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PERSPECTIVES

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EDITORIAL

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PERSPECTIVA

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EDITORIAL

Versão traduzida

Jorge Carneiro
Editor-in-Chief

Dear readers of *RAE-Revista de Administração de Empresas* (*Journal of Business Management*),

I am pleased to present the articles that have been selected for publication in this special issue on Food Waste: Challenges and opportunities in sustainable operations.

Special issues are an important part of *RAE*'s strategy of bringing you original articles that are of relevance to academic communities that share a common interest in a specific topic, but always in the area of business administration. In this way we hope to promote stronger dialogue among researchers, and advance knowledge on the subject, based on a greater number of works. Special issues also seek to encourage authors to address impacts that extend beyond any contributions they might make to theory or to research methods. They also cover impacts on society and make recommendations to companies and, if applicable, for public policies that influence the activities and management of different types of organization, whether profit-oriented or not.

With regard to this particular special edition, the numbers are expressive and indicate the interest in the topic and the expansion of the journal's international reach:

- 37 articles were submitted by the deadline of May 2020, of which 25 were produced exclusively by Brazilian authors, five articles were written exclusively by non-Brazilian researchers, and seven articles were produced in cooperation between Brazilians and non-Brazilians;
- 6 articles were selected for publication, following a rigorous desk review and double-blind review process;
- 12 countries (Australia, Brazil, Canada, China, Colombia, Nigeria, Portugal, Romania, Spain, Turkey, United Kingdom and USA) from all the continents were represented by the authors of the articles that were submitted, while 62 reviewers from 8 countries (Brazil, Denmark, Italy, Netherlands, Sweden, Turkey, United Kingdom and USA) made their own invaluable contributions to this edition.

The *RAE* team and I are extremely grateful for the dedication and competence of the six guest editors who were invited to head up this special issue, both for their choice of topic and for the diligence with which they dealt with the editorial process. Our many thanks to Luciana Marques Vieira, Marcia Dutra de Barcellos, Gustavo Porpino de Araujo, Mattias Eriksson, Manoj Dora, and Daniele Eckert Matzembacher.

More special issues are being prepared for *RAE* and calls for work for future special issues will be announced shortly. Any researchers wishing to consider the possibility of organizing a special issue for *RAE* are most welcome to speak with the editor-in-chief and our editorial team, who will provide you with strong operational and administrative support and input for dissemination.

Enjoy your reading!

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Invited article
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FOOD WASTE: CHALLENGES AND OPPORTUNITIES IN SUSTAINABLE OPERATIONS

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PURPOSE OF THE SPECIAL ISSUE

It is estimated that about 14% of the food produced in the world is lost before it reaches retail outlets (Food and Agriculture Organization of the United Nations [FAO], 2019), while an additional 17% of the food available for consumers is wasted (UNEP, 2021). Reducing and preventing food waste is important because negative externalities occur throughout the entire lifecycle of food and have an adverse impact on society. There are at least three major impacts: economic, environmental and social. Economically, resources used in production are wasted, such as land, water, labor, energy, etc. and profitability. Environmentally, it leads to unnecessary CO2 emissions and air pollution, caused mainly by food being discarded on landfill sites, or being incinerated, and arable land and the machinery involved in producing and transporting food are occupied in vain. From a social and ethical standpoint, food loss and waste jeopardize opportunities for combatting food insecurity, with access to food reducing because of decreased availability, which drives up prices (Cicatiello, Franco, Pancino, & Blasi, 2016; FAO, 2013; Gustavsson, Cederberg, Sonesson, Otterdijk, & Meybeck, 2011; Kummu et al., 2012; Lundqvist, Fraiture, & Molden, 2008). Reducing food waste, therefore, can save economic resources, reduce costs, improve food security, minimize negative social and environmental impacts, and help answer the growing pressure that businesses are facing to become more sustainable (Thyberg & Tonjes, 2016), all of which help create a sustainable food system (Lipinski et al., 2013). Reducing and preventing food waste also meets the Agenda 2030 goals, since target 12.3 aims to halve food loss and waste in supply chains by 2030 (UN General Assembly, 2015). Due to the complex nature of food supply, however, it is a big challenge for researchers and practitioners alike (Raak, Symmank, Zahn, Aschemann-Witzel, & Rohm, 2017).

Food waste solutions, therefore, are the new frontier in the search for sustainability in operations management. Achieving target 12.3 of the UN's Sustainable Development Goals to halve food waste requires multidisciplinary efforts from all the stakeholders in food systems.

Covid-19 has increased the urgency to fight food waste, especially in terms of redistributing food to those vulnerable people who are affected by pandemics, and multiple efforts are being made by public, private and the third sectors to tackle food insecurity and hunger. The net effect of the pandemic on food waste will depend on how long it lasts, and on the impact it has on the global economy, on agri-food supply chains, and on households, as well as on the measures that are being taken by local authorities, and regional, national and global pandemic management (Burlea-Schiopoiu et al., 2021). We believe that this Special Forum, which was created before Covid-19 changed our lives, is an important reading and learning opportunity for all of us, as consumers, citizens and researchers.

Contribution of the papers in this Special Forum

The call for papers for this Special Forum resulted in a very competitive selection of 37 being submitted. After several rounds of blind review, six papers were selected for this Special Forum. They clearly illustrate the challenges of carrying out research into sustainable operations and food waste reduction. They examine a variety of units of analysis and theories, which are embedded in different geographical contexts, and use a variety of analytical methods. What they all have in common is that they reveal just how applicable research aimed at finding solutions for reducing food waste is. In this Introductory article, we summarize the contributions of each of these six papers to the literature.

The first paper of this Special Forum (Costa, Campos, & Santana, 2021) reports the findings of an on-line survey of how consumer procrastination behavior relates to food waste, with 279 respondents answering questions that were analyzed using structural equation modelling. Findings are counterintuitive since procrastination has no direct relationship with food waste behavior. The paper uses the findings to illustrate the consumer side of food waste research and pose new questions. It contributes to our understanding of behavioral aspects of consumers related to food waste that can be helpful for promoting a sustainable food system.

Based on a systematic literature review, the second paper of this Special Forum (Santos & Martins, 2021) analyzes performance measurement systems and food waste. Findings reveal a conceptual map of the field and show how to move towards measuring supply chain performance systems. It contributes to food waste research by taking a supply chain perspective that can be applied to the flow of different food products.

The third paper of this special issue (Kazancoglu, Ekinei, Ozen, & Pala, 2021) describes the key elements of value stream mapping and illustrates it with a case study in Turkey. The study examines a single point, a meat processing plant, and is prescriptive for operations managers. It shows how a lean approach can minimize food waste in one focal company, and move it towards the circular economy.

The fourth paper is a systematic literature review of elements of resilience in food waste practices and the causes (Costa, Moraes, Silva, Pereira, Delai, & Jabbour, 2021). The study focuses on the application of elements of resilience at a single point on the supply chain, retail trade. The retail trade holds a powerful position in food distribution worldwide and by examining the theory this study points out important actions that can reduce food waste in retail operations.

The fifth paper is a single case study from a digital platform in Brazil (Moltene & Orsato, 2021). Digitalization in the food supply chain has been a major trend and this study focuses on the different kinds of digital platforms. It describes a case study of a digital platform that connects businesses that have surplus food with consumers. The study contributes to our understanding of the use and acceptance of this type of business model, which can help reduce food waste.

Using a single case study, the sixth paper of this Special Forum looked at the amount of food wasted by consumers in a Brazilian university dining hall during lunch time, and explored the factors that influence variations in the amount of food wasted (Deliberador, Batalha, Chung, & Cesar, 2021) With the findings of this study indicating that one of the causes of food waste is large portion sizes, which relate directly to the amount of food wasted, the paper suggests possible interventions for reducing it.

FINAL REMARKS

Moving to production and consumption that are more sustainable is no easy matter. Research has been suggesting solutions, but they tend to focus on the consumer or the supply chain. This special issue contains relevant and rigorous research into the topic, mainly from an emerging country perspective. There is still the challenge, however, of how to integrate the consumer and supply chain sides using mixed methods in the same research, since the reasons food is wasted along the supply chain, from producer to household, are interconnected and require systemic analysis. We hope that this Special Forum contributes to advancing research into ways of reducing food waste.

We hope you enjoy your read.

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AUTHOR'S CONTRIBUTION

Luciana Marques Vieira, Marcia Dutra de Barcellos,Gustavo Porpino de Araujo, Mattias Eriksson, Manoj Dora and Daniele Eckert Matzembacher worked on the conceptualization and theoretical-methodological approach. The theoretical review was conducted by Luciana Marques Vieira, Marcia Dutra de Barcellos,Gustavo Porpino de Araujo e Daniele Eckert Matzembacher Data collection was coordinated by Luciana Marques Vieira, Marcia Dutra de Barcellos,Gustavo Porpino de Araujo e Daniele Eckert Matzembacher Data analysis included Luciana Marques Vieira, Marcia Dutra de Barcellos,Gustavo Porpino de Araujo e Daniele Eckert Matzembacher. All authors worked together in the writing and final revision of the manuscript.

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REDUCING FOOD WASTE THROUGH LEAN AND SUSTAINABLE OPERATIONS: A CASE STUDY FROM THE POULTRY INDUSTRY

Redução do desperdício de alimentos por meio de operações sustentáveis e enxutas: Estudo de caso do setor avícola

Reducción del desperdicio de alimentos mediante operaciones lean y sostenibles: Estudio de caso de la industria avícola

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ABSTRACT

The growing need for solving the problem of food waste for tackling the survival of the planet and humankind is encouraging researchers to seek sustainable operations that alter the conventional methods that are currently in use in the food industry. Lean thinking has been used in this study to propose sustainable operations that incorporate social, economic, and environmental aspects and to handle the multidisciplinary and complex nature of reducing food waste. The value stream mapping methodology has been employed to explain food waste and generate drivers and to observe the end-to-end system flow. Since most of the waste is observed in upstream operations in emerging economies, one of the biggest meat-processing companies in Turkey is studied for illustrating the proposed methodology. As a result of the model, lean and sustainable food operations are suggested considering social, economic and environmental aspects.

KEYWORDS | Lean management, sustainability, food waste, value stream mapping, emerging economy.

RESUMO

A crescente necessidade de resolver o problema do desperdício de alimentos para a sobrevivência do planeta e da humanidade incentiva os pesquisadores a buscarem operações sustentáveis que alterem os métodos convencionais atualmente em uso na indústria de alimentos. Neste estudo, o pensamento enxuto foi utilizado para propor operações sustentáveis incorporando aspectos sociais, econômicos e ambientais e para lidar com a natureza multidisciplinar e complexa da redução do desperdício de alimentos. A metodologia de mapeamento do fluxo de valor foi empregada para explicar os fatores geradores de desperdício de alimentos e para ver o fluxo do sistema de ponta a ponta. Como a maioria dos resíduos pode ser observada em operações a montante em economias emergentes, a metodologia proposta é ilustrada em uma das maiores empresas de carne da Turquia. Como resultado do modelo, operações alimentares enxutas e sustentáveis foram sugeridas considerando aspectos sociais, econômicos e ambientais.

PALAVRAS-CHAVE */ Gestión eficiente, sostenibilidad, desperdicio de alimentos, mapeo de flujo de valor, economía emergente.*

RESUMEN

La creciente necesidad de resolver el problema del desperdicio de alimentos para la supervivencia del planeta y la humanidad alienta a los investigadores a buscar operaciones sostenibles que alteren los métodos convencionales que se utilizan actualmente en la industria alimenticia. En este estudio, se ha utilizado la filosofía lean para proponer operaciones sostenibles que incorporen aspectos sociales, económicos y ambientales y para manejar la naturaleza multidisciplinaria y compleja de la reducción del desperdicio de alimentos. La metodología de mapeo de flujo de valor se ha empleado para explicar los generadores del desperdicio de alimentos y para ver el flujo del sistema de extremo a extremo. Dado que el mayor desperdicio se observa en las operaciones iniciales en las economías emergentes, se estudió una de las compañías de carne más grandes de Turquía para ilustrar la metodología propuesta. Como resultado del modelo, se han sugerido operaciones alimentarias magras y sostenibles que consideren aspectos sociales, económicos y ambientales.

PALABRAS CLAVE */ Gestión eficiente, sostenibilidad, desechos alimentarios, mapeo de flujo de valor, economía emergente.*

INTRODUCTION

The world population is expected to reach 9.5 billion by 2075, which is motivating researchers to investigate sustainable operations for social, economic, environmental and political issues (Institution of Mechanical Engineers, 2013). A basic standpoint for solving interrelated problems in these areas is dealing with finding enough food supply for 1.7 billion additional people by the end of the century. Total production worldwide is approximately four billion metric tons per year, but 30-50% of the food produced is lost for various reasons (Institution of Mechanical Engineers, 2013; Kumar, Mangla, Kumar, & Karamperidis, 2020). Food waste starts with initial agricultural production for consumption by end-users and losses are high both in industrialized and emerging economies. In third world and emerging economies, food losses occur mostly in the farming, post-harvest and processing stages, whereas in industrialized countries waste occurs predominantly on the retail and customer sides (Food and Agriculture Organization of the United Nations [FAO], 2011a; Institution of Mechanical Engineers, 2013). If food loss can be reduced, it may be possible to feed an additional two billion people, since globally we already produce food enough for 10 billion people (Gimenez, Shattuck, Altieri, Herren, & Gliessman, 2010; World Food Program USA [WFPUSA], 2019). Continuing with the existing conventional methods both in agriculture and livestock production, however, will shortly lead to unsustainable outputs, so humankind must seek solutions for reducing food loss and improving food production processes (Castellini, Bastianoni, Granai, Bosco, & Brunetti, 2006; Gimenez et al., 2010; Kumm, 2002). Therefore, in the United Nations' sustainable development plan for 2030, ending hunger by providing sufficient, safe, affordable, and nutritious food, and reducing food waste starting from the production stage through to consumption are two main objectives for the welfare of humanity and the planet. It is understood that sustainable operations in food waste management are a crucial instrument for transforming sustainable societies and for the well-being of humans (Ingrao, Faccilongo, Gioia, & Messineo, 2018).

According to Thyberg and Tonjes (2016), food waste is a complex and interdisciplinary problem, which can be resolved by developing sustainable policies for a diverse range of waste generating drivers. On the other hand, Lean Thinking, which is applied in various fields from production to service systems, is a discipline comprising a collection of principles and philosophies that are used to eliminate waste and non-value adding activities. Therefore, the solutions being offered can cover various areas, including the social, economic, and environmental even within the same context. Systematically applying lean disciplines in the food industry is a common methodology for eliminating waste (Vlachos, 2015). Although the main causes of waste might be incorrectly assumed to be food miles and plastic packaging, in reality it has been discovered that the leading sources of waste are overproduction, overstocking, excessive transportation, waiting times, unnecessary movement throughout the supply chain, and production problems (such as poor-quality materials and equipment, incorrect procedures, etc.), all of which can be dealt with by way of lean thinking (Gooch et al., 2010). Value Stream Mapping (VSM), as a useful methodology for investigating value-adding and non-value-adding activities, and for offering solutions for eventually eliminating waste generating activities, has been employed relatively commonly in literature. Proposing solutions for reducing the waste that has implications for social, economic, and environmental aspects may also result in sustainability being achieved in the system of interest.

Our aim in this study is to explain the following research objectives:

- To propose a holistic approach for clarifying waste generating drivers while reviewing the system processes;
- To suggest solutions that alter conventional methods by way of sustainable operations based on lean philosophy;

- To explain how VSM can be a convenient methodology for recommending multidisciplinary solutions for food waste that can cover the three aspects of sustainability, which are economic, social, and environmental.

The VSM model has been used in this study to suggest lean and sustainable operations that cover social, economic and environmental aspects. With the help of the proposed solutions, it is proved that lean thinking is a suitable philosophy for reducing food waste. Since food waste occurs in upstream operations in emerging economies, the study focuses on one of the biggest meat companies in Turkey. Implementing VSM is suggested as a way of improving sustainable operations in food supply chain operations. The future state map is presented, which is followed by implications for both policymakers and managers.

Section 2 presents food waste in an emerging economy and reviews the literature dealing with lean management in the food industry. Section 3 outlines the research gap that exists with regard to lean and sustainable food operations. Section 4 describes VSM, while a case study in the poultry industry is explained in Section 5. Section 6 presents the contributions of the study to sustainable operations. Section 7 and Section 8 provide the managerial implications and the conclusion, respectively.

FOOD WASTE IN AN EMERGING ECONOMY

Food waste is a growing problem all around the world and according to the FAO Report (FAO, 2011b), From Farm to Fork, one-third of the world's food production is lost or wasted (Zhao et al., 2020). The excessive and unnecessary use of water and energy, and the greenhouse gas emissions caused by the production and distribution process, and the growth in population and demand all result in increasing food waste (Mangla et al., 2018). Food loss and food waste refer to reductions in quantity in the supply chain of the food that is produced, especially food for human consumption (FAO, 2011a). These losses and waste occur throughout the entire supply chain from field to table, and involve production, processing, packaging, transportation, and distribution (Ju, Osako, & Harashina, 2017; Parfitt, Barthel, & Macnaughton, 2010). Food loss and waste occur both in developed and emerging countries. While food loss and waste occur mostly in the retail and consumption areas in developed countries, the most significant food loss and waste in emerging countries occurs in the early and middle stages of the food supply chain (Verma et al., 2019). Developed countries consume food more than 200 million tons of food every year, mostly in the retail and consumption areas. Between 6 and11 kg. of waste per person are generated in Africa and South Asia, while there are between 95 and 115 kg. of food waste per person in Europe and North America every year (Ishangulyyev, Kim, & Lee, 2019). Encouraging consumers to buy more food than they need in markets with high-quality standards leads to food waste in developed countries (Wunderlich & Martinez, 2018).

On the other hand, in emerging countries like Turkey (Kayıkcı, Ozbiltekin, & Kazancoglu, 2019), the main causes of food waste are a lack of knowledge and technology during the harvesting process, a lack of appropriate infrastructure, a lack of knowledge of the post-harvest stage, and packaging processes (Wunderlich & Martinez, 2018). In the farming process, farmers suffer great losses during production because of early harvesting, storage, insect attack and careless use (Östergren et al., 2014). In the harvesting process, insufficient storage conditions result in bad consequences, such as insect infestation and the formation of mold, leading to food loss (Gustavsson, Cederberg, Sonesson, Otterdijk, & Meybeck, 2011; Ju et al., 2017). Decay organisms develop and increase with the emergence of fungi and diseases due to high temperatures and humidity after the harvest, which can lead to the

whole crop deteriorating (Verghese, Lewis, Lockrey, & Williams, 2015). Losses occur in processing plants due to a lack of technologies and insufficient facilities (Kumar & Kalita, 2017). According to the statistics, almost 50 percent of food losses occur at the post-harvest and processing levels (Kummu et al., 2012).

Turkey, an important emerging economy, has a growing population of more than 80 million inhabitants (United Nations High Commissioner for Refugees [UNHCR], 2019). This growth is leading to an increased demand for food for the country's consumers. Turkey is ranked among the top 20 countries in the world in agriculture, producing milk, wheat, and other crops (FAO, 2015). While annual food production in Turkey is calculated to be 122.9 Mt/y, the amount of food wasted is calculated at 16 Mt/y (The Standing Committee for Economic and Commercial Cooperation of the Organization of the Islamic Cooperation [COMCEC], 2017).

Like other emerging economies, food loss and waste in Turkey occur during all processes in the supply chain, from production to consumption (Tatlıdil, Dellal, & Bayramoglu, 2013). Food waste is also a growing issue in the country, and has economic, environmental, and social consequences (Yıldırım et al., 2016). According to the statistics, every year, some 26 million tons of food are thrown away in Turkey, which corresponds to almost 215 billion TL (Turkish Republic Ministry of Industry and Trade, 2018).

Lean approaches can be a solution for reducing food waste in emerging economies, because they not only minimize waste, but also increase operational efficiency. The following section contains a review of the literature on lean management in the food industry.

Lean management in the food industry

Lean management is the approach used for presenting value from the customers' perspective, for continuously developing an organization's processes, and for avoiding waste (Chronéer & Wallström, 2016). It is a management method for companies that try to adapt to current market conditions by way of functional and organizational changes (Dekier, 2012). Lean management also results in reducing costs, increasing customer interactions, quality, enhanced employee morale and improvements in culture and the use of push and pull systems (Liu, Yang, & Xin, 2019).

Although lean management is an essential for all industries, knowledge about lean practices and how to implement them in the food industry is a very narrow area. There is still a gap in lean practices and developing effective management in the food industry within the concept of lean management (Sreedharan & Raju, 2016). Moreover, increased pressure from consumers and competition between firms have recently affected the implementation of lean management (Dora, Goubergen, Kumar, Molnar, & Gellynck, 2014).

Lean management in the food industry is essential since the industry is a changeable sector (Singh, Luthra, Mangla, & Uniyal, 2019), in which production batches and processing times at the production stages vary because of seasonality and the shortness of shelf-life factors (Dora et al., 2014; Liu et al., 2019). In contrast with other industries, many food and agricultural products are harvested at certain times of the year and must be processed in large batches regardless of the frequency of customer demand (Liu et al., 2019; Mahalik & Nambiar, 2010). Therefore, it is difficult to produce on time within this sector. Lean management aims to reduce costs by increasing quality in the industry. With the help of lean management, the customer value of food companies increases though the company costs of food industry decreases (Lehtinen & Torkko, 2005).

In considering the literature review, there are many studies about lean management in the food industry. These studies focus on different parts of this industry, such as manufacturing, supply chains and processing. Exhibit 1 provides an overview of the literature about lean management in the food industry.

Exhibit 1. **The literature review of lean management in the food industry**

Author(s)	Method(s)	Focus Area
Cox and Chicksand (2005)	Case Study	Food Industry
Lehtinen and Torkko (2005)	Value Stream Map	Food Manufacturing
Taylor (2006)	Case Study	Agri-food Supply Chain
Gellynck and Molnar (2009)	Combined Taxonomy Compilation	Organizational Structures in the Food Industry
Scherrer-Rathje et al. (2009)	Case Study	Food Processing Machines
Perez et al. (2010)	Case Study	Food Supply Chain
Testa (2010)	Value Stream Map	Food Processing
Zarei et al. (2011)	Fuzzy Quality Function Deployment (QFD)	Food Supply Chain
Manzouri et al. (2013)	Survey	Food Supply Chain
Noorwali (2013)	Lean Approach, Taguchi, Simulation, and Correlation	Food Flow Processing
Besseris (2014)	Experimental Procedure	Food Product Improvement
Chaplin and O'Rourke (2014)	Observation	Food Production
Lopes et al. (2015)	Case Study	Process Innovation
Sreedharan and Raju (2016)	Systematic Literature Review	Different Industries
Ali et al. (2017)	Theoretical sampling	Food Production
Kezia et al. (2017)	Desk Research	Lean Manufacturing in the Food and Beverage Industry
Jie and Gengatharen (2019)	SPSS	Food Supply Chain
Castro and Posada (2019)	Questionnaire	Lean Manufacturing in the Baking Industry
Dora et al. (2014)	Questionnaire	Lean Practices in SMEs
Vlachos (2015)	Value Stream Mapping	Food Supply Chain
Chen, Liu & Oderanti (2020)	AHP	Food Supply Chain

In their study into lean management in food manufacturing, Lehtinen and Torkko (2005) discussed appropriate ways for applying lean concepts in a food-manufacturing company. They analyzed lean production, lean supply, and value stream mapping to understand the lean concept. Using a case study, they mapped out the collaboration that exists between the lean concept and supply chain management in the food chain. Chaplin and O'Rourke (2014) proposed a business development program, which covers the Lean Six Sigma concept in food manufacturing in the UK. Their study focuses on determining the gaps and benefits of the Lean Six Sigma program for marketing activities.

In their analysis of the benefits of lean manufacturing processes in the food and beverage industry, Kezia, Kumar, and Sai (2017) state that lean manufacturing leads to minimum waste and maximum utilization of resources. Castro and Posada (2019) focused on lean manufacturing in the baking industry to evaluate the results of lean techniques, which they did by way of a questionnaire. Ali. Tan, Suleiman, and Alam (2017) discussed ways of providing a balance between quality and cost with the help of lean approaches in the food industry. Their study looked at case studies in various companies in food supply chains.

There are also different studies on lean management in food processing in the literature. Testa (2010) analyzed food processing based on the lean approach concept. The lean concept framework and Value Stream Mapping is discussed in the study to spread lean approach concept in mind. Noorwali (2013) focused on lean activities in food processing systems. His study includes Taguchi, a lean approach that is a simulation for minimizing variability levels in the food processing system.

Some studies have focused on lean management in food supply chains. Taylor (2006) analyzed techniques based on value-chain analysis and opportunities for strategic change in the agri-food supply chain in the UK relating to two red meat industry supply chains, and proposed an initial model for an integrated supply chain based on the application of the lean concept. Perez, Castro, Simons, and Gimenez (2010) analyzed the performance of a Catalan pork supply chain. They demonstrated the adaptation of the pork supply chain and lean approaches using multiple case study research and semi-structured interviews.

Zarei, Fakhrzad, and Paghaleh (2011) used QFD in their study on maximizing lean levels in the food supply chain. For this purpose, they analyzed a case study using fuzzy logic to show the practical results of the methodology. Chen, Liu & Oderanti(2020) analyzed lean management in a food supply chain using the Analytical Hierarchy Process (AHP) to understand the opinions of experts with regard to lean thinking and objective performance. Scherrer-Rathje, Boyle, and Deflorin (2009) also state that lean management is critical both for the organization and for company supply chains. They highlighted critical rules for the lean concept, which provided the organizations in their study with lean knowledge, and analyzed two lean food processing equipment projects. Jie and Gengatharen (2019) focused on the Australian retail food sector in their study into how to improve the supply chain performance of small enterprises while reducing costs using lean thinking and knowledge sharing.

Manzouri, Rahman, Saibani, and Zain (2013) use a questionnaire with 300 food firms in Malaysia to evaluate the readiness level of lean practices in their supply chains. As a result, they discovered that more than half of the companies were not suitable for implementing lean approaches. Similarly, Vlachos (2015) tried to determine the compatibility of lean approaches and lean thinking in food supply chains and discovered that problems occur during the implementation of lean techniques. In this particular study, Value Stream Mapping is used for a case study that was based on a US tea company. Cox and Chicksand (2005) analyzed lean management implementation in the food industry using the case of a red meat supply chain.

Besseris (2014) discussed the Lean Six Sigma (LSS) concept and tried to provide LSS projects that can help those that introduce LSS with lean optimization efforts for addressing problems that are faced in food industry operations. A proposed model was adopted in a case study in the food industry. Lopes, Freitas, and Sousa (2015) put forward a study involving the implementation of lean management tools in two Portuguese food and drink companies. This study discussed the effect of lean management tools on these firms. Sreedharan and Raju (2016) systematically analyzed a literature review involving different sectors that adopt the lean management concept. They stated that there are fewer studies about lean management in the food sector than in other sectors.

Gellynck and Molnar (2009) studied the European food sector to determine product-level and chain-level relations based on governance structure. The study covered 54 companies in Italy, Belgium and Hungary. Using questionnaires Dora et al. (2014) focused on small and medium-size food enterprises to analyze the benefits of lean practices. With their study, they evaluated barriers to the implementation of lean techniques in small and medium-size European food enterprises.

Following the literature review, the research gap relating to lean and sustainable food operations is set out in the next section.

