to perishable foods (Bilska et al., 2016; Cicatiello et al., 2016). Finally, **leadership** (6.3%) can influence the implementation of measurements that assess the amount of food that is wasted in their stores, distribution centers and suppliers, and can enable the actors to work in favor of waste reduction and prevention (Bilska et al., 2016). Two elements were identified as barriers: **redundancy** due to the fact that many retailers choose to place orders in larger quantities, even if they do not have the demand for it - one reason for the bullwhip effect; also, **financial strength** acts as a barrier, especially in relation to the causes of lack of waste measurement, overproduction, sudden changes in orders and inadequate demand forecasting. Göbel et al. (2015) highlight the fact that wasted products, do not usually incur significant costs; because these networks prefer to waste them running the risk of not having products available.

Conclusion

This study offers three contributions. First, it refers to the proposed analysis model, relating resilience elements and causes of food waste, complementing the model suggested by Bilska et al. (2016) from the Ishikawa diagram, and focusing on food retailing. Second, it identifies that the redundancy and financial strength elements are possible barriers to reduce the causes of waste (negative influence). Third, following Ali et al. (2017) resilience capability framework, it shows that most of the resilience elements that help to minimize the causes of waste are related to anticipation and only one to recovery. In the case of food waste, this is not surprising at all, since the shelf life of the food is short and if it is not sold, processed or donated, it loses its value completely.

Based on these results, some limitations can be highlighted, such as the focus on retail (not exploring other supply links) and on the results from the literature. Thus, the discussion illustrated the concepts and relationships mentioned in the literature reviewed. Further studies may strengthen the relationships between the resilience elements and causes of waste, considering other databases or empirically verifying the identified proximity. Moreover, empirical studies that define better or find new connections between elements and causes in different links of the food chain are interesting to strengthen the present results. Finally, future studies could further explore the impact of reducing waste on costs and increasing food availability.

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