REDUCING FOOD WASTE USING LEAN AND SUSTAINABLE OPERATIONS

Food waste threatens not only society but also the environment and the economy (Baig, Al-Zahrani, Schneider, Straquadine, & Mourad, 2019). While ignoring sustainable operations in food waste threatens worker health, it also causes environmental problems, such as high carbon emissions and environmental pollution (Ritchie & Roser, 2020). It also lowers efficiency in the food supply chain, leading to increased costs (FAO, 2011a). However, various articles in the existing literature indicate the need to adopt sustainable operations for dealing with food waste in order to ensure the survival of the planet and human well-being. Since food waste is a complex issue in sustainable operations, multidisciplinary thinking should be employed that considers economic, social and environmental aspects in equal harmony, whereas existing literature is predominantly motivated to consider only one or two of these aspects (Garcia-Garcia et al., 2017).

Lean management is needed to achieve this integration between the dimensions of sustainability. Lean thinking also benefits waste minimization, increases efficiency, and improves customer value. The Lean approach helps companies change their policies and build longer-term, sustainable systems. Thus, the lean approach is extremely important for managers from production to service. Moreover, due to its ability to identify waste, VSM can be easily linked to food-related losses and waste, and can be used to assess waste in the food sector (Wesana et al., 2019).

In complex production environments, analyzing the system with all its features is a challenge. In this case, the usefulness of VSM is proven under lean-based approaches in terms of a better and clearer visualization of the processes (Seth et al., 2017). VSM is a useful tool for approaching a system that requires "observing the whole" and rethinking the functions for improving processes. It is also useful for recognizing any disconnections between processes, and for improving performance after careful consideration (Henrique et al., 2016).

VSM also provides an overall view of all kinds of activities in the system and enables waste to be identified where production outputs, such as product quality, response times, and production costs can be revealed by its features (Lacerda, Xambre, & Alvelos, 2016). Furthermore, VSM becomes most prominent because of its ability to quickly assess the state of production processes by their visual nature, allows quantification of production times, and reveals opportunities for improvement (Dinis-Carvalho et al., 2019).

Norton and Fearne (2009) revised the standard VSM methodology as Sustainable VSM by adding environmental performance indicators, like CO^2 emissions and waste. Lean thinking, therefore, is an approach that is mainly used for reviewing and eliminating waste from all types of processes. Therefore, lean philosophy can also be adapted for dealing with food waste in a sustainable manner. In this sense, as one of the main methods of lean thinking, VSM can be implemented in food supply chains for minimizing food waste.

VSM is especially helpful in this study:

- For seeing the big picture of the system of interest,
- For understanding and prioritizing the main drivers of the waste-generating factors based on the value-adding and non-value adding classification of activities.

Even though articles have been written on the application of VSM in the food industry, there is still a gap in the literature, most of which does not consider the sustainability aspect, but rather process improvements that try to eliminate unnecessary inventory, shorten the production period, etc. In this study, however, the main purpose is to eliminate waste in a sustainable way either by identifying waste generating factors, or by increasing

production performance. Unlike the existing literature, by incorporating the term "sustainability", this study aims to provide industry managers with promising multidisciplinary solutions for combining their economic, social and environmental objectives (Garcia-Garcia et al., 2017).

METHODOLOGY: VALUE STREAM MAPPING

As an important element of lean production, Value Stream Mapping (VSM) was first introduced by Rother and Shook (1998) as a functional method for reorganizing systems with a lean perspective (Lasa, Laburu, & Vila, 2008). VSM can be used for identifying problems in a production system by redesigning it to eliminate waste and improve performance (Stadnica & Litwin, 2019). VSM is a tool that can be defined as all the actions, including the value-added and non-value-added actions, that are required for production flow from raw materials to the customer. It is used for identifying waste, which is also useful for establishing and monitoring green and sustainable practices (Faulkner & Badurdeen, 2014).

VSM is a useful tool for visualizing and understanding the flow of information and materials along the value chain and gives a broad view of all activities in the production process (Lacerda et al., 2016). A very significant feature of VSM, unlike other process mapping methods, is that it documents not only basic product flows, but also the flow of information, including production scheduling and production information (Singh, Garg, & Sharma, 2011). The main advantages of VSM are: it is an effective tool for implementing lean principles; it provides a link between production processes and supply chain activities by visualizing all flows; and it enables production planning, demand forecasting, and production scheduling to be integrated (Jasti, Kota, & Sangwan, 2019).

Rother and Shook (1998) presented the stages of VSM application in five steps, which are:

(1) Selecting the product family;

(2) Modeling the current state map;

(3) Analyzing waste and proposing continuous improvement events, known as *kaizen*;

(4) Modeling the future state map;

(5) Making a work plan and composing it.

For the current state map, the main idea is data collection related to the current system for visualizing all the flows. The main steps for drawing up the current state map are: making observations and gathering data about customer requirements; presenting the physical flow of all processes with their data boxes and inventory details; mapping out the supply of materials; and determining the push and pull system and mapping out the information flow using specific graphical symbols for presenting the results (Masuti & Dabade, 2019).

A guideline is also needed for presenting the future state map as well. Lasa et al. (2008) summarized this guideline as follows. First, the amount of production should be determined in accordance with product demand, where Takt time reflects the rate. Second, a continuous flow should be established insofar as this is possible. Third, a pull system should be used between work stations, where continuous flow is not possible. Fourth, the pacemaker process should be defined to command production of the various parts. Fifth, pacemaker process scheduling should be used for leveling product mix and product volume. Finally, overall process efficiency should be improved.

In the following section, Value Stream Mapping is implemented in the food industry and a case study in the poultry industry is conducted using Value Stream Mapping.

A CASE STUDY IN THE POULTRY INDUSTRY: PROBLEM DEFINITION AND THE CURRENT STATE MAP

The case study was conducted in one of the biggest meat companies in Turkey that focuses particularly on turkey-meat products. The case company works with one supplier, which provides the company with live turkeys. Processes generally start with the turkeys being collected from the supplier, loading them into trucks, arriving at the company, unloading the trucks, cleaning the cages, continuing with the internal cutting processes, and ending with packing.

There are, however, many limitations related to capacity and animal welfare. For instance, turkeys must arrive at the company at night, since the death rate increases in the morning. The company does not like its employees working night shifts, however, because it reduces productivity, which leads to an increase in waiting times. At the same time, the supplier does not like having its turkeys collected at night because it wakes up the turkeys and increases their stress levels. In the current system, trucks wait for approximately 9 hours, and some 8-10 trucks arrive at the company every day. Truck capacity varies according to the gender of the turkeys, since females weigh less than males. In the current system, truck capacity for females, is 864, and 432 for males. Another limitation is that trucks have to wait for each other to unload, and the current facility is unable to unload more than one truck at a time. The unloading process takes approximately 35-40 minutes for male turkeys, and 60 minutes for female turkeys. The cage-washing process also has to be finished before moving on to the next truck, a process that takes approximately five minutes. Another problem with the current system is that the company does not follow the first-in-first-out (FIFO) rule for the trucks arriving at the company for unloading. All these limitations increase waiting times. From this point of view, this study focuses especially on reducing the waiting times of trucks loaded with live turkeys to avoid lowering meat quality and reducing any weight loss due to stress caused by long waiting times.

Observations of the current system in the case company showed that waste can be categorized under two main headings: waste related to the supplier; and waste related to the company's internal processes.

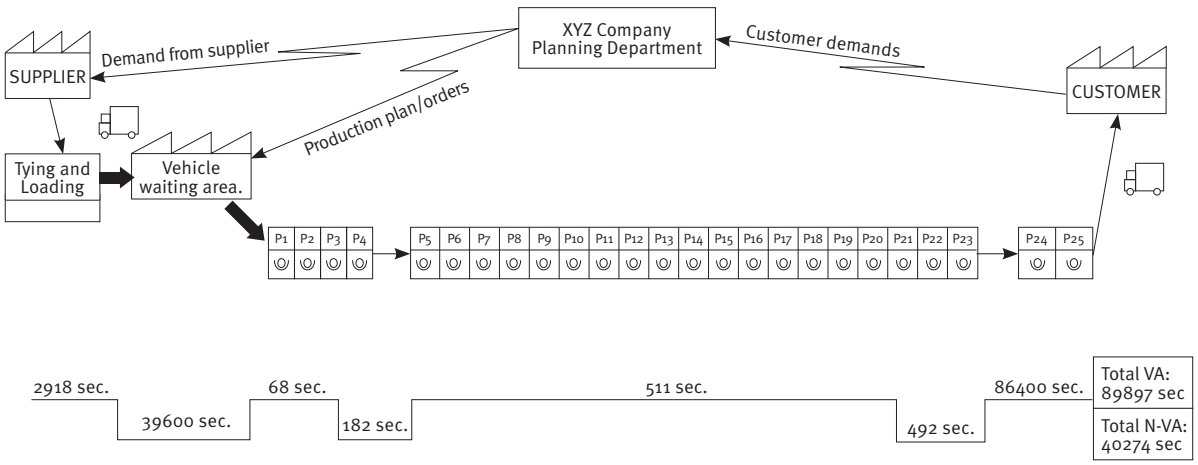
The main waste for the supplier relates to cooperatives and to transportation processes. The supplier has several cooperatives that supply the company with livestock. This results in different distances between the cooperatives and the company and reveals a non-standard transportation process. The duration of the process for collecting livestock from the suppliers also varies and is a barrier when it comes to standardizing processes. The second important root cause of waste related to the supplier is the process by which the livestock is transported from the cooperatives to the company. There are problems related to the arrival time of the trucks at the company, and also to the number of trucks varying, which exposes problems related to scheduling.

Waste related to the company's internal processes can be categorized as waste related to: workers; waiting times; and caused by incompatibility between the working hours of the company and the supplier. To start with, the number of workers is not sufficient in the slaughterhouse, which results in long waiting times. Furthermore, in the current system workers are also not specialists in specific tasks, but have responsibilities during the entire process flow. This results in inefficient conditions in different processes. Another waste is caused by waiting times, and this occurs during two main processes. These are unnecessary waiting times between when the trucks arrive

at the company and when the turkeys are unloaded, and between unloading the truck and waiting for the cages to be washed. The final problem related to internal processes is that the working hours of the company and the suppliers are different, and this results in an inconsistency between processes.

Based on this information, the current state map of the case study is shown in Figure 1. Due to the nature of the problem, and the focus area of this study, a two-stage VSM is drawn that shows both the processes of the suppliers and the internal processes. The map shows a total of 25 processes, but this study focuses particularly on the processes that precede the Shocking process (P4). Value-added and non-value-added times are also presented in the current state map.

Figure 1. **Current State Map**



(P1: Unloading cages, P2: Moving from cage to conveyor, P3: Hangking turkeys, P4: Shocking, P5: Throat cutting, P6: Blood train, P7: Tail cutting, P8: Fether softening, P9: Feather cutting, P10: Food cutting, P11: Second hanging, P12: Cutting throat leather, P13: Cutting back leather, P14: Cutting wings, P15: Stripping the neck skin, P16: Control, P17: Internal organ cleaning, P18: Washing, P19: Cutting Neck, P20: Measuring ment hanger, P21: Weighting and recording, P22: Loading to conveyor, P23 Final washing, P24 Resting turkeys in cold storage, P25 Packaging)

Eliminating waste: The Future State Map

The focus of this case study only covers the initial stages of VSM, which are the processes relating to the turkeys being collected from the supplier, arriving at the company, and being unloaded. For this reason, suggestions for improvements do not cover the processes in the slaughterhouse or the packing area. The following points are mentioned for the proposed future state map.

- Changing shift hours
- Late collection of turkeys
- Improving the tying and loading process using handling equipment
- The use of trailer trucks

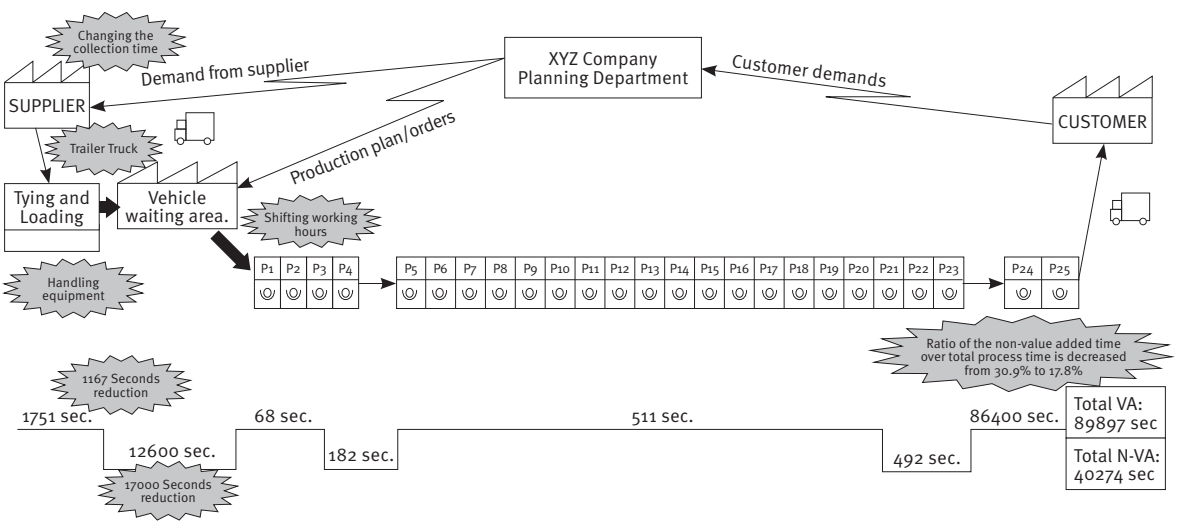
As mentioned before, one of the most significant reasons for the long waiting times is the difference between the working hours of the supplier and the company. By considering limitations related to animal welfare, meat quality and company policies, an arrangement can be suggested in terms of changing working hours for both the supplier and the company. After discussions between the company and the supplier, if the supplier starts collecting turkeys around 2 a.m. instead of 8:30 p.m., and the company introduces shift working and starts the slaughtering process at 5 a.m. instead of at 7 a.m., waiting times would reduce by around 3.5 hours. Therefore, the suggested initial improvement areas would be to change collection times and introduce shifts in the company.

Another improvement would be with regard to the tying and loading process, for which automatic handling equipment could be adopted. Manual handling is used in the current system, which results in extra effort on the part of employees and increases the stress level of the turkeys. Technological handling equipment can help eliminate movement waste, and also reduce processing time. An example of such equipment would be the TA 800 Turkey Loader, which would reduce processing time by 40%, improve both worker and animal welfare, reduce staff-related costs, and increase loading speed. An investment in this system would decrease the tying and loading process by 1167 seconds.

Trailer trucks could also be used for eliminating transportation waste and for carrying live animals more easily. The main advantages of a trailer truck are reducing the cost of additional vehicles, reducing maintenance costs, their usability for different purposes, providing additional carrying capacity and being more convenient during the loading process.

Based on these calculations, the ratio of non-value-added time to total process time is reduced from 30.9% to 17.8%, which shows the result of general improvements in the supplier phase and in the waiting area in the company. In the following section, these results will be discussed and implications will be presented.

Figure 2. **Future State Map**

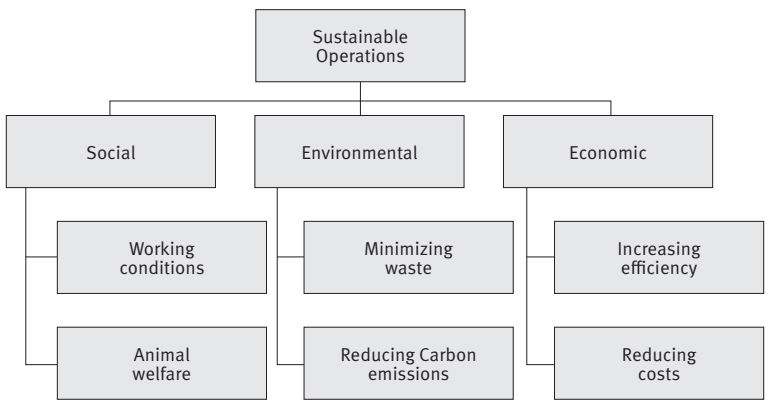


(P1: Unloading cages, P2: Moving from cage to conveyor, P3: Hangking turkeys, P4: Shocking, P5: Throat cutting, P6: Blood train, P7: Tail cutting, P8: Fether softening, P9: Feather cutting, P10: Food cutting, P11: Second hanging, P12: Cutting throat leather, P13: Cutting back leather, P14: Cutting wings, P15: Stripping the neck skin, P16: Control, P17: Internal organ cleaning, P18: Washing, P19: Cutting Neck, P20: Measuring ment hanger, P21: Weighting and recording, P22: Loading to conveyor, P23: Final washing, P24: Resting turkeys in cold storage, P25: Packaging)

CONTRIBUTIONS TO SUSTAINABLE FOOD OPERATIONS

As mentioned in earlier sections, food supply chains create waste that is related to transportation, storage, handling, etc. Due to the waste that occurs in food supply chains, the social, economic and environmental concerns that are the dimensions of sustainability remain under threat (Cicatiello, Franco, Pancino, & Blasi, 2016; Sharma, Mangla, Patil, & Liu, 2019; Thyberg & Tonjes, 2016; Vlachos, 2015). This waste prevents food operations from being sustainable. As a result, a lean philosophy and its practices can be a solution in food supply chains for minimizing waste (Ishangulyyev et al., 2019). This study provides social, environmental and economic benefits in sustainable food operations, as shown in Figure 3.

Figure 3. **Contributions to sustainable food operations**



One of this study's important contributions to sustainable food operations covers the working conditions of suppliers and the company. With shifts being introduced into employee working hours, the efficiency of the process improves because of increases in the productivity and dependency of the workers. Moreover, as a result of the analysis, it is seen that due to the difference between the working conditions of the company and the suppliers, animal welfare decreases. With the suggestion of a time change resulting from the introduction of the lean method, it is expected that the animals will not be woken at night and that related stress levels will be avoided. It is expected, therefore, that animal welfare will increase. Improvements in working conditions in the company and the supplier, and increasing animal welfare are crucial contributions to social sustainability in food operations.

In addition to the social benefits, lean approaches also contribute to the savings by reducing costs (Nahmens & Ikuma, 2012). The study's suggestions not only reduce personnel costs, but also reduce vehicle maintenance costs, because of the improvement in costs, and the increase in company efficiency. Therefore, these improvements contribute towards economic sustainability in food operations (Singh et al., 2019).

One of the most important contributions of this study is that it reduces and minimizes waste in food supply chains by considering environmental issues. The waste generated during the turkey collection stage by vehicles is minimized. Carbon emissions are also reduced through improved vehicle use and capacity.

To sum up, the proposed study model not only contributes to the economy but also provides environmental and social benefits in sustainable food operations.

IMPLICATIONS

The results of this study cover the processes from the collection of the turkeys from suppliers until they are unloaded in the company. For managers, there are several important implications that can be addressed for minimizing waste in food supply chains. These implications can be mainly grouped under the following points; storage and retrieval systems, handling equipment, vehicle selection and interdisciplinary issues.

Storage and retrieval systems are an important area on which managers should focus, and they should be suitable for cold chain operations within food supply chains. Hence, the waste related to inappropriate warehouse management, such as lost, rotten, or perished food, can be prevented or minimized. The use of appropriate, technological storage and retrieval systems can, therefore, significantly contribute towards minimizing waste.

Handling equipment can increase the efficiency and effectiveness of food supply chain operations. Handling equipment can prevent losses by improving biosecurity and making transportation easy, and it is highly durable and easy to maintain. To be more specific and within the scope of this study, the handling process in poultry houses can be improved. When turkeys are being caught and handled, they may be bruised, injured, or even killed due to the unwitting violent responses of workers and rough handling. Turkeys may also injure themselves or their wings while they are trying to escape.

Another important managerial implication is related to the transportation process, which means that vehicle selection is an important concern. The following criteria can be considered for vehicle selection within food supply chains for minimizing waste during transportation; their current capacity and multi-purpose features, convenient loading and unloading, flexibility for increasing capacity, and their appropriateness for cold chain operations.

Food supply chain management involves many stakeholders and requires knowledge of various fields. Interdisciplinary cooperation and collaboration, therefore, is crucial because of the nature of the complex structure of food supply chain. The purpose of minimizing waste in food supply chains requires the involvement of experts from various disciplines. For example, animal welfare should be considered during food supply operations to prevent losses and waste. In this sense, the expertise of veterinary and agricultural engineers can be used.

The term "value-added" in VSM can also be expanded in regards to sustainability. Therefore, it can deal not only with waste, but also with circularity or energy consumption.

To sum up, managers should not only employ lean principles in inhouse operations in the facility, but at every stage in the food supply chain. They should analyze each process along the chain and implement a lean philosophy and its tools in order to minimize food waste.

There are also implications for policymakers aiming to reduce food waste. Current or future rules and regulations should contain clear and holistic control mechanisms, and a “lean philosophy” should be the basis of these control mechanisms. Food waste should be tracked, quantified, and controlled throughout the food supply chain covering all processes and neglecting none of them. Clear targets can be established at each stage of the supply chain that are specific and suitable for each food category. Lean tools can be suggested and even taught to companies by governments or local authorities, and then companies will be controlled with regard to their usage and performance.

VSM can be used as a method for measuring and evaluating the sustainability performance of corporate food supply chains. This situation can be the basis of the incentive, control and inspection mechanisms of companies. This can be offered to policymakers as a tool.

CONCLUSION

According to the statistics, food waste is increasing worldwide. Particularly in emerging economies like Turkey, the increase in food waste is threatening the economic, social, and environmental aspects of countries. Due to its nature, food waste is a complex problem that requires holistic and interdisciplinary approaches. A lean philosophy is the approach that offers value to both customers and institutions by continuously improving processes and minimizing waste.

This study looked at ways of minimizing food waste in emerging economies with the help of lean philosophy and its tools, which were implemented in a poultry industry in Turkey. The current state map is prepared for processes that start with the collection of the turkeys from suppliers and conclude when they are slaughtered in the company, with VSM being implemented for these processes. Various improvements for sustainable operations are suggested for food supply chain processes involving the implementation of VSM. The results were presented and related implications for both policymakers and managers were set out.

According to the results, storage and retrieval systems are an essential process in food supply chain operations, and should be managed properly. With improvements in handling equipment, the efficiency and effectiveness of the food supply chain operations also improve by eliminating injuries that occur during animal capture with the use of proper handling equipment. It was shown that the transportation process is crucial in food supply chains. Proper transportation processes lead to improvements in current capacity, and convenient loading, and unloading, etc.

Although this study was developed considering emerging economies, it can be further extended to include developed economies. Future studies can be carried out by integrating the circular economy with lean and sustainable food operations. The proposed methodology can also be combined with Industry 4.0 and digitization. The current study can be integrated with blockchain technologies to improve traceability, and also applied to other types of food production and to other food industries.

One of the limitations of the study is that it was conducted in only one sector. However, the proposed methodology is generic and can be extended to other industries in the food sector. The context of the case study was limited to upstream operations, but can easily be extended to include downstream operations. The top management in companies should dedicate themselves to sustainability because the food industry has a complex structure and it is difficult to gather proper data for analyzing its operations.

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AUTHORS' CONTRIBUTIONS

The authors declare that they participated in all stages of development of the manuscript. Dr. Esra EKINCI worked on the conceptualization and theoretical-methodological approach. The theoretical review was conducted by Research Assistant Yesim Deniz Ozkan-Ozen & Research Assistant Melisa Ozbiltekin-Pala. Data collection was coordinated by Research Assistant Melisa Ozbiltekin-Pala and data analysis was conducted by Dr. Esra Ekinci. Prof. Yigit Kazancoglu encouraged Research Assistant Melisa Ozbiltekin-Pala and Research Assistant Yesim Deniz Ozkan-Ozen to investigate and supervised the findings of this work. All authors worked together in the writing and final revision of the manuscript.

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PROCRASTINATION, CONTROL AND PERCEIVED EFFORT IN FOOD WASTE BEHAVIOR

Procrastinação, controle e esforço percebido no comportamento de desperdício de alimentos

Procrastinación, control y esfuerzo percibido en el comportamiento de desperdicio de alimentos

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ABSTRACT

Food waste can be observed in the entire food industry, and it negatively impacts the social, environmental and economic spheres. This study aims to identify the predictive factors for such behavior, specifically those relating the propensity to procrastinate, and the "food control" and "perceived effort" variables as mediators of food waste behavior. To this end, data were collected by way of an online survey, resulting in a consistent final sample of 279 respondents, with the hypotheses being analyzed by structural equation modeling. As the key results of this study, procrastination was not significant for explaining food waste behavior, while food control reduces perceived effort. This study has also clarified that greater, intuitive control is counterproductive. As for its contributions to management, the urgent need to use booklets and training to disseminate food control techniques and access to information on the shelf life of food products stands out.

KEYWORDS | Procrastination, food control, perceived effort, food waste, consumer behavior.

RESUMO

O desperdício de alimentos pode ser observado em toda a indústria alimentícia, refletindo em efeitos negativos nas esferas social, ambiental e econômica. Este estudo objetiva contribuir para a identificação dos fatores preditores desse comportamento, especificamente, relacionando a propensão a procrastinar e as variáveis controle de alimentos e esforço percebido como mediadoras do comportamento em relação ao desperdício de alimentos. Para tanto, foi realizada uma coleta por meio de survey on-line, com uma amostra final de 279 respondentes, e as hipóteses foram analisadas com a modelagem de equações estruturais (MEE). Como principais resultados, destaca-se que a procrastinação não se mostrou significativa para explicar o comportamento de desperdício de alimentos, e o controle desses produtos reduz a percepção de esforço. Além disso, elucida-se que um maior controle realizado de maneira intuitiva é contraproducente. Como uma das principais contribuições gerenciais deste estudo, ressalta-se a urgência por difusão de cartilhas e treinamentos com o objetivo de disseminar técnicas de controle de alimentos e acessibilidade às informações sobre o período de durabilidade dos produtos alimentícios.

PALAVRAS-CHAVE */ Procrastinação, controle de alimentos, esforço percebido, desperdício de alimentos, comportamento do consumidor.*

RESUMEN

El desperdicio de alimentos se puede observar en toda la industria alimentaria, reflejando efectos negativos en los ámbitos social, ambiental y económico. Este estudio tiene como objetivo contribuir a la identificación de los factores predictivos de esta conducta, en concreto, relacionando la propensión a procrastinar y las variables control alimentario y esfuerzo percibido como mediadoras de la conducta en relación al desperdicio alimentario. Para ello, se realizó una recolección a través de una encuesta online, con una muestra final de 279 encuestados y se analizaron las hipótesis con la modelización de ecuaciones estructurales. Como principales resultados, se destaca que la procrastinación no fue significativa para explicar el comportamiento del desperdicio de alimentos, y que el control de estos productos reduce la percepción de esfuerzo. Además, se aclara que un mayor control realizado de forma intuitiva es contraproducente. Como una de las principales contribuciones gerenciales de este estudio, se enfatiza la necesidad urgente de difusión de folletos y capacitación para difundir técnicas de control de alimentos y acceso a información sobre la durabilidad de los alimentos.

PALABRAS CLAVE */ Procrastinación, control de alimentos, esfuerzo percibido, desperdicio alimentario, comportamiento del consumidor.*

INTRODUCTION

Food waste causes counterproductive effects in economic, social and environmental spheres (Patra, Leisnham, Tanui, & Pradham, 2020). This phenomenon is intrinsic to the increase in hunger, the emission of greenhouse gases, the degradation of the biosphere, and the scarcity of natural resources — particularly water. It also limits the production of certain foods for future generations (Stancu, Haugaard, & Lähteenmäki, 2016).

The Food and Agriculture Organization of the United Nations – the FAO (2018) - has pointed out that one-third of all food that is produced is wasted at some point in the production and consumption chain. This causes a substantial financial loss of over USD 900 billion per year, and minimizes household food security, thus increasing food market inflation and decreasing consumer purchasing power (FAO, 2018; Papargyropoulou, Lozano, Steinberger, Wright, & Ujang, 2014).

Some researchers have undertaken to understand the causes for such behavior, primarily by creating theoretical models based on the theory of planned behavior (TBP) (e.g., Neubig et al., 2020; Stancu et al., 2016). Despite the theoretical and practical contribution of these studies, however, some questions remain unanswered and require the construction of a theoretical model independent of TBP. Therefore, this study breaks away from this matrix and aims to create an original and predictive theoretical model.

Hitherto the literature has strongly indicated that one of the main causes of waste is the excessive purchase of products (Amirudin & Gin, 2019), especially when combined with a lack of proper food management (Aschemann-Witzel, Giménez, & Ares, 2019). The factors that explain the lack of motivation to engage in proper food control, however, have yet to be fully identified.

Food control is defined as those management activities that individuals carry out in their households to store food adequately and consume it within the established shelf life, and for making them aware of which items are about to expire (Aitken, Watkins, Williams, & Kean, 2020). But such activities are often neglected (Graham-Rowe, Jessop, & Sparks, 2014), as they require consumer awareness, dedication, and effort, thus increasing costs (Aschemann-Witzel et al., 2019). This study, therefore, suggests that one of the causes of this behavior may be associated with consumer procrastination with regard to engaging in such activities.

Procrastination refers to a person's tendency to put off or avoid doing certain activities, especially those that have a less immediate impact (Steel, 2010). In this sense, it tends to be accentuated when it concerns sustainable causes, like those that do not have a clear reward; in fact, this reduces the positive effects of environmental awareness (Lillemo, 2014).

From another perspective, the study by Porpino, Wansink and Parente (2016) points to procrastination as one of the dimensions of waste, and shows how families deal with leftovers, by storing them until they are spoiled so they can be disposed of without remorse. Similarly, Blichfeldt, Mikkelsen and Gram (2015) point to the fact that the longer people put off disposal, the easier it becomes, as the food becomes unsuitable for consumption, hence mitigating the feeling of guilt associated with waste.

Another potentially explanatory variant is perceived effort, especially in terms of the "hard work" undertaken in producing food for human consumption. As Dobernig and Schanes (2019) suggest, the investment of time and resources in this process generates a symbolic value. That said, it is expected that total food management and adequate use is more likely when people prepare their own food.

Given the above, this research seeks to advance the understanding of this phenomenon by analyzing whether there is a relationship between consumer procrastination behavior and food waste. The study also

assesses how the characteristics of individuals regarding food control and perceived effort interfere with and are affected by this relationship. Therefore, this work proposes an explanatory theoretical model and seeks to analyze the significance of this combination.

THEORETICAL FRAMEWORK

Food waste

Food waste can be defined as the practice of discarding food that is suitable for human consumption. It is caused by the negligence of consumers who allow products to exceed their expiry date, or fail to use them in their entirety (FAO, 2018). It is associated with ethical and sustainable factors and the profile of consumers in psychological, demographic, and cultural terms (Radzyminska, Jakubowska, & Staniewska, 2016). With this in mind, researchers have diligently sought to develop studies to understand the antecedents that lead individuals to waste food.

The study by Aktas et al. (2018), for instance, found results concerning financial education, routine management, excessive cooking and consumption, and social aspects. It is also known that psychological and sociodemographic aspects influence food waste, although the latter have poor explanatory power (Aschemann-Witzel, De Hooge, Amani, Bech-Larsen, & Oostindjer, 2015).

Adopting the theory of planned behavior, Russell, Young, Unsworth and Robinson (2017) contributed specifically towards identifying psychological factors. The authors point out that subjective norms, control of perceived behavior, and intention, as well as habits and emotions, are causally related to food waste. In turn, and contrary to what Aschemann-Witzel et al. (2015) pointed out, the study by Stancu et al. (2016) revealed that sociodemographic aspects have a significant impact on waste. The authors found that older individuals, members of small families, and those with lower incomes tend to waste less. Developed countries, in contrast, that have higher *per capita* incomes, account for a greater share of the total waste. Along these same lines, Carmo and Barcellos (2018) found that low-income individuals are less likely to engage in such behavior.

Woensel, Donselaar, Broekmeulen and Fransoo (2007) found that less-educated, low-income families tend to waste more due to a need to show off their social status by excess food consumption, and because of the higher number of children living in the household. The findings by Porpino et al. (2016) hint that parents aspire to be seen by their children as good, and they tend to symbolize this by the food they offer them. This, in turn, is materialized in the form of purchasing and storing excess products.

Interestingly, although most consumers know about the effects of waste,they do not feel impacted by it, so their behavior remains reckless (Radzyminska et al., 2016). Therefore, in addition to the aforementioned antecedents, other factors also promote this behavior, namely: the moral aspects of individuals (Raats, Shepherd, & Sparks, 1995); their cooking skills (Hartmann, Dohle, & Siegrist, 2013); over-buying and compulsive buying (Porpino et al., 2015); the non-use of leftovers (Stancu et al., 2016); feelings of guilt (Richter, 2017); and materialistic values (Abdelradi, 2018). This study aims to expand on these findings by correlating the procrastination, food control, and perceived effort variables as explanatory factors for waste. These topics will be addressed below.

Procrastination

According to Parfenova and Romashova (2019), procrastination has to do with a delay in carrying out activities, with no compelling reasons for doing so, and experiencing psychological discomfort as a result. It is defined as a tendency to put off the completion of a certain objective (Zanjani, Milne, & Miller, 2016), and is based on an absence of self-control, which especially affects activities that have an abstract future reward (Chen, Liu, Zhang, & Feng, 2020).

As Akerlof (1991) noted, one of the explanatory factors for such behavior is the change in the relationship between costs and benefits over time. When a task is established, the costs are interpreted as small, but they become bigger later, and the benefits become more abstract. In this sense, postponing activities entails high cognitive, psychological, and social costs (Liu et al., 2020).

Procrastination also has an impact on the economic and environmental spheres. Lillemo (2014), for example, points out that individuals who are prone to procrastinate tend to avoid engaging in activities related to sustainable causes, especially when they require psychological and monetary effort. This happens because their associated gains are commonly seen as having less impact on the present and may result in a devaluation of the investment of resources in environmentally friendly initiatives, and a reduction in the positive effects of environmental awareness.

Zhu, Bagchi and Hock (2019) explain the logic of behavior and its relationship with the cost of delayed tasks. The authors point out that the longer the term, the lower the perception of cost and the greater the probability of procrastinating. Furthermore, as productivity is perceived as a value (Gamst-Klaussen, Steel, & Svartdal, 2019), individuals tend to seek psychological comfort when they start performing tasks, not in any order of priority, but according to their degree of complexity. Therefore, they start with those that require less effort (Rusou, Amar, & Ayal, 2020).

In this context, the studies by Blichfeldt et al. (2015) and Porpino et al. (2016) introduce discussions concerning procrastination in the context of food waste, as being a way of reducing and mitigating guilt and remorse associated with disposal. Both studies show that individuals who procrastinate tend to keep leftover meals until they spoil, are no longer fit for human consumption and arouse feelings of disgust. This, in turn, makes disposal unavoidable and therefore guilt-free.

Based on the findings by previous exploratory studies, it is clear that procrastination can act as a predictor of food waste behavior. To measure this influence, the following hypothesis is postulated:

> H1: The greater the procrastination, the greater the food waste behavior.

Food control

Food control can be defined as the proper management of stored food and meal leftovers (Masson, Delarue, & Blumenthal, 2017). This process mainly encompasses the adequate storage and constant monitoring of products available in the household to avoid the non-use of food, nutritional losses, and health risks (Holsteijn & Kemna, 2018). Sensitivity is, therefore, required to identify whether a given food is still suitable for consumption, in addition to checking and correctly interpreting the packaging labels, which display the appropriate handling conditions (Kavanaugh & Quinlan, 2020).

In the literature on this construct, one strand of thought argues that knowing the techniques that are adequate for storing products can lead to a reduction in food waste (e.g., Graham-Rowe, Jessop, & Sparks, 2014; Schanes, Dobernig, & Gözet, 2018), and also that the conviction of having the competence to manage them significantly

influences control over them (Dobernig & Schanes, 2019). Not everyone agrees with this, however. Terpstra, Steenbekkers, De Maertelaere and Nijhuis (2005) and Dobernig and Schanes (2019) point out that even though the research subjects in their studies were aware of the storage guidelines and claimed to perform adequate control, they had still stored food for longer than recommended.

That said, the statement that consumers cannot manage food effectively remains valid (Farr-Wharton, Foth, & Choi, 2014). This is mainly due to a lack of systematic control and an organization routine (Costa, Farias, & Angelo, 2018; Romani et al., 2018), because even when such a control is carried out, consumers forget products, resulting in waste (Dobernig & Schanes, 2019). Individuals only seem to remember stored products when an item is needed for preparing a meal, or when the proper time is dedicated to checking and organizing them; it is at this point that people typically realize that these items are unsuitable for consumption (Aschemann-Witzel et al., 2019).

Therefore, despite efforts to understand how food control has an influence on reducing waste, its explanatory potential has yet to become entirely clear. This is especially true because, even though consumers are aware of the recommendations for the correct storage of food, they do not follow the suggested guidelines (Marklinder, Lindblad, Eriksson, Finnson, & Lindqvist, 2004). Based on this, this study seeks to contribute to the literature by measuring the explanatory potential of food control in reducing waste, and therefore the following hypothesis is postulated:

> H2: The greater the food control, the less the food waste behavior.

Despite the relevance of correct food management for increasing shelf life, Farr-Wharton et al. (2014) showed that many families fail to manage their food. It is implied that these consumers do not engage in such activities because they perceive the consequences as being in the distant future, they fail to think about such consequences, and they have no knowledge of their direct impacts on their lives. Blichfeldt et al. (2015) also point out that the dimensions of procrastination are involved in food waste, as individuals are inert when using leftovers, and so exceed their recommended storage time. One of the resources used to store food and increase its shelf life is the refrigerator, although the use of this particular technology has been shown to be a co-participant of procrastination (Evans, 2011). Therefore, the following hypothesis is proposed:

> H3: The greater the procrastination, the less food control.

Perceived effort

As mentioned above, several variables — either endogenous and/or exogenous — contribute to the performance of everyday human practices (Langan & Kumar, 2019). It is worth highlighting the notion of effort, which Brehm, Wright, Solomon, Silka and Greenberg (1983) conceptualized as an individuals perception of the behaviors to be adopted to achieve certain objectives. Mohr and Bitner (1995) also contribute to the formation of this construct by defining it as the energy exerted to achieve a task, or a set of tasks. For the purposes of this study, we shall adopt the definition of Modig, Dahlén and Colliander (2014), due to its specificity. Effort is here understood as the time, resources, and "hard work" spent in achieving tasks.

When observing individuals as specimens of *homo economicus*, researchers studying economic theories involved in decision-making (e.g., Hesse, Kangur, & Hunt, 2020; Zeelenberg & Van Dijk, 1997) argue that perceived effort decreases or neutralizes the value of the reward, which may cause aversion to the task. As Amirudin and Gin (2019) explain in the context of supermarket purchases, the greater the perceived effort in terms of commuting and time spent, the greater the chances that people will seek ways to avoid shopping. So, as the authors point out,

individuals tend to buy as much food as possible in order to put off the need for new purchases, thus resulting in increased food waste.

However, the effort is a paradoxical construct (Inzlicht, Shenhav, & Olivola, 2018) that, instead of decreasing, may increase the value of an activity (Harmon-Jones, Willoughby, Paul, & Harmon-Jones, 2020), as consumer involvement in the process moderates the perceived effort (Kallmuenzer, Peters, & Buhalis, 2019) and creates value, depending on the resources involved (Benfer, Bardeen, & Clauss, 2018). For instance, time and money represent different levels of effort for individuals, because "donating" time generates a higher level of perceived effort and, consequently, greater value when compared to donating money (Langan & Kumar, 2019). In the context of food waste, Ilyuk (2018) reveals that when consumers exert effort in terms of hard work, there is a greater appreciation of the product and an increase in psychological ownership, thus reducing disposal.

This positive relationship between involvement and value creation can be primarily found in the literature on co-creation (e.g., Ahn, Lee, Back, & Schmitt, 2019; Yen, Teng, & Tzeng, 2020). The joint production process is perceived as a marketing strategy that promotes purchase intentions and establishes a relationship of trust (Jacobsen, Tudoran, & Martinez, 2020). From this angle, it is clear that the byproducts of an individual's participatory creation tend to be overvalued (Banović, Krystallis, Guerrero, & Reinders, 2016). Therefore, based on the premise that the energy spent in food production assigns a symbolic value to the resources it requires (Dobernig & Schanes, 2019), we seek to contribute to the literature on effort and food waste by verifying the following hypothesis:

> H4: The greater the perceived effort, the less the food waste behavior.

When performing a task, the effort is justified when there is a proportional relationship with a clear reward, because when it does not depend exclusively on the effort, it tends to be underestimated, whereas the effort tends to be overestimated (Harmon-Jones et al., 2020). Besides, the quest to avoid losses influences an individual's willingness to exert effort more significantly than obtaining gains (Massar et al., 2020). We can infer, therefore, that activities that focus on gains tend to be procrastinated more frequently.

This relationship can be further intensified if the gains are viewed as abstract and/or have less impact in the present, as is the case with sustainable activities (Lillemo, 2014). As one of the reasons for avoiding food waste is to achieve environmental gains (Diaz-Ruiz, Costa-Font, & Gil, 2018), it is possible to infer that carrying out related activities tends to result in greater perceived effort, as the focus is on obtaining gains and these entail less immediate benefits. Based on this, it is assumed that the greater the procrastination, the greater the perceived effort to carry out activities aimed at reducing waste. To validate this, the following hypothesis was postulated:

> H5: The greater the procrastination, the greater the perceived effort.

In the literature on food control, some studies (e.g., Blichfeldt et al., 2015; Porpino et al., 2016; Romani et al., 2018) have demonstrated how an unplanned shopping routine and the absence of systematic control and organization may lead to an excessive number of products being stored. This results in a lack of effective food control and, consequently, waste (Farr-Wharton et al., 2014).

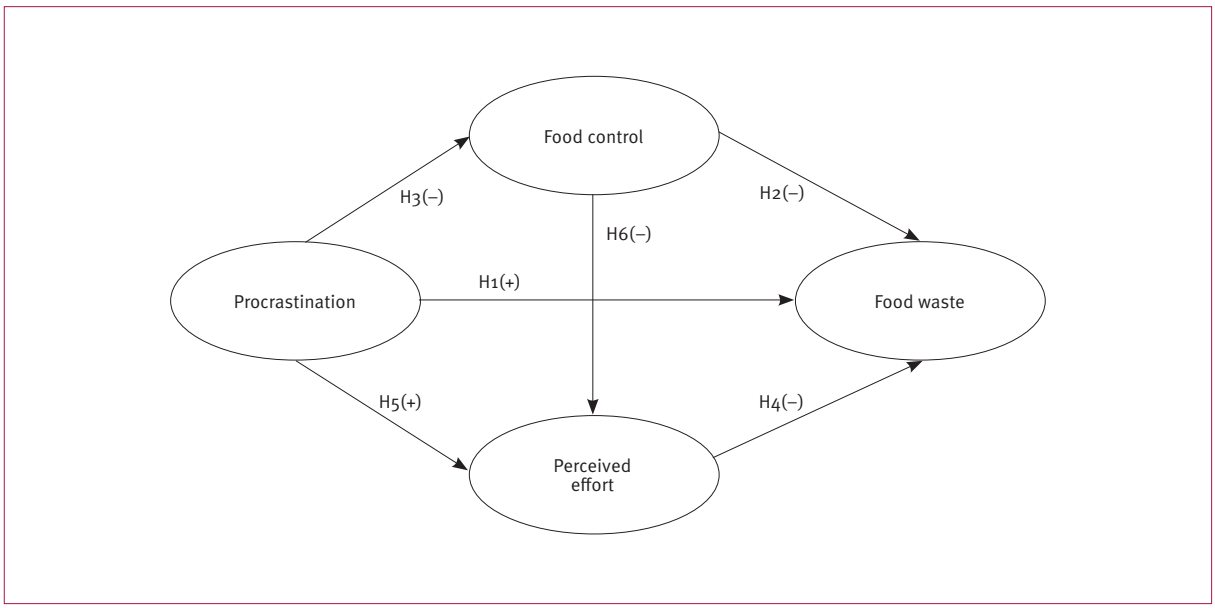
In the light of this situation, a new purchase cycle begins to ensure sufucient food for individuals (Hebrok & Boks, 2017). The access and time required in this process can moderate for the perceived effort and the opportunity cost of not purchasing. In other words, when the acquisition of products is intercepted by mobility problems and requires more time, the process is perceived as costly. A way of compensating for this, therefore, is by acquiring a greater number of products (Lee, 2018).

The study by Amirudin and Gin (2019) illustrates this relationship well by explaining how issues concerning easy access to food permeate the perception of effort and aversion to the activity. Indeed, they point out that the greater the perceived effort, the greater the excessive purchasing. In this sense, ease of access to products, both in terms of available hours and physical distance from the place of purchase, is reflected in lower quantities of food being purchased (Dobernig & Schanes, 2019), which, therefore, favors effective food control. That said, we can infer that greater food control is associated with lower levels of perceived effort. To test this, the following hypothesis was postulated:

H6: The greater the food control, the less the perceived effort.

For a better view of the theoretical model proposed here, see Figure 1, which shows the establishment of the predictive relationship between procrastination and food control, the perceived effort and food waste behavior, and the mediating link between food control and perceived effort with regard to waste behavior.

Figure 1. **Theoretical model**



METHOD

This study is quantitative and aims to develop an explanatory model for food waste behavior. It is a descriptive survey (Malhotra, 2012) based on the formulation of hypotheses. A literature review was initially carried out in the following databases: ScienceDirect, Scopus, Proquest, and Scielo. Then, as recommended by Churchill (1999), the cross-sectional survey method was used to collect data and establish the relationships between variables using structural equation modeling (SEM) (Kline, 2011).

Sampling

With regard to the sample, we sought to achieve greater heterogeneity for better validation of the results. The sample comprises Brazilian consumers and is characterized as non-probabilistic (Hair, Anderson, Taham, & Black, 2010). To ensure effectiveness in assessing food waste behavior, however, certain criteria were created for the respondents. Therefore, consumers categorized as young (18-40 years old) remained in the sample because older consumers tend to waste less (Stancu et al., 2016). Likewise, those who have the prospect of ascending the social ladder were also kept in the sample, that is, those who have a university degree, or are currently enrolled in higher education, for they are more likely to engage in waste behavior (Aschemann-Witzel et al., 2019).

That said, the sample size was defined on the basis of the guidelines of Hair et al. (2010) who recommend having at least five respondents for each question in the questionnaire, while following the recommendations of Tanaka (1987) for controlling sample size using structural equation modeling (SEM), so as not to exceed the maximum number of 400 respondents. Two samples were accordingly defined: the first had 140 respondents and aimed to refine the questionnaire, whereas the second aimed to test the hypotheses. In fact, the latter initially had 310 respondents, but it was necessary to exclude 31 questionnaires that did not fit the above criteria. Therefore, the final sample to test the hypotheses comprised 279 participants.

Data collection

Data were collected by way of a questionnaire that was based on a structured Likert scale containing 30 questions, in which the respondents indicated their degree of agreement to the statements. The technique used was snowball sampling. Data were collected in February 2020. The questionnaire was applied online using Google Forms and was divided into five sections, namely Procrastination (16 items), Food control (3 items), Perceived effort (4 items), Food waste (7 items), and finally the respondent's profile, consisting of six questions, namely gender, age, marital status, education, average monthly family income, and the total number of people living in the household. It is important to point out that the items on the procrastination scale were inverted for the purposes of this analysis. Exhibit 1 describes the items presented in each construct.

Data analysis

Descriptive statistics (frequency, mean and standard deviation) were used to understand the sample profile and the data collected in the research. The reliability of the scales was assessed using Cronbach's alpha; a reliability value greater than, or equal to 0.7 was accepted (Kline, 2011). SPSS and AMOS software was used for data processing, and structural equation modeling (SEM) was used to test the hypotheses.

To refine the questionnaire and assess the items in each construct to check whether they would load in a single factor, exploratory factor analysis (EFA) was carried out on a first version of the sample with 140 respondents.

Exhibit 1. Scales adopted in the study

Dimensions	Items	Codes
Procrastination Adapted from Tuckman (1990).	Q1. I delay finishing tasks unnecessarily, even when they are important.	P01
	Q2. I put off doing things I don't like to do.	P02
	Q3. I delay making difficult decisions.	P03
	Q4. I continue to put off improving my work habits.	P04
	Q5. I get down to business, even life's unpleasant chores. *	P05
	Q6. I may make excuses for not doing something.	P06
	Q7. I dedicate the necessary time to boring tasks, such as studying. *	P07
	Q8. When something is not worth it, I stop doing it.	P08
	Q9. I'm an incurable time waster.	P09
	Q10. I'm a time-waster and I can't help it.	P10
	Q11. I'd like to find an easy way to start producing.	P11
	Q12. I always finish important tasks ahead of time. *	P12
	Q13. When I finish my job, I check it. *	P13
	Q14. I look for a loophole or shortcut to get through a difficult task.	P14
	Q15. I remain idle despite knowing how important it is to start something.	P15
	Q16. Putting something off until tomorrow is not what I do. *	P16
Food Control Adapted from Russell et al. (2017)	Q17. How much control do you exert over food in your household?	CA1
	Q18. How difficult would it be for you to control food in your household?	CA2
	Q19. Controlling food in my household mainly depends on me.	CA3
Perceived Effort Adapted from Aktas et al. (2018).	Q20. I find it difficult to store food at high temperatures.	EP1
	Q21. I find it difficult to store food according to the required conditions.	EP2
	Q22. I find it difficult to store specific types of food.	EP3
	Q23. I find it difficult to buy food for one.	EP4
Food Waste Adapted from Von Kameke and Fischer (2018) and Aktas et al. (2018)	Q24. I think it's important to avoid wasting food in my household.	DA1
	Q25. I'd like to do more to avoid wasting food in my household.	DA2
	Q26. I'd waste less food if I planned my purchases more carefully.	DA3
	Q27. I waste food when I go out with my friends/family.	DA4
	Q28. I waste food when I have guests coming over.	DA5
	Q29. I waste food at work/school.	DA6
	Q30. I waste food stored at home whenever I travel.	DA7

Note. Items with (*) on the Procrastination scale were considered reversed.

Table 1. **Construct items with factorial loads**

Code	Factorial Loads				KMO	Bartlett			Cronbach
						df	x²	Sig	
P15	0.780				0.834	120	725.232	0.000	0.864
P02	0.763								
P01	0.756								
P10	0.756								
P09	0.725								
P04	0.702								
P03	0.647								
P06	0.555								
P14	0.494								
P12	0.465								
P11	0.456								
P16	0.452								
CA1		0.887			0.668	3	125.738	0.000	0.772
CA2		0.820							
CA3		0.801							
EP3			0.812		0.712	6	93.179	0.000	0.710
EP2			0.751						
EP1			0.691						
EP4			0.623						
DA1				0.832	0.746	6	137.494	0.000	0.786
DA2				0.804					
DA3				0.712					
DA4				0.702					

By identifying low factor loads or value loadings in other factors, some items were excluded from the constructs in order to obtain a single factor per construct. Items P05, P07, P08, and P13 were removed from Procrastination, so the construct had only one factor. It is worth noting that in the original scale of Tuckman (1990) the items were considered with factor loads starting from 0.3, and this was maintained in this paper for the EFA. A possible explanation for the need to remove items from the Procrastination scale may have to do with the translation of the statements, as the context and structure of some items may be interpreted differently by

respondents of other nationalities, which leads, in turn, to a certain degree of semantic deviation from the item in the original scale.

Items FW1, FW2, and FW3 were excluded from the Food Waste construct because two different scales were used to measure it, to check whether the items could load into a single dimension (factor). The tests showed that the three statements on the Kameke and Fischer scale (2018) had loads with a second factor, even after the items were inverted. Therefore, only the four items on the scale by Aktas et al. (2018) remained in that construct. As for Food Control and Perceived Effort, no item had to be excluded. The factorial loads that remained in each construct can be seen in Table 1.

ANALYSIS AND DISCUSSION OF RESULTS

Sample Profile

The sample consisted of 279 respondents (53.4% females and 46.6% males). As for schooling, 63.4% of the respondents have some type of college education, 19.4% had completed a graduate course, 12.5% have a bachelor's degree, and 4.3% had finished high school. The predominant marital status was single (82.1%). Married respondents, or those living under common-law accounted for 16.8% of the sample, whereas 1.1% declared they were divorced/separated. The age groups prevailing in the survey were 18 to 25 (69.2%), 26 to 32 (23.3%), and 33 to 40 (7.5%). The average age was 24 years old, and the range was from 18 to 40 (SD = 4.820). With regard to income, two groups stood out: the group with incomes between R$1 and 3,000.00 (59.9%), and the group with incomes from R$ 3,001.00 to 6,000.00 (29%). The average family income was R$ 3,506.41 (SD = 3,403) and the average number of people living in the same household was approximately three (DP = 1,464), with an average *per capita* income of R$ 1,414.00.

Measurement model

As Marôco (2014) advises, the Mahalanobis distance (D^2) was used to verify the existence and removal of outliers from the sample, but none of the observations had values requiring their exclusion from the analysis. This was followed by factor analysis of the measurement model. The results found in the first rounds of analysis suggested the exclusion of some items from the constructs so the model would achieve better fit rates. Therefore, items Po6, P11, P12, P14, and P16 were excluded from the Procrastination construct, along with PE4, from Perceived effort, and FC4, from Food control. After refining the item composition of the constructs, a new analysis was performed and the indices resulting from the measurement model were x^2/df (104.084/82) = 1.269 (p = 0.050); TLI = 0.978; CFI = 0.983; NFI = 0.925; PCFI = 0.767; RMSEA = 0.030; PCLOSE = 0.985; ECVI = 0.583; MECVI = 0.596. Therefore, these values attest to the model's goodness of fit.

Reliability (Cronbach), composite reliability (CC), and average variance extracted (AVE) were used to investigate the level of adequacy of the scales of each construct. Cronbach's alpha values of 0.7 or higher confirm the internal consistency of the items of each scale. Table 2 shows that all constructs have higher values. Composite reliability is also defined by an index equal to, or higher than 0.7 (Hair et al., 2010), a value that was reached by all constructs, according to Table 2. The mean and standard deviation of the constructs was calculated for the variables created using the summated scale for this purpose.

Table 2. **Descriptive statistics, reliability and validity**

Variables	Mean	SD	Cronbach	CR	AVE
Procrastination (P)	4.42	1.37	0.835	0.885	0.529
Food Control (FC)	4.39	1.67	0.751	0.846	0.652
Perceived Effort (PE)	3.69	1.56	0.701	0.794	0.567
Food Waste (FW)	2.44	1.41	0.784	0.853	0.602

Note. SD (Standard deviation); CR (Composite reliability); AVE (Average variance extracted)

Regarding the validity of the construct scales, three validities were performed, namely factorial, convergent, and discriminant (Kline, 2011). The first was performed by observing the standardized coefficients for each item of the constructs, and all showed values of 0.5 or higher, thus attesting to factorial validity. Convergent validity was based on the average variance extracted (AVE) values. As a measure of goodness of fit, this validity adopts values of 0.5 or higher. Table 2 shows that all constructs reached this value.

Table 3. **Correlations, shared variance and AVE**

Variables	P	FC	PE	FW
P	**0.529**	0.076	0.025	0.022
FC	0.277	**0.652**	0.128	0.024
PE	-0.159	-0.358	**0.567**	0.046
FW	-0.148	-0.156	0.216	0.602

Note. The AVE values are displayed diagonally in the table (in bold), whereas the values below the diagonal show the correlations, and the values above show the shared variances (squared correlations).

To verify discriminant validity, the AVE of each construct was compared with the shared variance. According to Fornell and Larcker (1981), the average variance extracted of a construct must not have a high correlation with other constructs, which are supposedly different. Therefore, the AVE values must be higher than those of the shared variances. Table 3 shows that this requirement has been met.

Structural model

The second stage of the SEM consists of the analysis of the structural model, to which the relations between the latent variables of the measurement model are added. Therefore, new goodness of fit indices were obtained, which can be seen in Table 4. The measures found attest to the goodness of fit of the structural model.

Table 4. **Goodness of fit measures**

Index	Results	Criteria
x^2/gl (172.759/108)	1.600	[1; 2] Good fit
p-value	0.000	‹0.05 Acceptable fit*
GFI	0.933	› 0.90 Good fit
IFI	0.955	› 0.95 Very good fit
TLI	0.942	› 0.95 Good fit
CFI	0.954	› 0.95 Very good fit
NFI	0.887	[0.80; 0.90] Acceptable fit
PCFI	0.757	[0.70; 0.80] Acceptable fit
RMSEA	0.046	‹ 0.05 Very good fit
PCLOSE	0.664	› 0.05 Very good fit
ECVI	0.945	The lower, the better
MECVI	0.968	The lower, the better

Note. *Large samples are more sensitive to having significant p-values.

The coefficients between the relationships of the latent variables (Table 5) were also analyzed, which allow for an evaluation of the hypotheses postulated. The p-value indicates that only the relationships of Hypotheses H3 (-) and H6 (-) had values less than 0.05. However, only H6 (-) can be considered to have been confirmed or supported, as it also met the negative value of the relationship. This was not true for H3 (-), which showed the positive valence of the relationship coefficient.

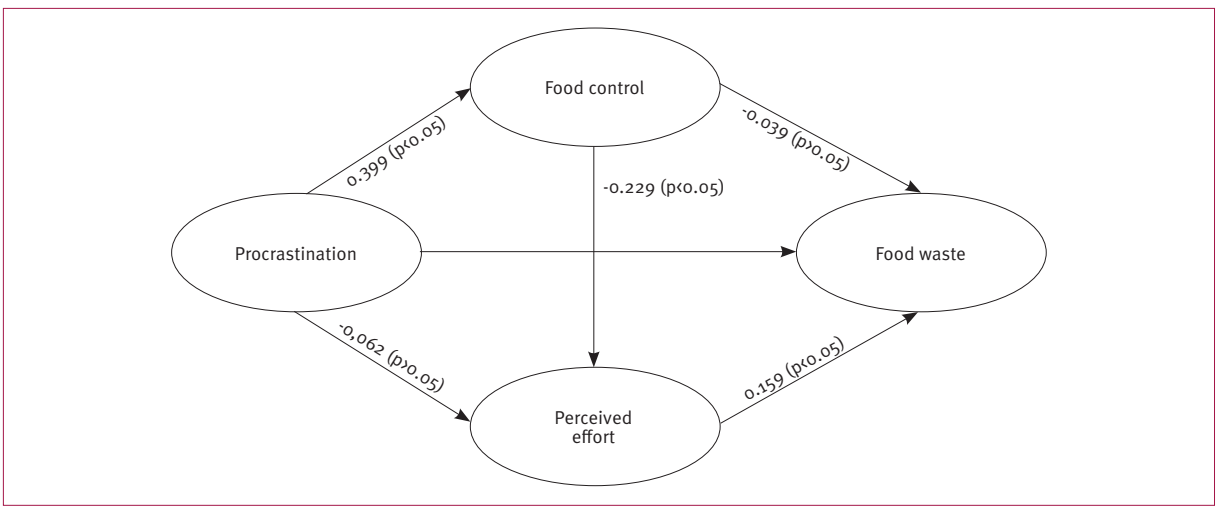
It is also noteworthy that H4 (-) might have been marginally accepted had a p-value of 0.10 been considered, but this study only considered p-values up to 0.05. Therefore, this hypothesis was also disproved.

Table 5. **Hypothesis testing**

Hypotheses	*Standardized coefficient*	*Unstandardized coefficient*	*SE*	*CR*	*p*	*Status*
H1(+): P ---› FW	-0.102	-0.089	0.070	-1.273	0.203	Not supported
H2(-): FC ---› FW	-0.065	-0.039	0.050	-0.782	0.434	Not supported
H3(-): P ---› FC	0.277	0.399	0.109	3.648	0.000	Not supported
H4(-): PE ---› FW	0.176	0.159	0.092	1.736	0.083	Not supported
H5(+): P ---› PE	-0.064	-0.062	0.076	-0.816	0.414	Not supported
H6(-): FC ---› PE	-0.341	-0.229	0.061	-3.744	0.000	Supported

Note. p<0.05; Marginal significance = p<0.10; SE = Standard error; CR = Critical ratio.

Figure 2. **Theoretical model with coefficients**



Discussion

The focus on avoiding waste is not guided by an orientation to obtain environmental gains, as suggested by some studies (e.g., Diaz-Ruiz et al., 2018; Lillemo, 2014), but to avoid losses. Although previous studies have pointed to the positive relationship between procrastinating and food waste behaviors, such as those by Blichfeldt et al. (2015) and Porpino et al. (2016), the result of the first hypothesis (H1) is counterintuitive, as it has not been supported. This is possibly explained by the fact that individuals engage more in activities that focus on avoiding negative

results, rather than on obtaining gains (Massar et al., 2020). Therefore, although individuals have a great tendency to procrastinate, they are likely to try and consume all of the food they purchase, and look for ways to prolong its shelf life, as wasting it would require more time beng spent on preparing new meals, and buying groceries. Indeed, as Langan and Kumar (2019) point out, the amount of time allocated to a task represents a high cost.

But a greater degree of food control does not lead to less waste. This result concerns Hypothesis H2, which has been refuted and contributes to the validation of what Terpstra et al. (2005) and Dobernig and Schanes (2019) pointed out, with both studies concluding that even individuals who claimed they exerted a control over their food stored it inadequately. In addition to food management not being regarded as a routine activity (Romani et al., 2018), food is also managed ineffectively (Farr-Wharton et al., 2014); if it were otherwise, there would be less waste (Kavanaugh & Quinlan, 2020). In this sense, the result found here points out that even in a highly controlled scenario, individuals possibly manage their food intuitively, and do not follow the guidelines of the health authorities, which results in waste. This, therefore, is a counterproductive activity.

This study also indicates that if food control is perceived as a component of low complexity, it is more likely to be performed, even by procrastinators. Accordingly, even Hypothesis H3 — which sought to verify the existence of a negative relationship between procrastination and food control — is statistically significant ($\beta = 0.399$, $p < 0.05$), although it has not met the valence of the relationship coefficient. Therefore, a directly proportional relationship has been established, a result that disproves previous research (e.g., Blichfeldt et al., 2015; Evan, 2011). It is still feasible, however, due to the tendency of some individuals to seek psychological comfort in performing tasks according to their level of complexity due to procrastination, because they are inclined to prioritize those that require less cognitive effort (Rusou et al., 2020).

The ability to control food can explain the positive relationship between procrastination and food control, for it allows the task to be interpreted as requiring less effort to perform, hence avoiding procrastination (Graham-Rowe et al., 2014). In fact, as economic theories of the decision-making process explain (e.g., Hesse, Kangur, & Hunt, 2020; Zeelenberg & Van Dijk, 1997), when an activity requires less effort, there is an increase in the value of the reward, which, in turns, stimulates execution. The emphasis on avoiding losses can play an important role in achieving control, even by individuals who tend to procrastinate, for it can lead to greater engagement (Massar et al., 2020). Therefore, imminent loss, which is primarily monetary in nature, potentially influences consumers to control their food.

The relationship between perceived effort and food waste is highlighted in this study by Hypothesis H4. It was postulated that a greater perceived effort would result in less food waste, but this was not confirmed. However, the results ($\beta = 0.159$; $p = 0.083$) allow for parsimonious reflection on the positive relationship between the constructs. When observing the means of perceived effort ($M = 3.69$) and food waste ($M = 2.44$), it appears that the respondents do not perceive storing products as requiring a lot of effort, and they tend not to engage in waste behavior. Therefore, based on the ratio coefficient found, it can be inferred that less effort results in less food waste. This may occur because less effort may be associated with confidence in the storage process, and thus reduce the individual's fear of becoming ill or poisoned by food when reusing meal leftovers, for instance; this may, in turn, result in less waste (Graham-Rowe et al., 2014).

As the result of H5 indicates, even though the procrastinatory behavior of individuals is significant, this is not reflected in them not engaging in activities associated with avoiding waste, which would affect perceived effort. This result is supported by previous findings, first because the activities associated with avoiding food waste are carried out with a focus on avoiding losses, in terms of how much time and money are spent, and

as has been pointed out, this focus results in greater engagement (Massar et al., 2020). Second, because it is highly probable that food-management activities will be carried out, because they are perceived as being of low complexity compared to other tasks (particularly those of an intellectual nature) performed by the respondents.

Finally, the last hypothesis (H6) was confirmed. As anticipated, greater food control implies less perceived effort. This result is consistent with that recommended by Dobernig and Schanes (2019), who explained this relationship using the example of the convenience of living close to a supermarket, which allows — and even induces — the purchase of food in smaller quantities, albeit on a more frequent basis. This, in turn, allows for greater control of food without necessarily having the effect of increasing perceived effort (Amirudin & Gin, 2019), while reducing intentions to discard products. All the findings of this investigation are summarized in Table 6 to ensure a better view of the theoretical and managerial contributions.

Table 6. **Consolidated Results**

Hypothesis	Theoretical implication	Managerial implication
H1(+): P ---› FW (Not supported)	The focus on avoiding waste is not to obtain gains but to avoid losses.	Awareness-raising campaigns should highlight the losses resulting from waste, particularly the associated waste of time.
H2(-): FC ---› FW (Not supported)	Greater control is counterproductive when performed intuitively.	Government agencies must devise strategies to disseminate the guidelines for food storage and hygiene, to better inform the population, and, above all, instruct them on the adequate control of each food category.
H3(-): P ---› FC (Not supported)	The ability to control food and the imminence of monetary loss can lead to engagement in control.	Advertisements must clarify the monetary loss resulting from food waste, and disseminate instructions on control, as this will potentially foster greater consumer engagement in the process.
H4(-): PE ---› FW (Not supported)	The lesser perceived effort may be associated with confidence in the storage process, consequently reducing food waste.	The instructions on the product labels and packages used for storage must be clear and explicit, as the easiness of procedures may potentially reduce food waste.
H5(+): P ---› PE (Not supported)	The focus on avoiding exerting future efforts and the perception of food control as not complex allows actions to reduce waste to be prioritized, rather than delayed.	Training the population to control food is effective when its low level of complexity is made clear, thus reducing the perceived effort. This can be done by way of public notices promoting extension projects in public universities, with an emphasis on the field of nutrition.
H6(-): FC ---› PE **(Supported)**	Greater food control results in less perceived effort.	The public policy agenda should include promoting greater accessibility to food products, to ensure less perceived effort. Also, consumers need to plan their shopping routines. This allows greater control and may help reduce the perceived effort.

CONCLUSION

Given the emerging need to understand the variables of food waste, this study is an effort for this cause, based on the assumption that psychosocial factors have a significant impact on consumer behavior. Using structural equation modeling (SEM), this study analyzed the relationship between procrastination and food waste, and between food control and the perceived effort exerted on food management.

The main results are state of the art, because they are considered to be theoretically counterintuitive. Procrastination has no positive relationship with food waste behavior, and even when individuals are prone to procrastinate, they make efforts to control food, possibly because they perceive this activity as being not very complex, hence mitigating their perceived efforts. This study also highlights that greater food control and greater perceived effort do not necessarily result in less waste.

We identified that the focus on making efforts to reduce food waste may not be based on obtaining sustainable gains, but on avoiding wasting money and time. Combined with the perceived low complexity of the activity, this encourages consumers not to procrastinate. In this sense, this study corroborates support for economic theories related to the decision-making process that provide for such an emphasis. It is also noteworthy that the perception of less effort being spent on food control, and the imminence of monetary loss caused by waste possibly leads to greater engagement in food management activities. Greater control, however, does not necessarily result in less waste when it is based on common sense.

As to the main practical implications, the study emphasizes the urgent need to disseminate appropriate control practices, and to expand access to information about food storage and conservation. Practically speaking, awareness campaigns and booklet distribution can instruct consumers on how to store and sanitize products. It is also possible to provide training for consolidating the disseminated information and encouraging regular control, as this can mitigate the perceived effort and the probability of wasting food.

The study does have its limitations. Despite the attempt to build a heterogeneous sample, it mainly consisted of respondents with quite similar levels of income, marital status, age, and schooling. Its results are also based on evidence from a cross-section that might have been different had a longitudinal investigation been carried out. Indeed, the latter limitation is a suggestion for future studies. The procrastination scale also has internal inconsistencies and required the exclusion of several items. These problems possibly occurred because of the structure of these items, which may have had a different connotation in other nationalities after they were translated.

Future research can also consider repositioning the variables studied here, as the model presented a statistical structure that proved its validity in the goodness of fit test. Therefore, future studies can relate perceived effort as a variable that negatively affects food control and procrastination, since these relationships stem from food waste behavior. Furthermore, researchers could conducted comparative studies by collecting data from individuals who have a lower level of education, a high income, and who are aged 40 years or more.

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AUTHORS' CONTRIBUTIONS

Marconi Freitas da Costa and Patrícia de Oliveira Campos worked on the conceptualization and theoretical-methodological approach. The theoretical review was conducted by Patrícia de Oliveira Campos and Poliana Nunes de Santana. Data collection was coordinated by Patrícia de Oliveira Campos. Data analysis included Marconi Freitas da Costa, Patrícia de Oliveira Campos and Poliana Nunes de Santana. All the authors worked together in the writing and final revision of the manuscript.

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FOOD WASTE AND PERFORMANCE MEASUREMENT SYSTEMS: A SYSTEMATIC REVIEW OF THE LITERATURE

Sistemas de medição de desempenho e desperdício de alimentos: Revisão sistemática da literatura

Sistemas de medición de desempeño y desperdicio de alimentos: Una revisión sistemática de la literatura

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ABSTRACT

This paper presents an analysis of the scientific production that deals with performance measurement and food waste, and examines the trends and challenges in the field. Food waste increases food insecurity and misuses scarce natural and financial resources. It is, however, very difficult to measure waste at the aggregate level, and the various ways companies use do not adopt a systemic approach. A systematic literature review was conducted using bibliometrics to guide content analysis. The results indicate that few articles focus on performance measurement systems for the whole supply chain, with a particular emphasis on sustainability. The use of digital technologies in performance measurement systems is a trend that was observed. This is an opportunity for research aimed at quantifying food waste better and helping reduce food insecurity.

KEYWORDS | Food waste, food loss, performance measurement systems, food security, literature review.

RESUMO

Este artigo apresenta uma análise da produção científica da medição de desempenho e do desperdício de alimentos, bem como as tendências e os desafios no campo. O desperdício de alimentos contribui para aumentar a insegurança alimentar e consome recursos financeiros e naturais escassos. Entretanto, existem inúmeras dificuldades para medir o desperdício em nível agregado, e as várias formas utilizadas nas empresas não têm abordagem sistêmica. Uma revisão sistemática da literatura foi realizada com o uso de bibliometria para direcionar análise de conteúdo. Os resultados apontam para uma falta de artigos com ênfase nos sistemas de medição de desempenho voltados para toda a cadeia de suprimentos com enfoque em sustentabilidade, melhoria e aprendizagem. A aplicação de tecnologias digitais nos sistemas de medição de desempenho é uma tendência observada. Isso é uma janela de oportunidades para desenvolvimento de pesquisas com o objetivo de quantificar melhor o desperdício de alimentos, que pode contribuir para a redução da insegurança alimentar.

PALAVRAS-CHAVE */ Desperdício de alimentos, perda de alimentos, segurança alimentar, sistemas de medição de desempenho, revisão de literatura.*

RESUMEN

Este artículo presenta un análisis de la producción científica sobre la medición de desempeño y el desperdicio de alimentos, así como las tendencias y desafíos. El desperdicio de alimentos contribuye a aumentar la inseguridad alimentaria y consume los escasos recursos financieros y naturales. Sin embargo, existen innumerables dificultades para medir el desperdicio a nivel agregado y las diversas formas utilizadas en las empresas no tienen un enfoque sistémico. Se realizó una revisión sistemática utilizando bibliometría para dirigir el análisis de contenido. Los resultados apuntan a la falta de artículos con énfasis en sistemas de medición de desempeño dirigidos a toda la cadena de suministro con un enfoque en la sostenibilidad, la mejora y el aprendizaje. Se observa una tendencia a la aplicación de tecnologías digitales en los sistemas de medición de desempeño. Esto es una ventana de oportunidades para el desarrollo de investigaciones con el fin de cuantificar mejor el desperdicio de alimentos que puede contribuir a reducir la inseguridad alimentaria.

PALABRAS CLAVE */ Desperdicio de alimentos, pérdida de alimentos, seguridad alimentaria, sistemas de medición de desempeño, revisión de la literatura.*

INTRODUCTION

Food waste occurs in the entire supply chain, from agricultural and livestock production to final consumption. With a focus on water waste, one of the first studies estimated that half of the food produced is wasted (Lundqvist, Fraiture, & Molden, 2008). The global estimate that is most cited in the literature, however, is that approximately one third of the food produced for human consumption is wasted, which equates to about 1.3 billion tons per year, while more than 820 million people go hungry (Gustavsson, Cederberg, Sonesson, Otterdijk, & Meybeck, 2011; Food and Agriculture Organization of the United Nations [FAO], 2019). Another study corroborates the previous estimate for food with an agricultural origin (Kummu et al., 2012). The UN Food and Agriculture Organization (FAO) has been coordinating an effort aimed at measuring food waste worldwide. This is necessary because of the growth in the global population, which is expected to reach almost 10 billion people by 2050, and will demand an increase in the food available for consumption (Searchinger et al., 2018). Although population growth occurs mainly in developing countries, developed nations are also facing food insecurity problems associated with distributing food to everyone (Buzby & Hyman, 2012). As a result, just increasing production and reducing waste are not enough. It is imperative to ensure food availability and economic and physical access to it (FAO, 2008). The efficient use of agricultural land and water, and biodiversity conservation are also global challenges caused by population growth (Lundqvist et al., 2008; Tscharntke et al., 2012).

Food waste is a central issue because of the financial and natural resources spent on food production, storage and transportation (Buzby & Hyman, 2012; Gustavsson et al., 2011). An example of this is annual water and fossil fuel consumption (Hall, Guo, Dore, & Chow, 2009; Lundqvist et al., 2008). It is also vital to consider water scarcity in order to forecast a realistic and desirable consumption level for food production (Lundqvist et al., 2008). Awareness of such losses is critical for reducing food waste and increasing efficiency in food supply chains. Negative externalities during the life cycle also affect society and the environment through greenhouse gas emissions, air and water pollution, soil erosion, salinization, and nutrient depletion (Buzby & Hyman, 2012).

Until 2009, food waste had not been a central issue in the food security debate (Hall et al., 2009). There are numerous possible causes of food waste, and they are highly dependent on the socioeconomic and cultural context in which the food chain actors operate (Cicatiello, Franco, Pancino, & Blasi, 2016). In almost all countries it is hard to estimate food waste at the national level (Hall et al., 2009). The data are scarce, dispersed, of poor quality, or of limited representativeness, which makes it crucial to improve data sources and to overcome the challenges of collecting the data (FAO, 2019). Overcoming these challenges will allow the "food loss index" (Indicator 12.3.1.a) and "food waste index" (Indicator 12.3.1.b) of the "Consumption and Responsible Production" Sustainable Development Goal, of the 2030 Agenda proposed by the 193 UN member countries to be measured. The UN recognizes that one of humanity's contemporary challenges is ensuring sustainable global food production. Reducing food waste, therefore, is one of the goals for achieving a more sustainable world by 2030 (Department of Economic and Social Affairs, 2016; West et al., 2014).

If it is difficult to quantify losses and waste on a worldwide level precisely, the same applies to supply chains and companies, because the performance measures currently used do not help identify the causes of waste, since they only measure cost, efficiency, and availability (Kaipia, Dukovska-Popovska, & Loikkaken, 2013).

Therefore, undertaking research into the performance of sustainable supply chains is important (Kaipia et al., 2013). The situation has changed little; waste management in the agri-food supply chain is still a promising subtopic for sustainable food supply chain studies (Luo, Ji, Qiu & Jia, 2018).

There is a lack of a systematic literature review that addresses food waste from the perspective of performance measurement systems. In this article, performance measurement systems (PMSs) is the process used for defining objectives, developing a set of performance measures, and collecting, analyzing, reporting, interpreting, reviewing and acting based on performance information (Bititci, Bourne, Cross, Nudurupati, & Sang, 2018). We pose and address, therefore, two research questions:

- QP1: What is the current state of scientific research into performance measurement systems for measuring food waste?
- QP2: What are the challenges and trends in implementing performance measurement systems for measuring food waste?

This paper aims to scrutinize the intellectual production dealing with performance measurement in measuring food waste, focusing on impacts and trends from a systematic literature review perspective.

THEORETICAL BACKGROUND

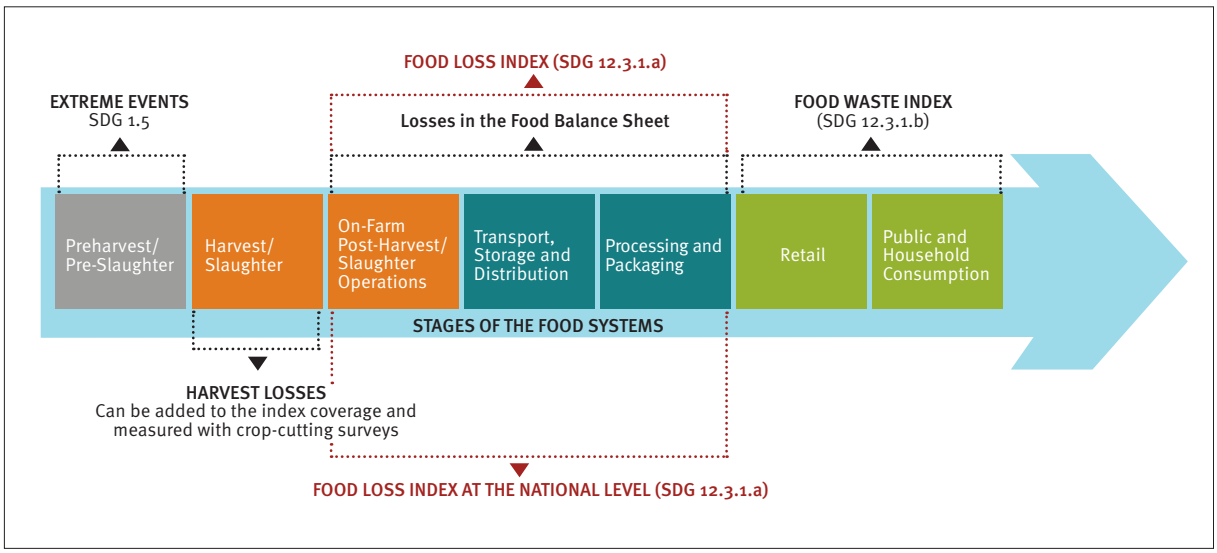
The two constructs that underlie this paper are food waste and performance measurement systems. We now provide a short review of the literature on those topics.

Food waste

There are no universally-standard definitions of food waste and food loss in literature (Buzby & Hyman, 2012). Food loss is the decrease in the quantity and quality of food, making it inadequate for human consumption. Food loss normally occurs at different stages in the agri-food supply chain (Parfitt, Barthel, & Macnaughton, 2010). Food waste is a food loss fraction, consisting of residue with a high organic concentration. Waste is generally derived from the processing of raw materials, resulting in secondary products in a liquid or solid form (Galanakis, 2012). For other authors, waste is losses at the end of the food supply chain (retail and final consumption), related to the behaviors of retailers and consumers (Parfitt et al., 2010). In this article, food waste includes low-quality products (rejected by the consumer) and waste generated during processing (Waarts et al., 2011). Finally, food waste measurement focuses only on products consumed by humans, excluding animal feed and the inedible parts of products (Parfitt et al., 2010).

In 2015, the United Nations published the 2030 Agenda for Sustainable Development that includes 17 Sustainable Development Goals (SDG), the aim being to raise awareness and lead international community actions over the next 15 years (2016-2030). The main performance measures for Objective 12, "Consumption and Responsible Production" are the food loss index (Indicator 12.3.1.a) and the food waste index (Indicator 12.3.1.b). Figure 1 gives the scope of the food supply chain considered by the SDG indices, whose objective is to enable policymakers to analyze the positive and negative trends in food waste by comparing it with the baseline to encourage improvements.

Figure 1. **Food loss index scope along the food supply chain**



Source: FAO (2019).

The FAO provides the Technical Platform on the Measurement and Reduction of Food Loss and Waste that facilitates food waste prevention, and the measurement and reduction of waste at the local, regional and national levels (FAO, 2017). Countries with the largest food surpluses tend to waste more (Stuart, 2009). In middle- and high-income countries, food is mainly wasted at the consumption stage when people dispose of food even if it is still suitable for human consumption. The percentage of food waste that occurs before the food reaches the retail area is around 13.8% (FAO, 2019). Based on a sample of 27 European countries, the European Commission (EC) estimated that 42% of food waste is produced by households, while 39% occurs in industry, 14% in the food service sector, and the remaining 5% in retail and distribution sectors (EC, 2010; Mirabella, Casstellani, & Sala, 2014; Raak, Symmank, Zahn, Aschemann-Witzel, & Rohm, 2017). Approximately 30 to 40% the food is wasted in developed and developing countries, although the causes of waste are very different (Godfray et al., 2010). In low-income countries, losses are much higher in the adjacent stages after the post-harvest period, while in developed countries, the greatest potential for reducing food waste lies in retail, food services, and in consumers' homes (Parfitt et al., 2010). Waste in South Africa is about 9.04 million tons per year (Oelofse & Nahman, 2013), while in Brazil it is 82.20 million tons per year (Dal'Magro & Talamini, 2019). Although food waste is present at all stages in the supply chain, the cause of food waste is often not at the same stage as where the waste was identified (Raak et al., 2017).

Food goes through several stages along the entire supply chain, from raw material production, processing and distribution to consumers. A quarter of the food is wasted in the supply chain due to physical damage to products or packaging, insect-related causes, and attack by microorganisms. Blackouts, equipment defects, waste from technical operations, human error, logistical limitations, hygiene regulations, and presumed causes of safety risks are other sources of food waste (Raak et al., 2017). Ineffective cold chains have recently been the cause of much of the food waste (Jedermann, Nicometo, Uysal, & Lang, 2014). It is worth mentioning that the three main food groups in terms of the value of the food lost at the end of the chain are: meat, poultry and fish (41%); vegetables (17%); and dairy products (14%) (Buzby & Hyman, 2012).

Reducing waste at each stage of the supply chain can reduce the total loss by 50%. This would help improve the food available to meet the future demands of approximately one billion people (Kummu et al., 2012). The use of technology, such as radio frequency identification, can also improve supply chain management, particularly for perishable goods. Data gathered by sensors and Internet of Things devices can help predict shelf-life throughout the supply chain.

Besides social factors and the depletion of natural and financial resources, food waste has an extreme impact on the environment and affects sustainability, a critical performance dimension in food supply chain management (Cicatiello et al., 2016; Kaipia et al., 2013). Food waste also contributes to the excessive consumption of fresh water and fossil fuels, which added to methane and CO_2 emissions from food decomposition, have a negative effect on global climate change (Hall et al., 2009). Food processing residue also requires treatment to minimize and prevent negative environmental effects due to its disposal (Galanakis, 2012). Incineration with other waste is a common disposal method of food waste, which is used for generating heat or energy (Kiran, Trzcinski, Ng, & Liu, 2014). Food waste is also a cheap source of valuable compounds, which become functional additives for other products after the recovery and recycling of some of their components (Galanakis, 2012). The bioconversion of food waste into energy (as ethanol, hydrogen, methane, and biodiesel) is economically viable and attractive (Kiran et al., 2014). As waste food requires additional processing before it can be used, intensifying research and integrating value-added product manufacturing processes are essential for improving efficiency and reducing production costs (Mirabella et al., 2014).

Following the three sustainability dimensions (environmental, economic, and social), the food waste hierarchy establishes the prioritization order as being: prevention, reuse, recycling, recovery, and disposal (Papargyropoulou, Lozano, Steinberger, Wright, & Ujang, 2014). A production surplus of approximately 30% is necessary to compensate for the waste, but currently this figure exceeds 50% (Papargyropoulou et al., 2014). Thus, the first step towards reducing food waste is adopting a more sustainable approach to production and consumption, by eliminating as much as possible of the surplus food produced and the food wasted in the entire food supply chain (Papargyropoulou et al., 2014).

Performance measurement systems

The basic assumption of most research related to performance measurement and management is that the environment of organizations is stable, while authors are still basing their works on the traditional control theory (Wamba, Akter, Edwards, Chopin, & Gnanzou, 2015). Nowadays, companies operate in increasingly complex environments that often require highly competitive capabilities to comply with the increasing dimensions that performance demands. Furthermore, performance depends heavily on stakeholders and supply chain partners (Bititci et al., 2018; Bourne, Franco-Santos, Micheli, & Pavlov, 2018). The result is an evolution in performance measurement; What should be measured for performance management; and How can performance measurement be used for managing organizations? Another change has been in the use of the terms "measurement" and "performance management" (Bititci, Garengo, Dörfler, & Nudurupati, 2012; Bititci et al., 2018; Melnyk, Bititci, Platts, Tobias, & Andersen, 2014), even though use of the term "performance measurement systems" (PMSs) still endures.

Several domains address performance measurement (Bititci et al., 2018; Franco-Santos et al., 2007; Neely, 1999). In this article, we have used the Operations Management domain. From this point of view, performance measurement is the process of quantifying or qualifying the efficiency and effectiveness of an action. Measurement

occurs on four levels – task, process, organization, and supply chain (Bititci et al., 2018). Performance measure is the metric used to quantify the efficiency and/or effectiveness of the action, while PMS is the set of metrics used to do the same (Neely, Gregory, & Platts, 1995).

Exhibit 1 shows the definitions coined by Bititci et al. (2018), who expand on the definitions used by Neely et al. (1995), with the addition of the definition of performance management.

Exhibit 1. **Key PMS definitions**

Concept	Definition
Performance	Efficiency and/or effectiveness of an action
Performance Measurement	Qualitative or quantitative evaluation of an action's efficiency and/or effectiveness
Performance Measurement System	Process (or processes) of defining objectives, developing a set of performance measures, collecting, analyzing, reporting, interpreting, reviewing, and acting on performance data (technical controls)
Performance Management	Cultural and behavioral routines that define how we use the performance measurement system to manage an organization's performance (social controls)

Source: Bititci et al. (2018).

Analyzing several PMS definitions, Franco-Santos et al. (2007) propose three groups of elements: *features*; *roles*; and *processes*. Features are essentially performance measures (financial and non-financial metrics) and the necessary infrastructure for system operation (manual or digital). Roles are common usages, such as measuring performance (usually for controlling purposes), managing strategy, communicating performance, influencing behavior, and leading learning and improvement. Processes are the sequence of activities used for developing performance measures, collecting and processing data, managing information, evaluating and rewarding performance, and reviewing the system. Scholars can use PMS elements to identify and clarify the focus and contribution of an investigation.

With regard to PMS processes, there is no consensus in the literature (Bititci & Nudurupati, 2002; Bourne, Mills, Wilcox, Neely, & Platts, 2000; Gutierrez, Scavarda, Fiorencio, & Martins, 2015; Helden, Johnsen, & Vakkuri, 2012; Maestrini, Maccarrone, Caniato, & Luzzini, 2018; Nudurupati, Bititci, Kumar, & Chan, 2011). PMS processes are generally associated with the system's life cycle (Gutierrez et al., 2015; Maestrini et al., 2018). Bourne et al. (2000) suggest three processes: development, implementation, and use/review. Gutierrez et al. (2015) and Maestrini et al. (2018), however, argue that use should be separated from review because of the importance of updating the system.

Performance information use is one of the pillars of PMS, while organizational culture and management style moderate it. Two common usages are diagnostic use for control, and interactive use for innovation and improvement (Bititci, Mendibil, Nudurupati, Garengo, & Turner, 2006; Ferreira & Otley, 2009; Henri; 2006; Simons, 1995; Simons et al., 2000). The major influence of PMS comes from people using the system properly (Hopwood, 1972; Nudurupati et al., 2011). Changing of the purpose of PMS use from controlling (traditional use) to improving may require an organizational change that is greater than system implementation or review (Blenkinsop & Burns, 1992; Henri, 2006; Simons, 1995).

IT-based systems are critical to the successful implementation of a PMS (Garengo, Nudurupati, & Bititci, 2007; Nudurupati et al., 2011), although they can also become a barrier if they exist, specifically in a review (Bourne, Neely, Mills, & Platts, 2003; Bourne, Neely, Platts, & Mills, 2002; Braz, Scavarda, & Martins, 2011; Gutierrez et al.,

2015; Nudurupati et al., 2011). The better the data available and the more accurate the information, the more effectively the performance (of decision makers) can be achieved if it is linked to the business strategy (Sztmczak et al., 2018). Reliable data collection and analysis, and investments in infrastructure and human resources are necessary for appropriate performance measurement and management (Mishra, Gunasekaran, Papadopoulos, & Dubey, 2018). IT is increasingly supporting the life cycle of PMSs (Nudurupati, Tebboune, & Hardman, 2016), but the challenge for efficiently measuring and managing performance in the digital age is twofold: adapting to the continuous transformation occurring in the external environment, and managing a large volume of data in diverse formats (Nudurupati et al., 2016). Digital ubiquity, therefore, is expected to transform the operation and the role of performance measurement and management systems (Xu, He, & Li, 2014).

Supply chains are complex, autonomous and interdependent systems, comprising companies and business units (Chan, 2011). Their success does not depend on the aggregation of individual operations and each company's performance, but on integrated and adaptive activities, and on relations between companies in the supply chain (Bourne et al., 2018). PMSs commonly improve the performance of firms indirectly, and socialization between companies (Cousins, Lawson, & Squire, 2008; Mahama, 2006). The number of effective approaches to managing supply chain performance is growing because of economic globalization and intensified competitiveness (Rezaei, Shirazi, & Karimi, 2017). Consequently, organizations need to change their performance evaluation to embrace a broader perspective (Nudurupati et al., 2016), so managers should pursue data integration along the entire supply chain information structure (Szymczak et al., 2018).

RESEARCH METHOD

The research method was a combination of bibliometric and content analyses of the literature (Luo et al., 2018; Morioka, Iritani, Ometto, & Carvalho, 2018; Lopes & Martins, 2021). Bibliometric analysis followed the steps proposed by Zupic and Čater (2015): (1) study definition: objective definition, database selection, and definition of the filters for delimiting the sample; (2) data compilation: selection, collection, and data processing after applying the filters in Step 1; (3) analysis: using software for bibliometric and statistical analysis; (4) visualization: selecting the method and software for visualizing the data; and (5) interpretation: interpreting and disseminating the results. Content analysis concentrated on performance measurement proposals for food waste.

We elected the Web of Science (WoS) scientific index for data collection because the metadata-cited references' format of the index is more suitable for data processing. We determined the following principles to ensure document consistency and eligibility:

- we considered journal articles, conference articles, reviews, and articles in early access;
- due to the lack of any similar studies, we did not apply a timespan filter.

We applied the following search strings: TS=(("performance measur*" OR "performance metric*" OR "key-performance indicator*" OR "measur* performance" OR "performance indicator*" OR "KPI *") AND ("food wast*" OR "food loss*" OR "waste* of food*" OR "waste* of the food*" OR "loss* of food*" OR "loss* of the food*"))). The combination of the terms associated with the two main topics, food waste and PMS, led to the search string composition. Applying the symbol * to some keywords means that the suffix words may vary. The aim was to cover term derivations in order to increase the return of registers.

We used the R Bibliometrix package, version 3.0.0, in the RStudio environment, version 1.2.5042 for bibliometric analysis and multivariate analysis of registers of the sample records extracted from the Web of Science (Aria & Cuccurullo, 2017). For charts and tables, we used Excel software, version 3.2.0. Finally, we used VOSViewer software, version 1.6.11, for analyzing the social networks (Eck & Waltman, 2013).

RESULTS

Bibliometric analysis

The bibliometric analysis enabled us to identify the main publications, their impact, the leading journals, and the top research issues related to PMS and food waste. On 5/25/2020, we searched the WoS, the result being 29 registers (23 journal articles, two conference articles, and four reviews). These registers had been published in 19 sources (journals and conference proceedings) between 2013 and 2020.

Figure 2 illustrates the scientific production and its impact (in terms of citations). Production is recent and driven by FAO publications (2013, 2014, 2015) and is the most significant since 2016, the peak being in 2018. With regard to impact, the average number of citations was at its most significant in 2013 (an average of 23.9 citations in the year), with subsequent values decreasing as expected, since recent publications have not yet had time to receive many citations.

Figure 2. **Number of documents published annually and average citations per year**

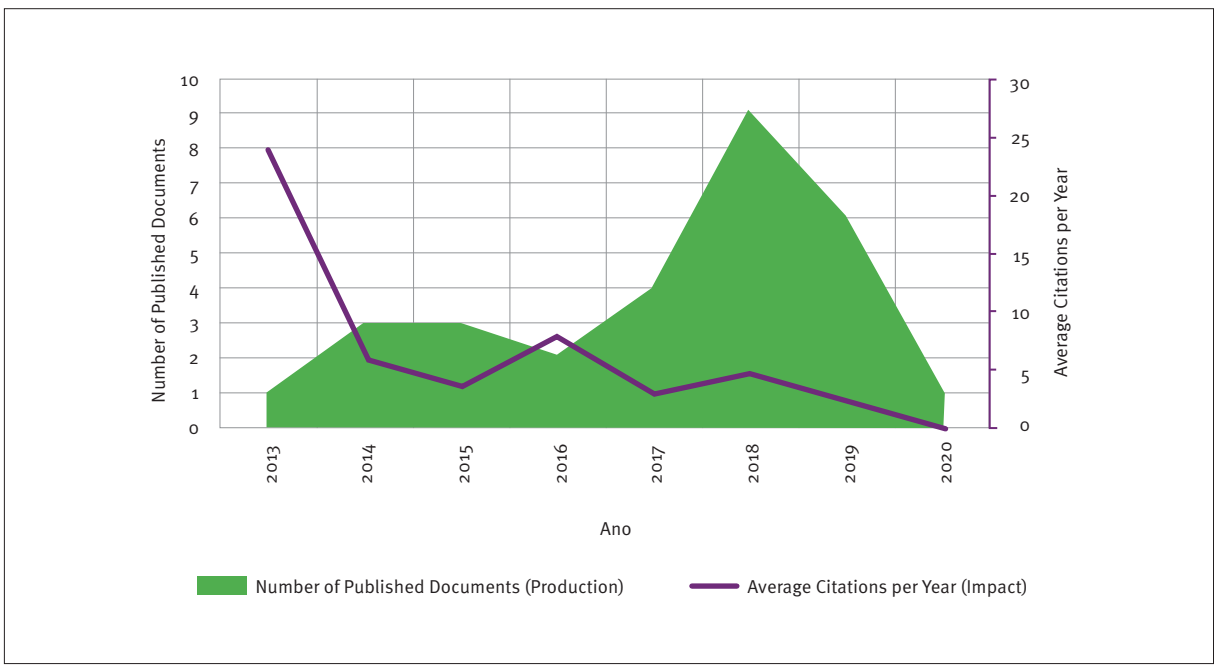


Table 1 details the impact of the scientific production, highlighting the documents with the greatest impact in terms of total citations and total citations per year. Brown and Li (2013) have the most cited article (167 citations), and the most citations per year (20.9). This explains the high average impact value per year in 2013 (Figure 2).

ElMekawy, Srikanth, Vanbroekhoven, Wever and Pant (2014) follow with 58 citations. Both works deal with the application of biotechnology for reducing food waste. Soysal, Bloemhof-Ruwaard, Haijema and Vorst (2018) (45 citations) and Hertog, Uysal, McCarthy, Verlinden and Nicolaï (2014) (41 citations) also stand out, with Soysal co-authoring both papers. Pirani and Arafat (2016) and Steur, Wesana, Dora, Pearce and Gellynck (2016) suggested management approaches to food waste.

Table 1. **Most cited sample articles**

First Author	Year	Journal	TC[1]	TC by Year	TC Ranking by Year
Brown D	2013	Bioresource Technol	167	20.9	1
Elmekawy A	2014	J Power Sources	58	8.3	3
Soysal M	2018	Comput Oper Res	45	15.0	2
Duke Mlatm	2014	Philos T T Soc A	41	5.9	5
Pirani Si	2016	J Clean Prod	40	8.0	4
Sturgeon H	2016	Waste Manage	23	4.6	7
Charlebois S	2015	Int J Cult Tour Hosp	20	3.3	9
Manser Nd	2015	Bioresource Technol	17	2.8	10
Martin-rilo S	2015	J Clean Prod	17	2.8	10
Menna F	2018	Waste Manage	14	4.7	6
Sun H	2017	Waste Manage	14	3.5	8

[1] The acronym TC refers to the total citations of each document

Changing the focus to journals and conference proceedings, Table 2 shows the central outlets that published sample articles. These journals published seven of the 11 most cited articles (Table 1), their domains being: Environmental Sciences [ES]; Industrial Engineering [IE]; and Energy [E]. *Journal of Cleaner Production* published the biggest number of the sample articles, followed by *Waste Management*. Although *Bioresource Technology* did not publish the largest number of articles, it has the greatest impact (number of citations).

Table 2. **Top journals in the field**

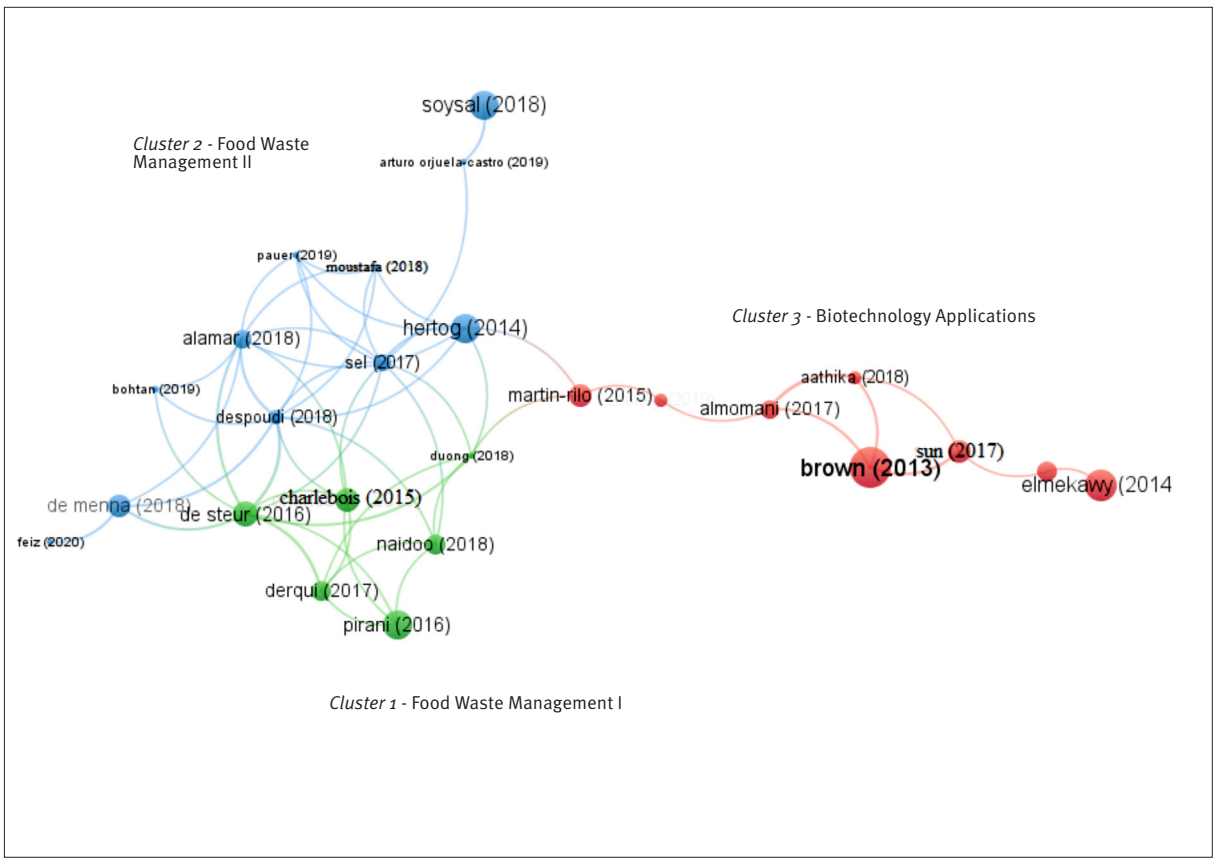
Journal	Articles	TC[1]	h index[2]	Areas[3]	Publisher
Journal of Cleaner Production	5	83	150	[ES] [IE] [E]	Elsevier B.V.
Waste Management	4	60	127	[ES]	Elsevier Ltd.
Bioresource Technology	3	193	251	[ES] [E]	Elsevier B.V.
Sustainability	2	0	53	[ES] [IE]	MDPI Open Access Publishing

[1] TC means the total citations of each document.
[2] The Hirsch index (or h index) estimates the importance, significance and impact of accumulated scientific production (Hirsch, 2005).
[3] Research areas: [ES] - Environmental Sciences; [IE] - Industrial Engineering; and [E] - Energy.

To identify the research themes of the sample documents, we used a bibliographic coupling network that enabled the similarities between the documents to be identified from their theoretical framework (Zupic & Čater, 2015). After clustering, we checked the research themes of the articles to name the clusters. At this point, our

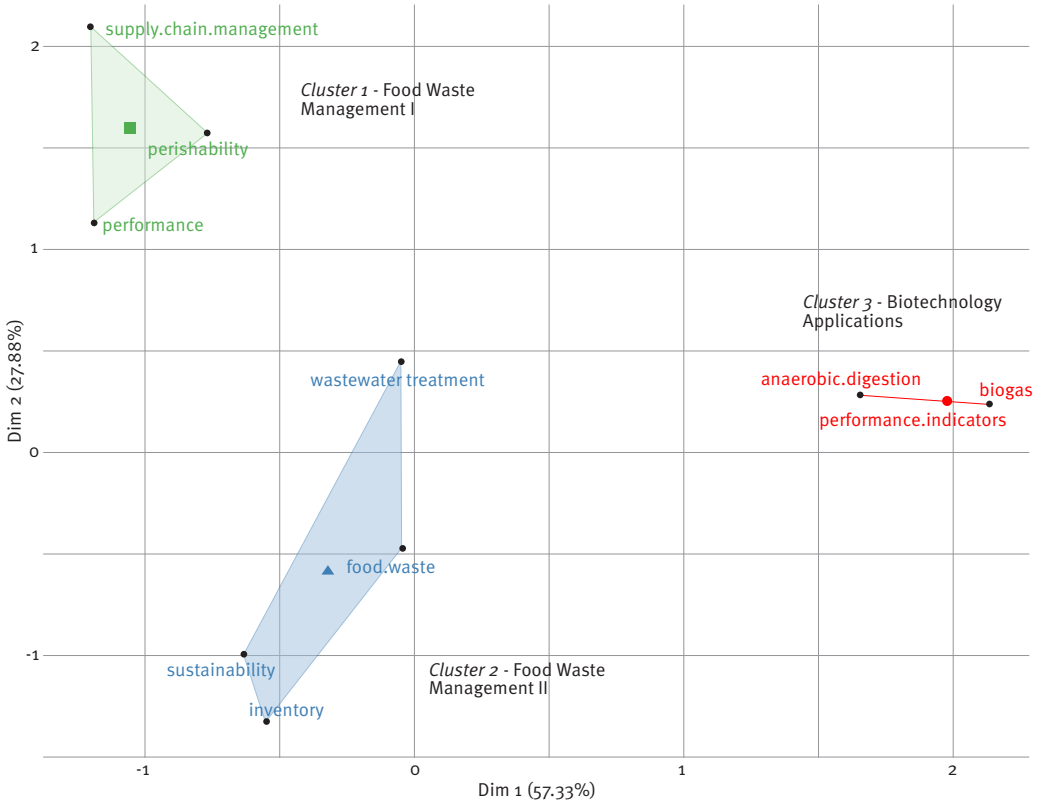
method is different from the methods used by Luo et al. (2018) and Morioka et al. (2018), but follows Lopes & Martins (2021). Figure 3 shows three clusters. Based on document titles, we identified that Cluster 1 (green) and Cluster 2 (blue) deal with food waste management approaches, while Cluster 3 (red) refers to the use of biotechnology in food waste.

Figure 3. **Bibliographic coupling network**



Analysis of the documents' keywords enabled the conceptual structure of a field to be mapped out, thus creating a map with multiple correspondence analysis application (Cobo, López- Herrera, Herrera- Viedma, & Herrera, 2011). Figure 4 shows the conceptual map of the domain with the authors' keywords; we identified three research streams. We assigned the cluster numbers in alignment with the findings of Figure 3. Cluster 1 in green encompasses *supply chain management, perishability,* and *performance*; Cluster 2 in blue, *sustainability*, *inventory, wastewater treatment* and *food waste;* finally, Cluster 3 in red, *anaerobic digestion, performance indicators,* and *biogas)*. Figure 4 differentiates between Clusters 1 and 2 that were identified earlier in Figure 3.

Figure 4. **Conceptual map of the field**



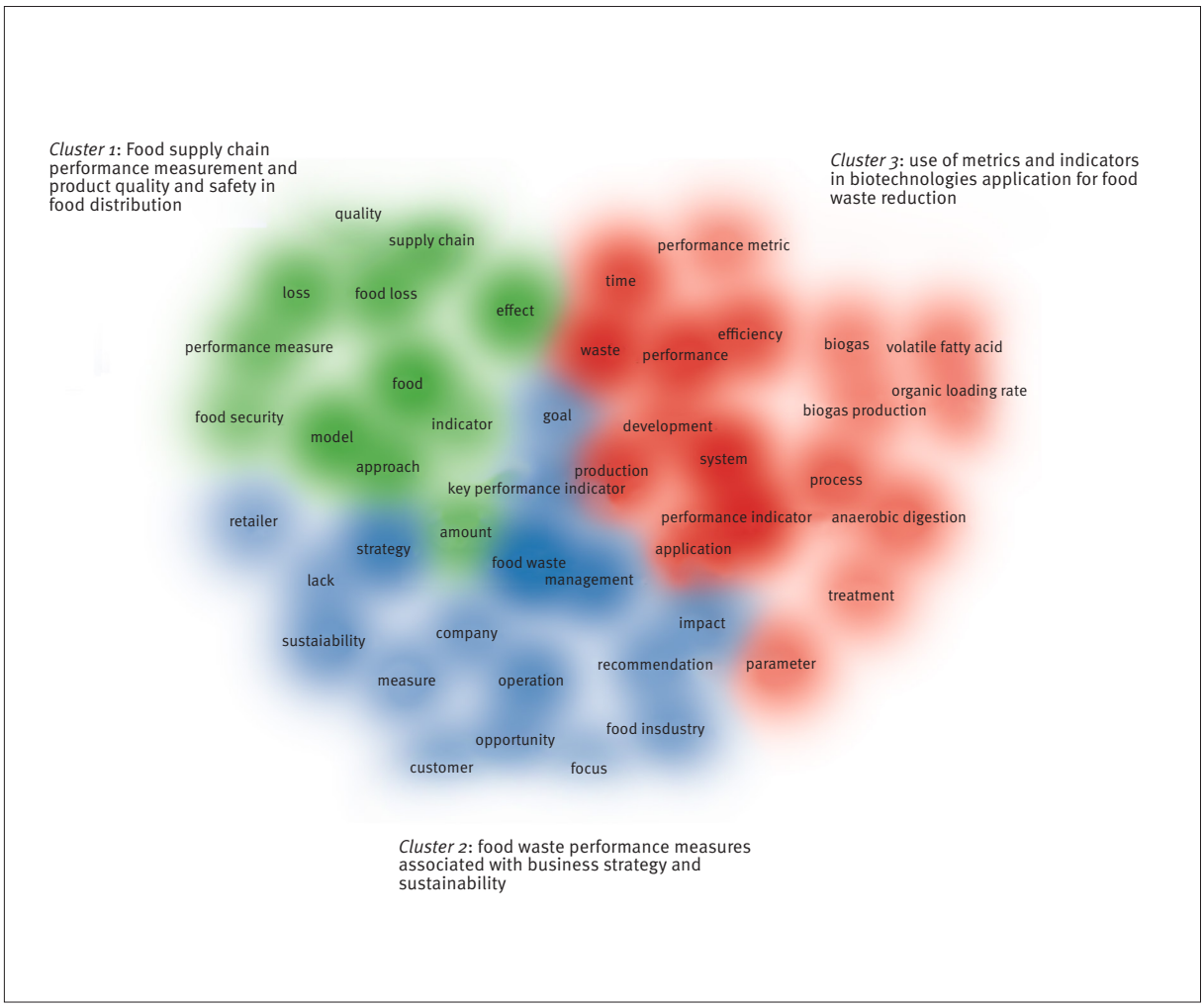
Due to the small number of articles in the sample, we used text mining with document abstracts to improve our understanding of the contents of the clusters (Eck & Waltman, 2013). This kind of analysis differentiates our method from that of Luo et al. (2018), Morioka et al. (2018), and Lopes & Martins (2021), although Liboni, Cezarino, Jabbour, Oliveira and Stefanelli (2019) did the same. Figure 5 illustrates the three distinct clusters that detail the previous results (Figures 3 and 4). We identified the clusters as follows: food supply chain performance measurement and product quality and safety in food distribution (Cluster 1 – green); food waste performance measures associated with business strategy and sustainability (Cluster 2 – blue); and the use of metrics and indicators in the application of biotechnology used for reducing food waste (Cluster 3 – red).

Cluster content analysis

Content analysis provides the domain details on the research themes that were identified: food supply chain performance measurement: product quality and safety in food distribution (Cluster 1 – green); food waste performance measures associated with business strategy and sustainability (Cluster 2 - blue); and the use of

metrics and indicators in the application of biotechnology for reducing food waste (Cluster 3 - red). Content analysis in this paper focuses on Clusters 1 and 2, because they have an intrinsic association with food waste and performance measurement. Cluster 3 is about the application of technology for reducing food waste. We therefore ignore it because the topic is not the focus of this article.

Figure 5. **Abstract co-occurrent words**



Food supply chain performance measurement: product quality and safety in food distribution

Several of the sample articles focus on the performance measurement role in ensuring product quality throughout the supply chain. Steur et al. (2016) show the potential of value stream mapping for identifying and reducing food waste and improving nutrient retention in the supply chain. These authors present the state-of-the-art in the application of lean practices in the agri-food industry. They identify lead time as the most suitable performance measure. A reduction in lead times increases customer satisfaction because of faster responses to demand, which is important for perishable products. These authors also point out that most waste occurs during the processing stage.

Naidoo and Gasparatos (2018) explore the major factors for adopting environmental sustainability strategies in the food retail sector, and present the typical strategies and performance measures employed. The authors approach the subject from a PMS perspective. Their results suggest that the primary motivation for retailers in implementing sustainable strategies is the expected economic benefit associated with reducing resource use. These authors also identify the lack of studies on sustainability performance measures in the retail sector, particularly in developing countries. They also argue that big data should be used as a source of information for sustainable strategies and measuring performance.

The agricultural sector must implement new technologies to increase food production in order to comply with the growing demand for food because of population growth. Duong, Wood, and Wang (2018) investigate the three perishable food stock effects on performance: uncertain consumer demand, product life, and lost sales. Using a simulation model these authors evaluate the performance of different scenarios from the perspective of non-financial measures (average stock, supply rate, and proportion of order variation). Analytic Hierarchy Process (AHP) weighted performance measures relevance, and Data Envelopment Analysis (DEA) evaluates and classifies the performance of all scenarios. For these authors, managers should consider using non-financial performance measures to improve communication flow along the perishable products supply chain. They recommend more research for identifying and analyzing possible communication structures for promoting sustainability in this kind of supply chain.

Regarding food waste in services, Charlebois, Creedy and Massow (2015) identify the key determinants of food waste at points of sale. From a case study involving a well-known restaurant chain in Canada, these authors offer a perspective on the relationship between waste and factors such as cooking practices, services, cost management, risk mitigation, menu development, and technical knowledge in hospitality. Although those authors do not deal with performance measures, they identify measurement dimensions and the need to use metrics for a sharper analysis and for validating findings.

Pirani and Arafat (2016) evaluate the current practice of food waste management in the hospitality sector in the UAE. They establish that the style and hours of service, the type of food served, and inaccuracy in predicting the number of customers contribute most to the generation of food waste. Based on these parameters, they introduced an aggregate performance measure to assess service sustainability, "FRESH" (Food Waste Rating for Events vis-à-vis Sustainability in the Hospitality sector). To calculate the metric, the authors use five performance measures that reflect a dimension of the food service process and have an influence on the amount of food wasted. FRESH enables establishments, authorities, and customers to assess food service sustainability.

Derqui and Fernandez (2017) developed standardization guidelines for auditing and self-assessment in measuring food waste in school cafeterias. The authors obtained basic performance measures from public and private schools, and from outsourced companies. The metrics selected were: the planned number of meals vs. the actual number; aggregate waste by food type; the number of trays without waste; waste disposal; and the cost of food waste. Four schools then used these performance measures. The study indicates that if managers and employees are unaware of the amount of food wasted in the cafeterias, they will not be inclined to implement audits and actions for reducing waste. Institutions that focus on sustainability allocate more resources for reducing food waste, and so they are more likely to use these performance measures.

Food waste performance measures associated with business strategy and sustainability

Menna, Dietershagen, Loubiere and Vittuari (2018) focus on the life cycle of food products. Based on different aspects of life cycle cost analysis, the authors evaluate food waste management and product value. The food waste management perspective, however, requires a consistent integration between life cycle analysis and costs to avoid choosing between environmental or economic impacts. Therefore, interpretation of the results of the life cycle cost of food waste should acknowledge the effect on larger economic systems.

Pauer, Wohner, Heinrich and Tacker (2019) summarize the methods used for assessing the environmental sustainability of food packaging, whose function is both to protect food and increase shelf life. The proposed model defines three aspects of food packaging sustainability: direct environmental effects; losses and food waste generated during packaging; and circularity. The major circularity performance measures are:

- input: recycled content; reuse rate; renewable content;
- output: recyclability; recycling rate; recycling production rate; downcycling factor; reuse rate; compostability;
- energy: share of renewable energy.

Feiz et al. (2020) offer their recommendations for improving life cycle analysis modeling and simulations by aggregating environmental and economic performance analysis in the production of biogas from food waste. The suggested method and metrics consider the multiple functions of biogas production from food waste: waste management, renewable energy transportation, and nutrient recycling. Among the performance measures are: the effective yield of methane, climate impact, energy balance, the potential for nitrogen recycling, the potential for phosphorus recycling, the improvement in nitrogen available in the plant, and the cost of the resource.

Regarding collaboration within the food chain, Alamar, Falagán, Aktas and Terry (2018) encourage the development and implementation of collective solutions to better preserve and use food. If the quality of the post-harvest waste data available is questionable, the information generated using performance measures may be inaccurate. In order to reduce food waste there needs to be research into supply chains, an exchange of knowledge, and training.

From this same perspective, Despoudi, Papaioannou, Saridakis and Dani (2018) investigate the effects of different levels of collaboration on food waste in the post-harvest period. The authors also use a measurement model to identify the effect of different levels of collaboration on food waste. Findings suggest that high levels of collaboration between producers and cooperatives lead to low levels of food waste. The relationship between collaboration and performance requires more investigation in the context of food supply chains. Best practices for long-term collaboration also need to be identified.

With regard to the development of a mathematical model, Sel, Pınarbaşı, Soysal and Çimen (2017) model a food supply chain considering production and service management. The authors develop a stochastic programming model to solve demand problems, considering metrics like total amount of waste, total scarcity, and the total cost of production and distribution. Such metrics enable the sustainability performance of supply chains to be evaluated. The model relates food waste to economic performance and to environmental and social impacts.

Moustafa, Galal and El-Kilany (2018) investigate dynamic pricing strategies to maximize revenue and minimize food waste for driving sustainability. Price and product shelf life are the foundation of a stochastic on-demand simulation model. The authors analyze the inventory replacement effect on performance measures. Simulation

results show the superiority of a dynamic pricing strategy over a fixed pricing strategy in relation to retailer profit and food waste.

Garcia-Garcia, Stone and Rahimifard (2019) model waste flow to achieve two goals: to provide data on manufacturing and food waste; and to analyze existing food waste management practices for implementing alternative value solutions. The most relevant metrics are: eco-efficiency, eco-intensity, the waste/product ratio, and the waste/raw materials ratio. The conclusion is that opportunities for food waste inventory management exist. They make recommendations for an improved food waste management system that focuses on assessment opportunities.

Other studies emphasize how to avoid waste during transportation. Hertog et al. (2014) propose a model for monitoring the quality and validity of perishable products. They differentiate traditional supply chain planning from the proposed use of metrics that relate shelf life to cost. The model offers strategic responses to supply chain management using product expiry and quality metrics in a real-time monitoring system. One critical factor that they identified is the willingness of all chain agents to participate and share information.

Soysal et al. (2018) develop a decision support model to evaluate the benefits of collaboration. They relate it to perishability, the energy use of transportation operations, and logistics costs. The proposed model enables collaboration benefits to be analyzed using various performance measures: emissions; driving time; and total cost, comprising routing, inventory, and the cost of waste when demand is uncertain. The results show that horizontal collaboration between suppliers contributes towards the total aggregate cost and leads to a reduction in emissions in the logistics system.

Exhibit 2. **Summary of performance measurement elements in Clusters 1 and 2**

Cluster	Article	Research Type	Performance Measures	Performance Measurement System	Performance Measurement Scope	Performance Measurement Use	PMS Processes
1	Pirani and Arafat (2016)	Empirical	Sustainability Indicator	Does not address	Public and Household Consumption	Control	Measurement Selection and Design
	Duong et al. (2018)	Empirical	Set of Sustainability Indicators	Does not address	Transportation, Storage and Retail Distribution	Improvement	Measurement Selection and Design
	Charlebois et al. (2015)	Empirical	Waste Sources only	Does not address	Retail	Control	Measurement Selection and Design
	Sturgeon et al. (2016)	Theoretical	Set of Indicators with Causal Relations in the Economic Dimension	Does not address	Transportation, Storage and Distribution to Public and Household Consumption	Improvement	Measurement Selection and Design
	Derqui e Fernandez (2017)	Empirical	Social, Economic and Sustainability Indicators	Does not address	Public and Household Consumption	Improvement	Data Collection and Manipulation
	Naidoo and Gasparatos (2018)	Theoretical	Set of Sustainability Indicators	Yes	Retail	Strategic Management	Measurement Selection and Design Information Management

Continue

Exhibit 2. **Summary of performance measurement elements in Clusters 1 and 2** Concludes

Cluster	Article	Research Type	Performance Measures	Performance Measurement System	Performance Measurement Scope	Performance Measurement Use	PMS Processes
2	Duke et al. (2014)	Theoretical	Indicators with Causals Relations in the Economic Dimension	Does not address	Transportation, Storage and Distribution	Strategic Management Communication	Measurement Selection and Design Data Collection and Manipulation
	Alamar et al. (2018)	Theoretical	Measures with Causal Relations in the Economic Dimension	Does not address	Harvest/ Slaughter Processing and Packaging	Improvement	Data Collection and Manipulation
	Soysal et al. (2018)	Empirical	Set of Economic and Sustainability Indicators	Does not address	Transportation, Storage and Distribution	Control Communication	Measurement Selection and Design
	Despoudi et al. (2018)	Empirical	Tons wasted, as Economic and Sustainability Indicator	Does not address	Post-Harvest/ Slaughter Operations	Control	Information Management
	Orjuela-Castro et al. (2019)	Empirical	Set of Economic Indicators	Does not address	Transportation, Storage and Distribution	Improvement	Measurement Selection and Design
	Feiz et al. (2020)	Empirical	Set of Economic and Sustainability Indicators	Does not address	Processing and Packaging	Control	Measurement Selection and Design
	Salt et al. (2017)	Empirical	Set of Economic Indicators	Does not address	Public and Household Consumption	Control	Measurement Selection and Design
	Menna et al. (2018)	Theoretical	Set of Economic Indicators	Does not address	All Supply Chain Stages	Control	Unidentified
	Moustafa et al. (2018)	Theoretical	Set of Economic Indicators	Does not address	Retail	Control	Measurement Selection and Design
	Pauer et al. (2019)	Theoretical	Set of Sustainability Indicators	Yes	Processing and Packaging	Control	Measurement Selection and Design
	Bohtan et al. (2019)	Empirical	Set of Indicators with Causal Relations in the Economic Dimension	Yes	Post-Harvest/ Retail Slaughter Operations	Control Improvement	Measurement Selection and Design Data Collection and Manipulation
	Garcia-Garcia et al. (2019)	Empirical	Set of Sustainability Indicators	Does not address	Transportation, Storage and Distribution to Processing and Packaging	Control	Measurement Selection and Design

Orjuela-Castro, Orejuela-Cabrera and Adarme-Jaimes (2019) present a mathematical vehicle routing model for perishable foods, which models: a fleet of heterogeneous vehicles; the fixed cost of transport; a variable cost per distance traveled; and the cost of fruit waste associated with transportation time. The model also considers the perishability of fruit in an explicit relationship with travel time and vehicle capacity. The findings show the need to investigate multi-objective models, using performance measures of efficiency, quality, and responsiveness.

Bohtan, Mathiyazhagan and Vrat (2019) address food chain management using performance and productivity objectives to develop a PMS for a public food distribution system in India. The proposed PMS covers all transportation stages, because fast transport is vital for reducing food perishability. The system goal is to evaluate the effectiveness (meeting customer requirements) and efficiency (resource savings) of the supply chain. The authors recognize that performance measurement and improvement studies are fundamental for standardizing and optimizing the entire supply chain.

Exhibit 2 summarizes the elements of the performance measurement system found in the articles in Clusters 1 and 2. We analyzed each paper with regard to: the nature of the research (theoretical or empirical); the performance measures used (isolated or joint, economic or sustainability); the PMS approach; the scope of performance measurement (links in the food supply chain – Figure 1); the use of performance measurement (control, strategy, communication, influence on behavior, or improvement); and PMS processes (measurement selection and design, data collection and manipulation, information management, performance evaluation, and systems review). Franco-Santos et al. (2007) established the basis of the last two categories.

DISCUSSION OF RESULTS

The analysis first concentrates on the type of research described in the articles (Exhibit 2). Most papers are empirical (61.1%), as opposed to theoretical papers, like literature reviews, modeling or axiomatic simulations. Another point are the performance measures. We identify two types of performance measure; stand-alone, and sets of metrics, whose clustering does not reveal a logic. Many non-financial metrics establish a causal relationship between financial performance measures for assessing the impact of food waste, and loss (Buzby & Hyman, 2012; Gustavsson et al., 2011; Hall et al., 2009). An exception to this are Charlebois et al. (2015), who ignore performance measures, but indicate the sources of waste for developing metrics. Despoudi et al. (2018) substantiate their analysis of the economic and sustainability performance based on a single non-financial performance measure (the amount of food wasted). Pirani and Arafat (2016) propose an aggregate performance measure derived from six other measures, all of them non-financial.

The performance measures taken from the sample documents form an association with the financial, sustainability, and eco-financial dimensions (Exhibit 2). An exception to this are Derqui and Fernandez (2017), who include social performance measures from a triple bottom line perspective. The importance of the financial dimension is clear in Exhibit 2 (column "Performance Measures"), notably in the articles in Cluster 2. These articles deal with those food waste performance measures that are associated with business strategy and sustainability. Only three articles follow Bititci et al.'s (2018) PMS definition (Exhibit 1) that deals with a proposal for performance measurement systems and how to use them. This finding is alarming because scholars have been addressing performance measurement from a narrow perspective by emphasizing the performance measures used. This evidence corroborates the previous result. The sample documents cited 1,618 references, even though they only

once cited traditional references to PMS, such as those by Kaplan and Norton (1992), Neely *et al.* (1995), Kaplan and Norton (1995), and Bititci, Carrie and McDevitt (1997). The absence of a theoretical background for PMS may explain the narrow approach adopted by the authors of the papers in Clusters 1 and 2.

A third point is the scope of performance measurement that deals with supply chain links in the sample documents (Exhibit 2). Menna *et al.* (2018) are the only ones to present a broad perspective involving all the links in the food supply chain, according to the FAO (2019). Most articles, especially those in Cluster 1, address those elements that are commonly found towards the end of the supply chain, like retailers, and public and household consumption. Even those authors who address PMS do so from the limited scope of the immediate supply chain (an upstream or downstream link with the coordinating link). Naidoo and Gasparatos (2018) and Pauer et al. (2019) focus only on one link, while Bohtan et al. (2019) consider the intermediate part of the supply chain.

A fourth point is the use of performance measurement. The findings deal with using PMS for control and improvement purposes (Exhibit 2). Hertog et al. (2014) propose using it for strategic management (emphasis on control) and communication with other links in the supply chain. Soysal et al. (2018) focus on suppliers. Finally, Bohtan et al. (2019) recommend using PMS for controlling and improving, and deal with its use from a broader perspective. This result corroborates the fact that the sample documents are lacking a broad performance measurement perspective. Scholars need to change and study the latest uses for PMS that focus on influencing agents and people's behaviors. These uses also highlight the lack of an approach looking at the whole of the supply chain, which is another alarming result.

The fifth point has to do with PMS processes. The findings show the dominance of the process for selecting and designing measures. Most articles present proposals for performance measures that reinforce previous findings. No article, however, develops the Bohdan metrics in accordance with PMS literature. Derqui and Fernandez (2017) and Naidoo and Gasparatos (2018) are exceptions in Cluster 1 because they deal with data collection and manipulation, the selection and design of measures, and communication management. Similarly, in Cluster 2, Hertog et al. (2014), Alamar et al. (2018) and Bohtan et al. (2019) deal with data collection and manipulation. Despoudi et al. (2018) is the only paper to address information management. The sample documents do not address performance evaluation or system review.

A sixth and final point is the scant attention that is paid to Industry 4.0 and its related terms, such as smart manufacturing or digitization, taken from sample authors. Only Naidoo and Gasparatos (2018) claim that retailers could take advantage of big data to improve their environmental performance by optimizing the supply chain. Hertog et al. (2014) also recognize radio frequency identification (RFID) as an enabler of rapid communication in the supply chain. The authors also admit that the application of cyber-physical systems is essential for a responsive and flexible supply chain and for reducing waste. There is no mention of communication technologies using cloud computing, blockchain, machine learning, artificial intelligence or human-machine interface. The sample articles do not mention techniques like additive manufacturing, virtual factories, or digital twins.

CONCLUSIONS

Using bibliometric and content analysis, the systematic literature review enabled us to respond to QP1: "What is the current state of experimental research into performance measurement systems for measuring food waste?" Current scientific production is incipient and has a low impact. Despite all the efforts by FAO/UN at the company

and food chain level, the sample document authors developed or used performance measures for several aims. They evaluate performance using mathematical models or empirical research, as well as showing the potential for sustainable benefits for economic purposes. Cluster 1 and Cluster 2 articles follow the literature recommendations on food waste and try to connect food waste and natural resources with the financial dimension. Performance measures are also elements of waste management and food losses.

With relation to QP2: "What are the challenges and trends in implementing performance measurement systems for measuring food waste?", few articles address performance measurement for proposing metrics or systems, or how to use them. Controlling essentially dominates the use of performance measurement, followed by improving. The traditional view of how to use PMS probably prevails over using it for improving and learning. The most common PMS processes are selecting and designing metrics, while performance evaluation and system review are unexplored by Cluster 1 and Cluster 2 authors. This emphasis is in line with the focus on performance measures rather than on PMS. Performance measures are generally used in isolation, with the financial dimension predominating. Even sustainable metrics are often used merely to establish causal relationships with financial measures. Results point to the need to move towards performance management, focusing on PMS and the influence of agents and people's behaviors. Finally, among the many challenges, the central goal is to move from measuring the performance of supply chain links to using a PMS for the entire supply chain. The findings indicate an avenue for developing research to reduce waste and mitigate the effects, thus helping reduce food insecurity.

Many opportunities for future investigations emerge in the search for answers to the proposed research questions. Most articles in the sample, especially in Cluster 1, address the final links in the supply chain (retailers, and public and household consumption). Even authors who deal with PMSs do so from a narrow supply chain scope, and often only address the immediate supply chain. Undertaking research that moves the scope to include the whole of the food supply chain is a demanding task. Data collection and manipulation, and information management processes were not the focus of the sample articles. These PMS processes can benefit from Industry 4.0 digital technologies. Digital technologies could measure food waste more accurately from the perspective of the entire food supply chain. Finally, the use of performance information should influence attitudes towards reducing waste, with mitigation of the environmental and economic effects. The focus when using a PMS should be on improvement and learning, with the intensive application of digital technologies in PMS processes. Although choosing the WoS scientific index might have limited our investigation, we believe that the additional number of papers that might have been included in the sample would not have substantially changed the results.

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DOES RESILIENCE IMPACT FOOD WASTE? MOVING THE DEBATE ON

Resiliência impacta a redução de desperdício de alimentos? Avançando o debate

¿La resiliencia afecta la reducción del desperdicio de alimentos? Avanzando en el debate

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ABSTRACT

The main purpose of this paper is to analyze the contributions of elements of resilience (EoRs) to food waste reduction practices (FWRP) and to deal with causes of food waste (FWC). Based on a systematic literature review, a content analysis process was carried out with 143 relevant papers. Three main EoRs were identified: knowledge management, collaboration and flexibility. Financial health and redundancy are factors which can increase food waste (FW). The ability to anticipate is the most important practice to develop. This paper is the first attempt to establish the role of EoRs in tackling food waste management, and to propose new avenues of research.

KEYWORDS | Food waste, resilience, retail, sustainability, elements of resilience.

RESUMO

O objetivo deste artigo é analisar as contribuições dos elementos da resiliência (ERs) para as práticas de redução de desperdício de alimentos (PRDAs) e para lidar com as causas de desperdício de alimentos (CDAs). A partir de uma revisão sistemática da literatura, realizou-se uma análise de conteúdo em 143 artigos. Entre os elementos que mais contribuem para as PRDAs, estão: gestão do conhecimento, colaboração e flexibilidade. Entretanto, saúde financeira e redundância podem aumentar o desperdício de alimentos (DA), e antecipação é a capacidade prioritária a ser desenvolvida. Este artigo é a primeira tentativa de estabelecer o papel dos ERs na redução do desperdício de alimentos, e uma agenda de pesquisa é proposta.

PALAVRAS-CHAVE */ Desperdício de alimentos, resiliência, varejo, sustentabilidade, elementos da resiliência.*

RESUMEN

El objetivo de este artículo es caracterizar y analizar cómo los elementos de resiliencia (ER) contribuyen a las prácticas de reducción (PRDA) y las causas de desperdicio de alimentos (CDA). Por medio de una revisión sistemática de la literatura, se realizó un análisis de contenido en 143 artículos. Entre los elementos que más contribuyen, están: gestión del conocimiento, colaboración y flexibilidad. Sin embargo, la salud financiera y la redundancia pueden aumentar el desperdicio de alimentos (DA) y la anticipación es la habilidad prioritaria a desarrollar. Este artículo es el primer intento de establecer el papel de los ER en la reducción del desperdicio de alimentos, y propone una agenda de investigación.

PALABRAS CLAVE */ Desperdicio de alimentos, resiliencia, minoristas, sustentabilidad, elementos de resiliência.*

INTRODUCTION

Tackling food waste (FW) has become a top priority on the agendas of various governments and economic sectors in their pursuit of achieving the UN's Sustainable Development Goals (SDGs). There is, however, no commonly agreed definition of food lost (FL) and food waste (FW). Both FL and FW refer to reductions in the quantity or quality of food in the food supply chain. FL generally refers to losses in the food supply chain from harvest up to - but not including - the retail level. FW, on the other hand, occurs in the final stages of the chain, such as during the distribution, sale, and/or consumption of the food. As this study analyzes distribution with a focus on retail, FW will be the term used herein (Food and Agricultural Organization of the United Nations - FAO, 2019). It is estimated that every month 25 kg of food are wasted per capita in both Europe and the United States, with figures of 18 kg in Latin America, and 10 kg in South and Southeast Asia (Gustavsson, Cederberg, Sonesson, Otterdijk, & Meybeck, 2011). Recognizing the significant levels of waste that are generated in food supply chains (Gustavsson et al., 2011) due to various factors, such as environmental instability, market dynamism and increasing globalization, new management approaches have been developed in order to optimize the use of organizational resources and maintain competitive advantage.

Resilience is one way in which supply chain performance can be managed and improved when facing different types of disruption (e.g., internal, external and environmental). In operations management, resilience is defined as the adaptive capacity of a supply chain to resist and deal with unexpected events (disruptions) while maintaining control over its structure and functions, and enabling it to recover and respond to such disruptions in order to restore the chain to its original (or better) state of operation (Christopher & Peck, 2004; Kamalahmadi & Parast, 2016; Ponomarov & Holcomb, 2009). Individuals and organizations can address disruptions or discontinuities better by utilizing the core elements of resilience (EoRs), i.e., the basic concepts that help develop the abilities required for anticipating, adapting and responding to, and recovering and learning from disruptions.

Resilience can be a means of ensuring that food production and distribution processes deal with the causes of waste, and respond to and recover from disruptions while achieving sustainable development goals (Food and Agricultural Organization of the United Nations - FAO, 2016). For instance, Mena, Adenso-Diaz and Yurt (2011) state that unexpected events, such as climate change and demand variability, are important causes of food waste. Visibility and flexibility are elements of resilience (EoRs) that can help minimize the impact of such events. On the other hand, the absence of EoRs, like trust, visibility and communication (Kamalahmadi & Parast, 2016) are highlighted by Canali et al. (2016) as causes of food waste.

Few existing studies (Macfadyen et al., 2016; Manning & Soon, 2016; Moraes, Costa, Silva, Delai, & Pereira, 2019) have focused on exploring whether resilience can reduce levels of food waste. The following are just some of the examples of previous areas of study within the field of resilience and FW. Moraes et al. (2019) explore the theoretical relationship between resilience and FW. They point out that studies on resilience and FW have generally been developed separately from each other, and that discussions on integrating these two topics are necessary in order to describe how resilience can influence FW, so that organizations can prepare to avoid waste and improve their operations. Gružauskas, Gimžauskienė and Navickas (2019) mention that adaptation – an aspect of resilience – improves the alignment of supply and demand and can reduce FW. These same authors

also highlight the need to maintain resilience in food systems in order to increase sustainability, while reducing FW. They address resilience as a means of preparing for upcoming market fluctuations and reducing the effects of such fluctuations on FW (Gružauskas et al., 2019).

Although a number of studies thoroughly explore the importance of EoRs (Ali, Mahfouz, & Arisha, 2017; Kamalahmadi & Parast, 2016; Scholten, Scott, & Fynes, 2014), and others deals with reductions in FW (Canali et al., 2016; Diaz-Ruiz, Costa-Font, López-i-Gelats, & Gil, 2019; Holweg, Teller, & Kotzab, 2016; Mena, Terry, Williams, & Ellram, 2014), discussions concerning the integration of these topics have not been found so far in extant literature. Hence, there is a need to explore how resilience contributes to the reduction in FW, so that organizations can implement practices to anticipate, prevent and reduce it.

There are typically lower rates of waste at the retail stage of the supply chain than at other stages, such as production and post-harvest (Stenmarck, Jensen, Quested, & Moates, 2016). Despite this, supermarkets are at the center of food systems and can exert significant influence on FW throughout a chain, making this area an important link to study (Gruber, Holweg, & Teller, 2015). Retailers are also able to understand consumers' decision-making processes better (Cunha, Spers, & Zylbersztajn, 2011), and influence their behavior by raising awareness of FW, for instance.

The objective of this article is to analyze the contributions of EoRs to food waste reduction practices (FWRPs) and deal with the causes of food waste (FWCs). The basis of this article is a systematic literature review (SLR) and it analyzes possible FW avoidance actions that can be implemented in retail chains. It contributes to the theoretical debate around FW by highlighting the role of resilience in helping retailers anticipate and respond to the causes of waste by avoiding and minimizing possible disruptions in their operations.

RESEARCH METHOD

An SLR was undertaken to understand the state of the current literature on EoRs and FW. In doing so, three macro-stages were used based on Tranfield, Denyer and Smart (2003). The first stage involved establishing the scope of the project in order to define the research problem, the research questions, and the review protocol. Four research questions were proposed:

Q1) What are the main elements required for building resilience in a supply chain?

Q2) What are the main causes of food waste in a supply chain?

Q3) What are the main practices for reducing and/or preventing food waste?

Q4) How do elements of resilience contribute towards reducing and/or preventing practices, and the causes of food waste?

Aiming to provide robust and reliable results, a review protocol (Exhibit 1) was developed that set out the details of all of the steps in the SLR., Several keywords (identified from the initial scope review) were listed for each research question covering the main points of interest. The keywords and codes used were extracted from the constructs of the research questions, and possible search strings were tested before defining the final versions. All of this information is available in Exhibit 2.

Exhibit 1. SLR Protocol

Stage	Details
Strategy for identifying studies	- Identify constructs (Exhibit 2); - Define keywords (Exhibit 2); - Develop search strings (Exhibit 2); - Search on Web of Science, Scopus, EBSCO Academic Premier, Scielo and Spell databases; - Search in 17-year period (2000 - 2017).
Selecting the studies	- 1st selection: titles, abstracts and keyword screening; - 2nd selection: introduction and conclusion; - 3rd selection: analysis of the quality of the journal, complete reading and evaluation of the quality of the article
Data extraction & monitoring process	- Read full paper; - Use QDA Miner (qualitative software) to code the content based on the results of the research questions.
Data synthesis	- Content analysis based on literature review by cross-referencing data from different concepts, discussion and authors; - Answer the review question based on what is known in the literature; - Highlight the relevant points and gaps in the literature.

Exhibit 2. Constructs, keywords and search strings

Construct/Research Question	Keywords Used	Search Strings
Supply Chain Resilience	Supply chain resilience; Resilient supply chain; Resilience; Supply resilience; Supply chain risk management; Risk management; Vulnerability; Supply chain vulnerability.	((("supply net*") OR ("value chain*") OR ("supply chain*")) w/3 (resilien* OR risk* OR vulnerabilit*))
FWC	Food supply chain; Food waste; Food loss; Food surplus; Food waste cause; Food waste source;	((("supply net*") OR ("value chain*") OR ("supply chain*")) AND ((food) W/5 (wast* OR surplus OR los*)) AND (cause* OR source* OR fount* OR origin* OR generat*))
Practices for reducing and/ or preventing food waste	Food supply chain; Food waste; Food loss; Food surplus; Reduce food waste; Waste minimization; Waste prevention; Waste reduction; Waste management; Reduction practices; Waste management practices; Prevention practices	((("supply net*") OR ("value chain*") OR ("supply chain*")) AND ((food) W/5 (wast* OR surplus OR los*)) AND (minimi* OR prevent* OR avoid* OR reduct* OR diminution* OR decrease* OR manag* OR practice* OR strateg* OR act* OR proce* OR police* OR initiative))
Supply Chain Resilience and FW	All the words mentioned before	((("supply net*") OR ("value chain*") OR ("supply chain*")) w/3 (resilien* OR risk* OR vulnerabilit*)) AND ((food) w/5 (wast* OR surplus OR los*))

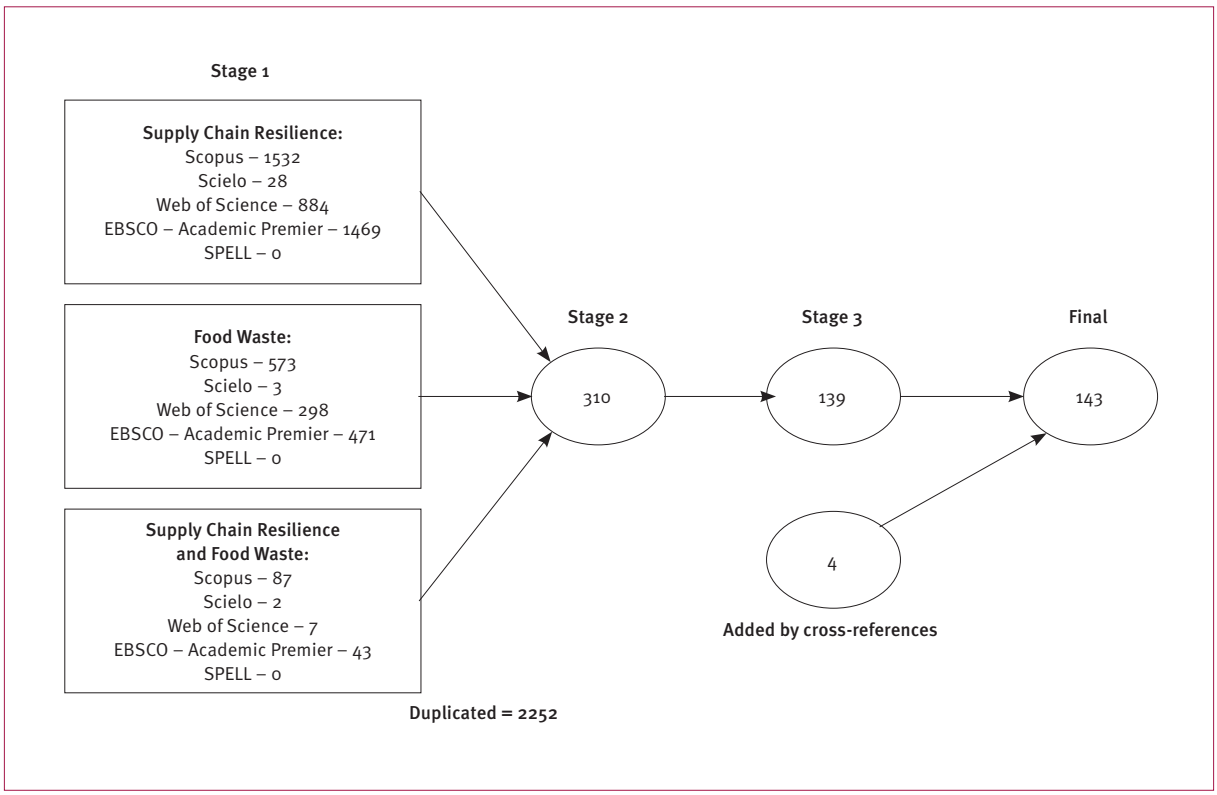
The search was conducted using five databases: Web of Science, Scopus, EBSCO, Scielo, and Spell, since combining sources provides better research results (Chadegani et al., 2013). The first two databases were chosen because they are regularly updated, and contain a wide breadth of coverage on most scientific subjects (Chadegani et al., 2013), besides offering powerful features for conducting searches and refining results (Boyle & Sherman, 2008). The EBSCO/Academic Premier database was considered because it is one of the most extensive databases in the field of management studies (Thomé, Scavarda, Fernandez, & Scavarda, 2012). Scielo and Spell were included as they provide specific information regarding emerging economies, such as Brazil, thereby enriching the results of the SLR. The study considered articles published between 2000 and 2017, recognizing that publications dealing with both resilience in supply chains and FW began to be published around 2000 at the earliest (Ali et al., 2017).

The second stage was carrying out the review. Three filters were used at this stage to select relevant papers (Exhibit 1), which were collected and read in full by two junior researchers. The general evaluation criteria used are detailed in Exhibit 3. Based on the keywords chosen, the initial search yielded 5,397 articles, of which 2,252 were duplicates. After applying the inclusion and exclusion criteria (Tranfield et al., 2003), 143 articles were ultimately selected, with four new articles being added by manual cross-referencing, as they were not identified using the established keyword strings. The general results of the search and filter process used are shown in Figure 1.

Exhibit 3. **General assessment criteria**

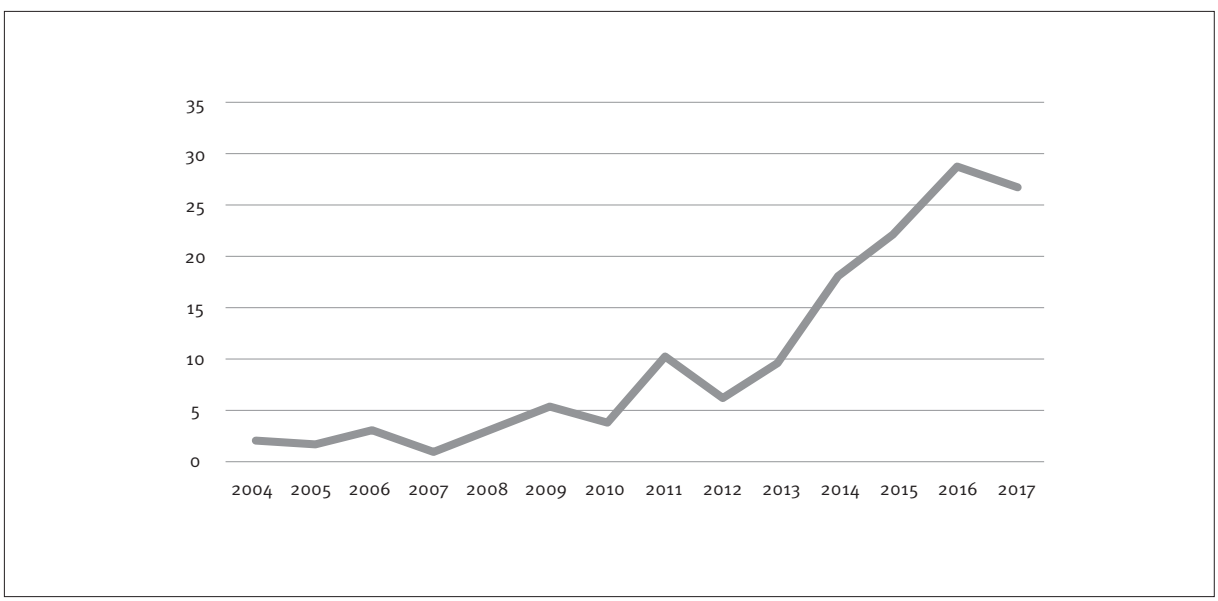
	Criteria	Inclusion Criteria	Exclusion Criteria
1	Focus	Dealing with resilience and/or FW in SCM, Operations Management and Sustainability..	Refers to resilience and/or management (reduction) of FW focusing on another area rather than supply chain and operations management.
	Resilience	Directly addresses resilience and/or includes elements for building up resilience.	Does not refer directly to resilience and/or management (reduction) of FW in the supply chain, does not consist of enablers for creating supply chain resilience.
	Food waste	Directly addresses the causes of FW in the supply chain and/or practices for reduction and prevention.	Does not directly address the causes of FW in the supply chain and/or practices for reduction and prevention.
2	Access	Has access to the paper, is written in English or Portuguese.	Does not have access to the paper, it is not written in English or Portuguese.
	Quality	Peer-reviewed scientific journals.	Scientific journals not peer-reviewed, business journals, current journals, conferences, books and websites.
	Theoretical framework	Concepts of resilience and/or FW in a context of operations management and/or supply chain management, sustainability as the focus of work.	Concepts referring to material science or the environment, physiology, psychology and human behavior, strength and urban studies.
	Unit of analysis	Supply chain resilience and/or waste focused on distributing products from the retail supplier, internally from retail and the final distribution by the retailer.	Deals with resilience and/or FW in communities, materials, environment or unrelated individuals to organizations.

Figure 1. **Results of the SLR filters**



An important aspect to highlight is the evolution of these topics over the years. Figure 2 depicts the historical distribution of the articles that were identified.

Figure 2. **The historical distribution of the articles identified**



The third stage included reporting and dissemination. The content analysis method was chosen to synthesize and communicate the results (Krippendorff, 2013). The full papers were input into QDA Miner (Qualitative Data Analysis software) for processing as part of content analysis. This software was used to divide up the articles at the sentence and text levels, according to the codifications created. The creation of codifications with branch levels enabled common patterns in the articles to be identified, and initial comparisons to be made. A scoping review was carried out to codify the articles considered in this research and, with the aid of senior researchers, a number of initial codifications were identified and used to create a codebook.

Codes were added, withdrawn or combined during the detailed reading of the articles. As this research began with a small group of previously defined categories and underwent changes during the coding process, both concept-driven coding, which starts from a group of previously defined codes and seeks to extract them from texts, and data-driven coding, where the research begins without any pre-defined codes, but allows them to 'emerge' from the literature, were used (Gibbs, 2009).

To ensure the accuracy and reliability/validity of the coding process, two researchers read and coded all the articles and reviewed each other's encodings (Krippendorff, 2013). To guarantee that all relevant excerpts from the articles were coded, and to answer possible doubts about certain codified sections, three senior researchers reviewed the results. Proximity plots were used to identify the relationships between the constructs studied. This type of graph presents the proximity of encodings across the texts studied, or co-occurrences among the constructs, thus enabling an understanding and illustration of the elements that are most frequently associated with the main FWCs and the practices of reduction and/or prevention (QDA Miner, 2017).

The coefficient of co-occurrence was calculated based on Jaccard's coefficient, which attributes equal weight to cases where co-occurrence is identified and cases where one item is found but not the other (Chen, Ibekwe-SanJuan, & Hou, 2010). By codifying the articles and identifying the sections that referred to elements of resilience, causes of waste and prevention practices, the relationships between these three main constructs could be analyzed.

To facilitate this analysis, the intersections between the elements of resilience and the causes and practices of reducing and preventing FW were classified using Ishikawa groups. Table 1 shows the proximity values generated from the content analysis with the aid of QDA Miner software. The numbers highlighted in Table 1 represent the relationships that are within 80% in terms of proximity values, and that are the focus of the discussion in this article. The numbers in bold indicate the use of the Pareto principle to select elements that represent 80% of the total proximity between the elements (Defeo & Juran, 2010), the causes and practices of each Ishikawa (1986) group of causes; these elements are discussed throughout this article.

Proximity reports were generated in pairs in order to conduct this analysis – first between EoRs and FWCs, and then between EoRs and FWRPs. The EoRs with the greatest influence on both FWCs and FWRPs are detailed in the following section.

Table 1. **Intersections between the elements of resilience and the Ishikawa groups (causes and practices)**

		machine_ cause	machine_ practice	method_cause	method_ practice	people_cause	people_ practice
Element	Supply chain structure	0,206	0,006	0,783	0,237	0,066	
	Flexibility	0,133	0,016	0,545	0,251		
	Leadership	0,111		**0,619**	**0,301**	0,310	
	Collaboration	0,100		**0,598**	**0,455**	0,057	
	Knowledge management	0,059		**0,522**	**0,310**	**0,338**	**0,043**
	Visibility	0,151	0,014	0,403	0,242	0,109	
	Sensing	**0,133**	**0,063**	0,295	0,337		
	Trust	0,063		0,519			
	Communication	0,061		0,433	0,229		
	Innovation	0,181		0,273	0,247	0,066	
	Security Technologies	**0,248**	**0,087**	0,326	0,210	0,115	
	Agility	0,111	0,042	0,388	0,331	0,109	
	Risk management	0,127		0,361			
EB	Redundancy	0,112		0,512	**0,356**	0,205	
	Financial Strength	0,057		**0,481**	**0,362**	**0,121**	**0,111**
Total		1,853	0,228	7,058	3,868	1,496	0,154

		material_ causa	material_ practice	measurement_ cause	measurement_ practice	environment_ cause	environment_ practice
Element	Supply chain structure	0,094	0,020	0,117		0,079	
	Flexibility	0,149	0,025	**0,190**	**0,031**	0,130	
	Leadership	0,049		0,102		0,072	
	Collaboration	0,066	0,025	0,157	0,025	0,111	
	Knowledge management	0,028		0,071		0,071	
	Visibility	**0,142**	**0,027**	0,227	0,027	0,120	
	Sensing	0,015		**0,237**	**0,038**	0,167	
	Trust	0,016		0,054			
	Communication	**0,081**	**0,051**	0,092	0,029	0,084	
	Innovation	**0,171**	**0,061**	0,095	0,034	0,120	
	Security Technologies	0,071	0,026	0,056	0,026	0,071	
	Agility	0,236		0,101	0,028		
	Risk management	0,050		0,072		0,162	
EB	Redundancy	0,046		0,173		0,068	
	Financial Strength	0,025		0,074		0,218	
Total		1,239	0,235	1,818	0,238	1,473	

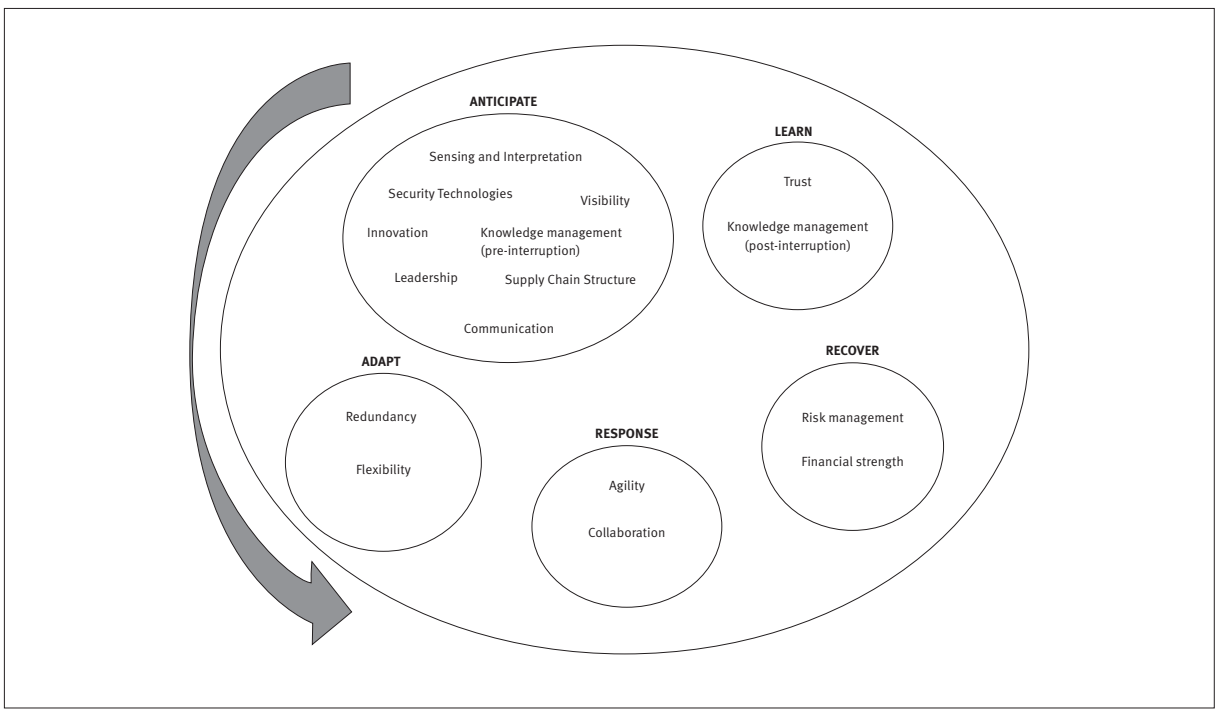
RESULTS AND DISCUSSIONS

This section presents the results of the SLR, which are organized in order to answer the four research questions proposed above.

Elements of resilience (EoRs)

Disruptions in the flow of goods, services and/or information are sudden and unexpected events that can cause a supply chain to fail in its mission to deliver products and/or services to its customers according to specified locations, quantities, time and defined costs (Ponomarov & Holcomb, 2009). EoRs might be organized in terms of abilities, such as the anticipation of, adaptation and response to, and recovery and lessons learned from disruptions. Figure 3 was based on the abilities and elements of resilience that were identified and classified by Ali et al. (2017), combined with other elements that were found in the extant literature.

Figure 3. **Elements of resilience**

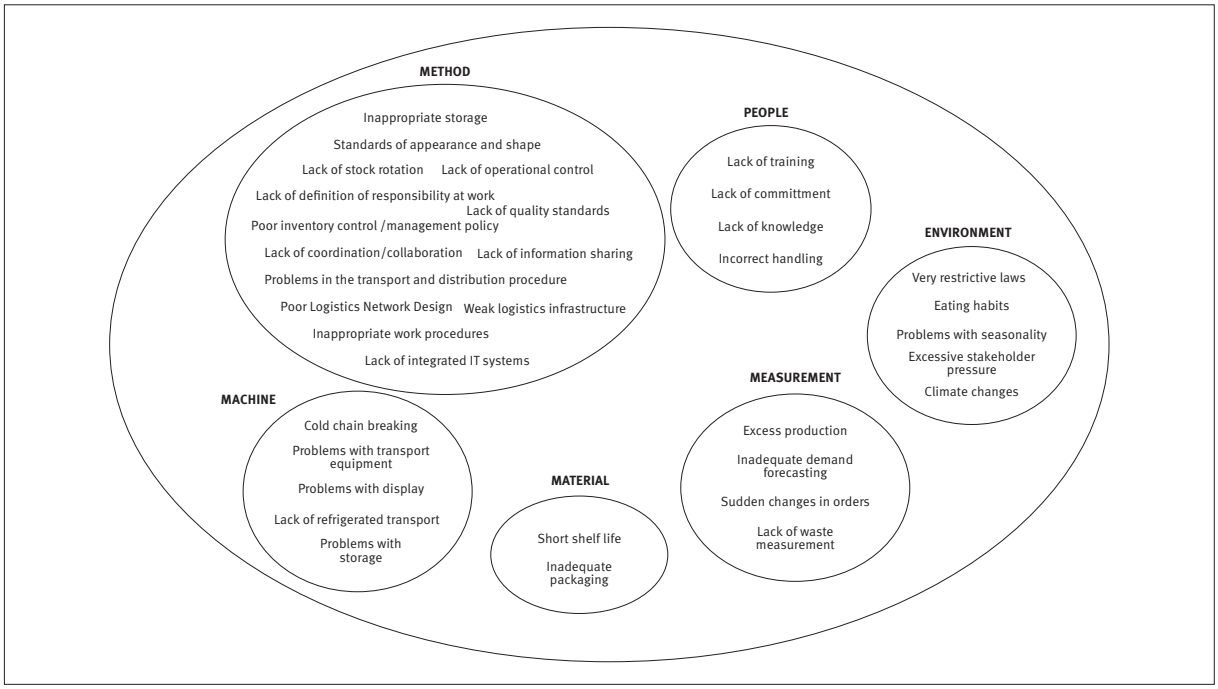


Source: Adapted from Ali et al. (2017).

Food Waste Causes (FWCs) and Food Waste Reduction Practices (FWRPs)

Figures 4 and 5 were developed based on the FWCs and FWRPs identified in the articles of the Systematic Literature Review, following the codebook presented in the methodology section, which were later classified into Ishikawa groups to facilitate analysis, following the method used in the Systematic Literature Review performed by Moraes, Costa, Pereira, Silva and Delai (2020). The main FWCs identified are shown in Figure 4. To better identify and group these causes, the model developed by Bilska, Wrzosek, Kołożyn-Krajewska and Krajewski (2016) was followed. Using this method, it is possible to discover, organize and summarize a group's knowledge about the possible causes that contribute to FW.

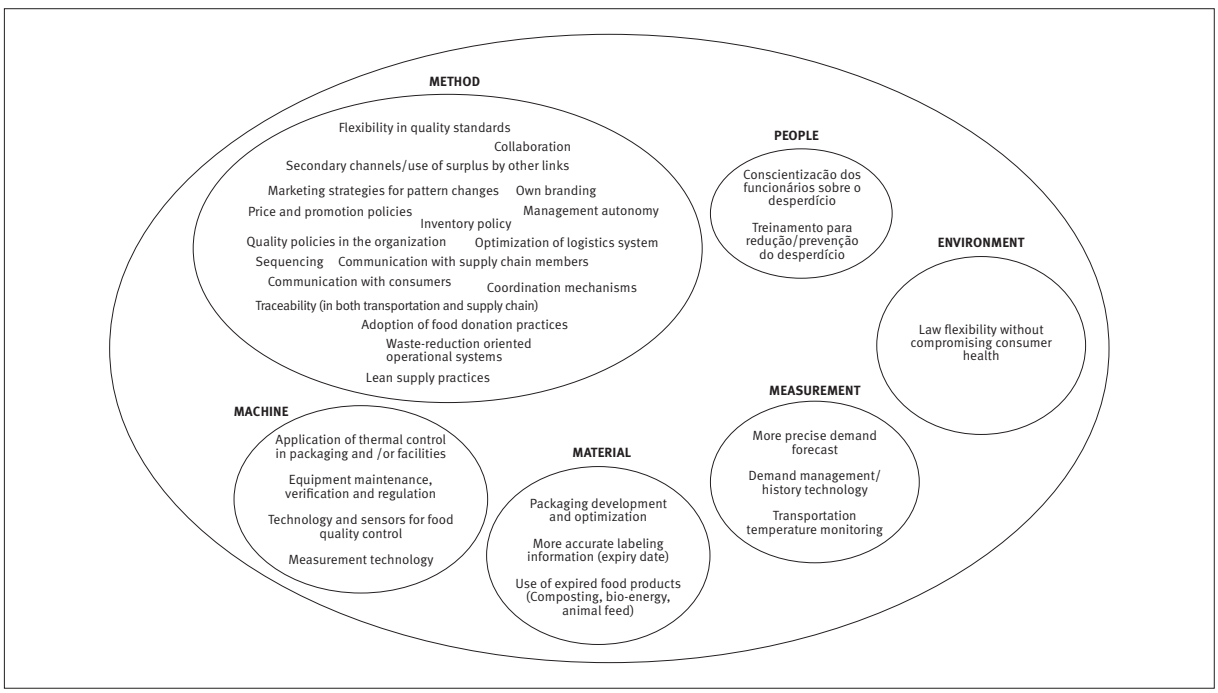
Figure 4. **FMC**



Source: Adapted from Moraes et al. (2020) and Bilska et al. (2016).

The main FWRPs identified are shown in Figure 5.

Figure 5. **FWRP**



Source: Adapted from previous SLR Moraes et al. (2020)

How do elements of resilience contribute towards minimizing food waste in the supply chain?

This section characterizes and analyzes how EoRs contribute to FWRPs and, consequently, to reducing FWCs. In doing so, EoRs are organized in terms of abilities (anticipation, adaptation, response, recovery and lessons) (Ali et al., 2017). Exhibit 4 shows the relationships generated by these proximities and presents only the relationships found between EoRs, FWRPs, and FWCs.

Exhibit 4. **Intersections between EoR, FWRP and FWC**

	EoR	FWRP	Clas.	FWC	Clas.
ANTICIPATE	COMMUNICATION	Packaging development and optimization	MAT	Inadequate packaging	MAT
				Short shelf life	MAT
		More accurate labeling information (expiry date)	MAT	Inadequate packaging	MAT
				Short shelf life	MAT
	INNOVATION	Packaging development and optimization	MAT	Inadequate packaging	MAT
				Short shelf life	MAT
	KNOWLEDGE MANAGEMENT	Communication with supply chain members	MET	Lack of information sharing	MET
		Communication with consumers	MET		
		Training for waste reduction/prevention	PEO	Lack of training	PEO
				Lack of knowledge	PEO
		Employee awareness of waste	PEO	Lack of training	PEO
				Lack of knowledge	PEO
	LEADERSHIP	Management autonomy	MET	Lack of coordination/ collaboration	MET
				Appearance and shape standards	MET
				Inappropriate work procedures	MET
				Lack of operational control	MET
		Quality policies in the organization	MET	Lack of coordination/ collaboration	MET
				Appearance and shape standards	MET
				Inappropriate work procedures	MET
				Lack of operational control	MET
	SECURITY TECHNOLOGIES	Technology and sensors for food quality control	MAC	Cold chain breaking	MAC
	SENSING	Technology and sensors for food quality control		Cold chain breaking	MAC
		More precise demand forecast	MEAS	Inadequate demand forecasting	MEAS
	VISIBILITY	Packing development and optimization	MAT	Inadequate Packing	MAT

Continue

Exhibit 4. **Intersections between EoR, FWRP and FWC**

Concludes

	EoR	FWRP	Clas.	FWC	Clas.
ADAPT	FLEXIBILITY	Secondary channels/use of surplus by other links	MET	Poor Logistics Network Design	MET
				Poor inventory control / management policy	MET
				Lack of stock rotation	MET
		Inventory policy	MET	Poor Logistics Network Design	MET
				Poor inventory control / management policy	MET
				Lack of stock rotation	MET
		More precise demand forecast	MEAS	Excess production	MEAS
				Inadequate demand forecasting	MEAS
				Sudden changes in orders	MEAS
	REDUNDANCY (BARRIER)	Inventory policy	MET	Poor inventory control / management policy	MET
RESPOND	COLLABORATION	Collaboration	MET	Lack of information sharing	MET
				Lack of coordination/ collaboration	MET
		Adoption of food donation practices	MET	Lack of information sharing	MET
				Lack of coordination/ collaboration	MET
		Communication with supply chain members	MET	Lack of information sharing	MET
				Lack of coordination/ collaboration	MET
RECOVER	FINANCIAL STRENGTH (BARRIER)	Inventory policy	MET	Problems in the transport and distribution procedure	MET
		Optimization of logistics system		Inappropriate work procedures	MET
		Training for waste reduction/prevention	PEO	Lack of training	PEO
				Lack of knowledge	PEO
				Lack of commitment	PEO
	Ishikawa Classification	MET – METHOD	MEAS – MEASURE		
		MAC – MACHINE	ENV - ENVIROMENMENT		
		MAT - MATERIAL	PEO – PEOPLE		

Anticipate

According to Ali et al. (2017), this ability encompasses elements that are proactive in identifying ruptures and changes in the environment. As a consequence, these interruptions do not affect supply chain operations, thus avoiding FW. Seven elements of the ability to anticipate were found that relate to FWRPs and FWCs, as follows.

Communication

Communication refers to the exchange of information required to reduce asymmetries between manufacturers and suppliers (Wieland & Wallenburg, 2013). Since FW is produced at all links in the supply chain, FWRPs should include communication between these links (Aiello, Enea, & Muriana, 2015; Derqui, Fayos, & Fernandez, 2016). For example, more accurate shelf-life information on labels can reduce information asymmetries among suppliers, retailers, and consumers. Clear date labels and storage instructions are also essential for the correct storage of food until its consumption (Aschemann-Witzel, Hooge, & Normann, 2016). Communication between links in a food supply chain can improve the development of packaging. As a result, more efficient distribution packaging can reduce shipping and handling damage, which increase waste. An example of efficient packaging is prepacked vegetables and fruit, which reduces handling and improves turnover in stores (Verghese, Lewis, Lockrey, & Williams, 2015).

Innovation

Innovation is related to the creation/adoption of new products, processes or packaging, and improvements in technologies, which generate adaptability (Golgeci & Ponomarov, 2013; Kamalahmadi & Parast, 2016). Innovation enables the optimization of food packaging for better quality monitoring, appropriate ventilation and temperature control, and increased shelf life for fresh produce (Shafiee-Jood & Cai, 2016). Further innovations include efficient distribution packaging to reduce transportation and handling damage, more appropriate serving sizes and clearer labels indicating contents and shelf life, to avoid consumer waste (Verghese et al., 2015).

Security technology

This EoR refers to early defensive mechanisms, such as global positioning systems and digital/information security (Rajesh & Ravi, 2015). The primary application of sensing systems is for monitoring the attributes of food products (Raak, Symmank, Zahn, Aschemann-Witzel, & Rohm, 2017). The use of these sensors reduces FW caused by fluctuating temperatures during transportation and storage. Jedermann, Nicometo, Uysal and Lang (2014) mention that a data logger with a built-in sensor is crucial for monitoring and adjusting deviations in produce temperature along the chain.

Leadership

Leadership, or the commitment to and support of the company's top managers in the creation and maintenance of chain resilience (Christopher & Peck, 2004; Kamalahmadi & Parast, 2016; Scholten et al., 2014), can influence FWCs and FWRPs, insofar as they can have a direct impact on management's autonomy and commitment to develop and implement a quality policy. By carrying out regular management reviews and guaranteeing adequate resources (Bilska et al., 2016; Göbel, Langen, Blumenthal, Teitscheid, & Ritter, 2015; Gruber et al., 2015), the supply chain can reduce the causes of FW, such as inappropriate work procedures, a lack of operational control/information sharing/coordination/collaboration, and changes in the appearance and shape of food.

Sensing

Sensing (detecting problems) involves interpreting events, planning for the continuity of operations and mapping out the vulnerabilities of the supply chain (Ali et al., 2017). This element is influential in implementing food waste reduction practices, such as using technologies and sensors to evaluate the condition of the food, allowing for problems to be interpreted (equipment/process), and response and control strategies to be defined (Ali et al., 2017; Derqui et al., 2016).

This aspect also influences the measurement, interpretation, and analysis of sales and production forecasts, as well as monitoring and perceiving changes in demand (Raak et al., 2017). It assists in analyzing the information collected about supply, demand, and quantities wasted, and in decision-making based on the information obtained from this monitoring (Hodges, Buzby, & Bennett, 2011).

Visibility

This aspect enables companies to identify risks, demands and other crucial information for supply chain management and control (Kamalahmadi & Parast, 2016; Pettit, Fiksel, & Croxton, 2013). Bilska et al. (2016) argue that visibility helps in planning the use of resources, equipment and processes. A clear understanding of the supply chain and consumers allows those areas to be identified that require more appropriate information in terms of labels and product presentation on the shelves (Mena et al., 2014; Verghese et al., 2015).

Knowledge management

This aspect includes reviewing the company's leadership policies and factors related to managers' accumulated knowledge, the goal being to take effective action in case of disruptive events (Sahu & Mahapatra, 2017; Scholten et al., 2014). Scholten et al. (2014) found that previous experience, lessons learned and training can all assist in recovering from disruptions. According to both Scholten and Schilder (2015) and Kamalahmadi and Parast (2016), the ability to manage knowledge derives from training, access to information, or experience gained from previous disruptions. It reflects the need for organizations to share information with other links in their supply chains, as knowledge often tends to be limited to only a few individuals, thereby increasing the frequency of causes related to the lack of information sharing (Canali et al., 2016).

Waste reduction and prevention campaigns have either been inspired by previous initiatives or recognized by subsequent ones (Thyberg & Tonjes, 2016). According to Aschemann-Witzel et al. (2016), this reinforces the importance of promoting and facilitating the dissemination of knowledge about existing initiatives throughout the chain. Employees' knowledge of safe handling helps reduce FW (Bilska et al., 2016). The extent to which managers and employees are aware of safe food handling and know how to communicate issues make it possible to exchange ideas about preventing and reducing FW (Gruber et al., 2015).

Bilska et al. (2016) posit that training should be conducted regularly in order to update knowledge, implement behavioral changes and enhance employee commitment to the task of preventing FW. The knowledge accumulated by managers and those in higher positions can positively influence waste reduction and can be passed on to employees and to other agents in the chain for decision-making (Gardas, Raut, & Narkhede, 2017).

Adapt

This ability encompasses the concurrent capabilities required to continually manage and adjust critical supply chain resources during disruptions, by adapting to change quickly and readily (Ali et al., 2017). Two elements belonging to the ability-to-adapt category were found to be related to FWRP and FWC.

Flexibility

Flexibility, or the ability to alter a process, product/supplier or customer/logistic network, may impact the journey of products to secondary markets, which can be ensured by having flexible logistics networks, and by firms' internal processes for reclassifying products as capable of being destined for other markets (Garrone, Melacini, & Perego, 2014). In other words, flexibility enables surplus products or products that have lower quality standards to be reclassified or repurposed, which in turn reduces waste. Holweg et al. (2016) state that flexibility allows products to be repurposed for other areas, thus contributing to reducing waste generated by errors or unexpected changes in demand.

Redundancy as a barrier

The literature reviewed supports the idea that this element can negatively influence reduction practices; it does not contribute towards reducing waste, and may even increase it. According to Gruber et al. (2015), this is because managers request a higher quantity of products to guarantee a temporary 'safety stock'. Mena et al. (2014) posit that there is a tendency to keep excess stocks because managers prefer to lose surplus products, rather than lack products that are needed. They also suggest that changes in this behavior could help reduce waste.

Redundancy can hinder certain practices at one stage in the supply chain, thus leading to FW in others. For instance, this can occur when the inventory level at a retail store is reduced and permanent availability from suppliers' inventories is required, thus transferring the risk of deterioration to an earlier stage of the chain (Göbel et al., 2015).

Respond

This ability encompasses the concurrent elements needed to react to supply chain events quickly and efficiently to lessen the impact of disruptions. It refers to a company's immediate response to sudden and significant shifts in the environment in the form of uncertain demand, maintaining control and offering a first response to disruptions (Ali et al., 2017). Collaboration in this area was found to be related to FWRP and FWC.

Collaboration

Since waste can be produced at all stages of the chain, *collaboration* – individuals or entities working effectively together and obtaining mutual benefit in disruption situations (Johnson, Elliott, & Drake, 2013; Pettit et al., 2013) – is necessary. Collaboration influences both the primary topics, as the actions of one link in a chain can contribute either positively or negatively to the other links (Aiello et al., 2015). A lack of collaboration can generate a context whereby each company involved will try to optimize its processes, leading to the accumulation of waste in the pre-and post-chain stages (Göbel et al., 2015). Therefore, there is a need to collaborate with logistics partners and suppliers (Derqui et al., 2016; Gruber et al., 2015).

Moreover, federal, state and local government agencies need to collaborate with both the private sector (retail, community groups, NGOs and the waste industry, for instance) and the public sector to make joint efforts to tackle FW and accept shared responsibility (Hodges et al., 2011).

Recover

This ability refers to reactive elements that are essential in the aftershock of a disruption in order to assess the plans that can be activated in this phase (e.g., adjustments in product market share and organizational efficiency, supply chain reconfiguration, scenario analysis) (Ali et al., 2017). In this area, financial health was found to be related to FWRP and FWC, although it acted as a barrier.

Financial health as a barrier

This element entails the firm's ability to absorb possible fluctuations in its cash flow, provide economic incentives and maintain additional suppliers (Pettit et al., 2013). Financial health can be considered to be a barrier, because economic efficiency prevails in decision-making and may restrict various investments that are needed for implementing reduction practices. This may encourage the use of cheaper logistics systems or means of transport, and lead to failures in inventory, forcing food product to travel longer distances, require more frequent manipulation, and so increase the risk of causes related to the method group (Mena et al., 2011).

This is an important factor behind the lack of investment in training, and monetary and non-monetary benefits, such as bonuses for employees. Gruber et al. (2015) found that, according to retailers, it is cheaper to throw food away than to invest in staff training for addressing FW issues.

RESEARCH AGENDA

This study identified several relationships between resilience and the reduction in FW. The following are some of the key findings and suggested research directions for future development of the field. First of all, considering the number of related causes (see Exhibit 4), the conclusion is that four EoRs (leadership, knowledge management, collaboration and flexibility) are broadly related to FWRP and FWC. The first two elements have a greater influence on the method and people cause/practice groups, while collaboration plays an important role in the method group (particularly in coordination and communication), while flexibility contributes to the method and measurement groups.

Second, the majority of the EoRs that help reduce FW relate to the ability to anticipate it, since a higher number of relationships was identified in this phase. This result differs from the perception that FW is generally an unavoidable consequence of uncontrollable events, as cited by Muriana (2017). Thus, considering the ability to anticipate it, it is possible that companies can respond in advance to the occurrence of waste, and only in secondary cases consider food recovery, donation (Aiello et al., 2015; Bilska et al., 2016; Garrone et al., 2014) or industrial uses (Girotto, Alibardi, & Cossu, 2015).

Third, with regard to the Ishikawa classification of FWCs and FWRPs, it was observed that most of the causes and practices identified were classified in the method group. This predominance indicates the large influence that the internal working methods of retail companies – such as procedures and policies related to quality, logistics,

product display procedures, management and the measurement of waste – have on the generation of FW, as identified by Moraes et al. (2020). The second most widely relevant group is linked to people, which highlights the need to expand internal engagement in organizations, mainly by developing practices such as training for waste reduction/prevention, and employee awareness of waste. These actions should also be extended to encompass all tiers in the supply chains, which enables a systemic approach to the food chain to be developed and incentivized.

We found that the elements of resilience can influence FWCs and FWRPs both positively and negatively. Most of the elements of resilience that help reduce FWCs are classified in the ability to anticipate, as defined by Ali et al. (2017). We corroborate the work on FW of Holweg et al. (2016), who pointed out that as food has a short shelf life, it loses its value if it is not sold, processed or donated in a timely manner. When disruptions happen, therefore, waste will occur if there is no quick and effective response to them. In order to avoid waste, the impact of breakages in the chain must be minimized, or avoided before they occur, so the ability to anticipate FW should be emphasized in food supply chains.

Finally, the following are suggestions for advancing the research agenda with regard to how EoRs can influence FWRPs and/or FWCs. We developed these suggestions taking into account the results previously mentioned and the general finding that EoRs and FW have so far been studied in a disconnected and incipient fashion. Highlighting major topics that have not been discussed in the existing literature, the following are suggested avenues for future research:

- Leadership, knowledge management, collaboration and flexibility may assist focal companies design the structure of supply chains in an attempt to reduce FW. According to Scavarda, Ceryno, Pires and Klingebiel (2015), members of a supply chain may compromise the building of resilience in the chain as a whole, so it is important to align the resilience abilities of all members of the chain.
- Leadership, knowledge management, collaboration and flexibility are the main EoRs for dealing with the FWRPs and FWCs resulting from various sources. Future studies could analyze which digital and virtual technologies might help retailers improve coordination and information sharing within and across a supply chain, and how.

In-depth studies addressing the EoRs mentioned (see Exhibit 4) could be carried out to identify best practices in order to develop guidelines for retailers on how to apply them for reducing FWCs. These practices include: communication with members of the chain, training for waste reduction/prevention and employee awareness of waste, management autonomy, company quality, secondary channels/usage practices by other links, and more accurate demand forecasts.

It is worth studying critical success factors in depth in order to develop EoRs aimed at the method and people groups of causes.

It is also important to investigate whether or not companies have adopted EoRs as a means of achieving sustainable FW development goals, in particular zero hunger and responsible consumption and production.

Studying these matters using theoretical approaches is another possible research avenue. The Resource Dependency Theory could be useful for observing the influence of external resources on retailers, and whether there is a dependency relationship between the various organizations that go to make up the chain (Pfeffer & Salancik, 2003). Another opportunity could be the use of the Resourced Based View to understand the internal conditions

of a firm; being able, for example, to develop resilience abilities by observing and analyzing how resources are acquired, combined and applied, and result in competitive advantage (Barney, 1991).

Expanding the focus of analysis beyond retail to observe the food supply chain as a whole, including production, processing, distribution and consumption aspects. This can be useful for analyzing whether EoRs and FW act differently in different supply chain links. In this case, culture is an important variable to be considered.

FINAL COMMENTS

The key theoretical contribution of this article is that it identifies the synergy that exists between resilience and the reduction in food waste. In this sense, this research sought to unify the resilience literature (specifically its elements) as an approach for explaining the problem of food waste in supply chains (specifically in the retail link). It was pointed out that not all EoRs can help reduce food waste, as is the case with redundancy and financial health. Most of the elements that help reduce food waste are related to the ability to anticipate it. This finding differs from the view that food waste is generally considered to be an unavoidable consequence of uncontrollable factors. Managerially, it helps retail managers better identify which practices are appropriate for mitigating the causes of FW and developing certain EoRs.

As with all research, this study has certain limitations. First, the unit of analysis used covers only a part of the supply chain and its specific problems related to food waste. Despite being part of a larger research study, this article does not include empirical data, the present results being limited to a theoretical focus. Second, it cannot be inferred that there is no relationship between EoRs, FWRPs and FWCs for elements that are not discussed in this article.

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FOOD WASTE: EVIDENCE FROM A UNIVERSITY DINING HALL IN BRAZIL

Desperdício de alimentos: Evidências de um refeitório universitário no Brasil

Desperdicio de alimentos: Evidencias de un restaurante universitario en Brasil

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ABSTRACT

Studying the causes of food waste and potential interventions for minimizing it is one of the main concerns of those who work with food on all levels. Food in the education sector, which includes dining halls in higher education institutions, is among the sectors that deserve attention, since its consumers generate significant amounts of food waste. There is still a lack of studies, however, addressing the problem of food waste in dining halls. The general objective of this study is to investigate food waste in a Brazilian university dining hall, and consumer perceptions of the meals. By means of a questionnaire, it was possible to investigate the main perceptions of consumers, and what might be behind the waste generated. Spearman's correlation was performed in order to verify the correlation between consumer food waste and consumer perceptions as to the reasons behind the food waste that is generated. It was found that average waste was 68g/consumer. It was also observed that consumers who placed their food in trays wasted more food than those who chose to eat from a dish. All the collected information was used to propose potential interventions to reduce food waste in university dining halls.

KEYWORDS | Food waste, university, dining hall, perception, consumers.

RESUMO

O estudo das causas do desperdício alimentar e das potenciais intervenções para a sua minimização está entre as preocupações centrais daqueles que trabalham com alimentos. A alimentação na educação, que inclui os refeitórios das universidades, está entre os setores que merecem atenção, uma vez que quantidades significativas de alimentos são desperdiçadas pelos consumidores. Entretanto, ainda há uma escassez de estudos que abordem o problema. Este estudo teve como objetivo geral investigar o desperdício de alimentos em um refeitório de uma universidade brasileira, bem como a percepção dos consumidores em relação às refeições servidas. Por meio de um questionário, foi possível investigar quais as principais percepções dos consumidores, e o que poderia estar por trás da geração do desperdício. Utilizou-se a correlação de Spearman a fim de verificar a correlação entre o desperdício alimentar e a percepção dos consumidores sobre as razões por trás da geração do desperdício. Verificou-se um desperdício médio de 68 g/ consumidor. Além disso, foi observado que os consumidores que colocavam os alimentos em bandejas desperdiçavam mais alimentos do que aqueles que optavam por comer em pratos. As informações coletadas foram utilizadas para propor potenciais intervenções voltadas à redução do desperdício de alimentos em refeitórios universitários.

PALAVRAS-CHAVE */ Desperdício de alimentos, universidades, refeitório, percepção, consumidores.*

RESUMEN

El estudio de las causas del desperdicio de alimentos y las posibles intervenciones para reducirlo al mínimo son algunas de las preocupaciones centrales de quienes trabajan con alimentos. La alimentación en la educación, que incluye los restaurantes de las universidades, es uno de los sectores que merecen atención, ya que los consumidores desperdician cantidades importantes de alimentos. Sin embargo, todavía hay escasez de estudios que aborden el problema. Este estudio tenía el objetivo general de investigar los residuos de comida en una cafetería de una universidad brasileña, así como la percepción de los consumidores sobre las comidas servidas. Mediante un cuestionario se pudo investigar cuáles eran las principales percepciones de los consumidores y cuáles podían estar detrás de la generación de desechos. La correlación de Spearman se realizó con el fin de verificar la correlación entre el desperdicio de alimentos y la percepción de los consumidores sobre las razones que motivan la generación de desechos. Se verificó un promedio de desperdicio de 68g/consumidor. Además, se observó que los consumidores que ponían comida en bandejas desperdiciaban más comida que los que elegían comer en los platos. La información reunida se utilizó para proponer posibles intervenciones para reducir el desperdicio de alimentos en los comedores universitarios.

PALABRAS CLAVE */ Desperdicio de alimentos, universidades, restaurante, percepción, consumidores.*

INTRODUCTION

It is estimated that 1.3 billion tons of food are lost or wasted annually, which is equivalent to 30% of the world's food production, with a monetary value that equates to US$ 750 billion (FAO, 2013). As food production is resource intensive, food losses and waste are indirectly accompanied by an extensive variety of environmental, social and economic impacts (Schanes, Dobernig, & Gözet, 2018).

Food waste is commonly grouped into three categories (Richter & Bokelmann, 2016): (i) avoidable, (ii) possibly avoidable, and (iii) unavoidable food waste. Some studies argue that only the avoidable and possibly avoidable waste comprises food that is considered edible under normal conditions (Grandhi & Singh, 2016). Unavoidable food waste is the waste from food that is inedible under normal circumstances (e.g., bones) (Brancoli, Rousta, & Bolton, 2017). Papargyropoulou, Lozano, Steinberger, Wright and Ujang (2014) mention the relevance of distinguishing between avoidable and unavoidable food waste as a key factor in any food waste prevention strategy.

The amount of food lost or wasted diverges between countries and can be influenced by factors such as income levels, industrialization and development (Chalak, Abou-Daher, Chaaban, & Abiad, 2016). Different definitions and a lack of standards for data collection around the world make it difficult to understand the scope of food losses and waste. Food losses are generally attributed to inadequate agricultural practices, technical constraints, financial and labor constraints, and inadequate infrastructure for storage, processing and transportation (Chaboud & Daviron, 2017; Gustavsson, Cederberg, Sonesson, Otterdijk, & Meybeck, 2011). For some authors, food waste is mainly driven by consumers' values, behaviors and attitudes (Chaboud & Daviron, 2017; Gustavsson et al., 2011).

Brazilian food waste started being studied in a more intense way in the late 1990s, when food security became more widely debated in Brazilian society (Porpino, Parente, & Wansink, 2015). In 2003, the *Fome Zero* (Zero Hunger) program was created to ensure the implementation of food security policies (Porpino et al., 2015), and in 2014 Brazil was removed from the World Hunger Map for the first time. The number of undernourished people in Brazil fell by more than 80% in ten years. The new status was achieved through a combination of public policies and an increase in food supply in the domestic market, as a result of the excellent agricultural production performance in Brazil (Porpino et al., 2015).

No in-depth food waste studies in university settings have ever been carried out (Stockli, Dorn, & Liechti, 2018). Deliberator, Batalha, Mozambani, Müller and Fontenelle (2018), for example, conducted an extensive systematic review of the literature in the management area using five databases and found few articles that address food waste in university dining halls. Their findings did show, however, an evolution in the number of publications over the years and potential areas of study. In order to reduce food waste, it is necessary to quantify the waste generated (Eriksson et al., 2018). Any examination of food waste in service institutions, however, calls for accurate data (Eriksson et al., 2018). Some studies are based mainly on qualitative observations (Hanks Wansink, & Just, 2014). Indeed, the scope and research methods used for quantifying food waste in previous studies vary.

Food waste research was initially performed in the education and health sectors (Mirosa, Munro, Mangan-Walker, & Pearson, 2016). Here, the education sector was considered as an object of study. A number of studies have previously been carried out in the education sector, with different objectives. For example, Thiagarajah and Getty (2013) investigated how changing the service system could reduce food waste in the Indiana University (United States) dining hall; Babich and Smith (2010) tried to understand the University of Southern Illinois' dining hall sustainability process (United States); and Jagau and Vyrastekova (2017) proposed implementing an information

campaign to increase awareness of the food waste problem in the Radboud University (Netherlands) dining hall. In Brazil, Siqueira, Cavalcante, Leme, Santos and Oladeinde (2007) carried out an educational project to minimize food waste in the São Paulo University (São Carlos) dining hall. As a result, food waste in trays reduced from 83.1g to 60.1g.

Higher education institutions' food service operations provide an opportunity to obtain data from a controlled environment. Once service operations become the subject of management practices, it is possible to facilitate interventions more readily for reducing food waste (Costello, Birisci, & McGarvey, 2016). Gao, Tian, Wang, Wennersten and Sun (2017) suggest observing university dining halls because they consume significant amounts of resources, mainly energy and water, and generate large amounts of food waste (Babich & Smith, 2010). As Babich and Smith (2010) state, higher education institutions perform a fundamental role in the development of sustainable food policies.

Food waste threatens the main purpose of university dining halls, which is to provide its consumers with a proper, balanced daily meal (Boschini, Falasconi, Giordano, & Alboni, 2018). Large amounts of food waste commonly indicate operational deficiencies, for example, poor food quality, inadequate portion sizes and menu inefficiency (Al-Domi et al., 2011). Higher education institutions can be considered to be smaller versions of cities, and their activities have potential financial and environmental implications (Boschini et al., 2018; Marais, Smit, Koen, & Lötze, 2017). Knowing the amount of food wasted, therefore, and proposing effective interventions can result in financial savings and be of benefit to the environment (Eriksson, Ghosh, Mattsson, & Ismatov, 2017).

This research was conducted in a Brazilian federal university dining hall. This university has 39 undergraduate courses and 63 graduate courses, and is one of the 10 biggest universities in Brazil. Its academic community is divided into 8,486 undergraduate students, 3,259 graduate students, 903 professors, and 745 administrative officers.

In Brazil, 88.8% of the federal universities have at least one dining hall (Deliberador, 2019). The objective of this study was to answer the following questions: (1) What amount of food is wasted in total and *per capita* in a Brazilian university dining hall? (2) What are the consumers' perceptions of the reasons behind the food waste generated? (3) Which reasons most influence food waste generation in Brazilian university dining halls? (4) Which potential interventions could be recommended for reducing food waste generation in Brazilian university dining halls?

The research is organized as follows. In Section 1, we present a contextualization of the study. The materials and methods are presented in Section 2. In Section 3, the measured food waste generation is presented. The consumers' perceptions of the reasons behind food waste generation and a correlation analysis are presented in Section 4. Potential interventions for reducing food waste are discussed in Section 5. Section 6 concludes the study.

MATERIAL AND METHODS

Study area

The study took place in the dining hall of a federal university in Brazil. The dining hall was inaugurated in August 1979 and is the main food facility on the university campus. At present, the facility has 85 employees and distributes about 4,500 meals a day (3,000 meals at lunch time and 1,500 meals at dinner) to students, professors, trainees,

staff, and other members of the academic community. The main objective of the dining hall is to provide those who use it with healthy, low-cost meals, in a way that makes it easy for them to stay at the university throughout the day.

The meals that are provided to the dining hall's customers include rice, beans, side dishes, leafy salads and vegetables. There are also two dietary options available: one derived from animal protein, and one that is vegetarian (plant-based protein). The meals are accompanied by desserts, which can be a fruit or a sweet dish. The consumers are allowed to serve themselves. The two diet dishes available, however, are served by the dining hall's employees, who place the meat or the plant-based protein on the consumer's plate in standard portions.

From Monday to Friday, the facility serves lunch from 11:15 a.m. to 1:30 p.m., and dinner from 5:15 p.m. to 7:00 p.m. On Saturdays, the dining hall serves only lunch and operates from 11:30 to 1:00 p.m. Access to the facility is computerized and users are obliged to present an institutional identification card, which is personal and non-transferrable. The meal prices in US dollars (1USD = 3.81 BRL) for each category considered are as follows: scholarship students = $0.00; undergraduate and graduate students = $0.47; administrative officers & trainees = $0.58; professors = $0.71; and visitors = $0.68.

Sampling strategy

The study verified the amount of food wasted by consumers in a Brazilian university dining hall during lunch time, and explored the factors that have an influence on variations in the amount of food wasted. The sample was calculated based on the estimate of the population that eats there on any one day (3,000 consumers). For this calculation, a 95% confidence level ($Z_{a/2}$) and a 5% sampling error (E) were considered. This resulted in 342 consumers participating in this study.

As the dining hall operates over a period of 2 hours and 15 minutes, at least three consumers per minute were approached, meaning that more than 342 participants were randomly selected. The large number of consumers approached is justified because some questionnaires might be returned with incomplete information; some participants might not return the questionnaire at all; and the confusing mixture of plates/trays from different consumers might make it impossible to associate the amount of food wasted with the questionnaire completed by the corresponding consumer.

Data collection

The study was conducted in the second semester of 2018 over the course of three days, when there were different menus at lunchtime. Ethical clearance for the study was obtained from the São Carlos Federal University Ethics Committee. To avoid tendentious eating behaviors among consumers during data collection, they were not told about the imminent study beforehand. Data were collected in two stages: first, the questionnaires were delivered to the consumers to gain their insights into self-identification and their perceptions of the reasons behind food waste; second, consumers were invited to hand over their questionnaires when they returned the plate or tray they had used during lunch. The questionnaire was divided into two sections: the consumers' characteristics and the consumers' perceptions.

Section 1 collected information about the institution's consumer category, sex, age group, dishware used for the meal (plate or tray), and the protein chosen (animal or plant-based). Section 2 was based on the outcome of a systematic literature review that was undertaken in line with the guidelines in Tranfild, Denyer and Smart (2003), and involved the five databases (Engineering Village, ProQuest, Scopus, Web of Science and Scielo) used

by Deliberador et al. (2018). Based on the results of this systematic literature review, twelve items/questions were formulated by the authors to evaluate the consumers' perceptions of the reasons behind the food waste generated (Table 1).

Table 1. **Reasons behind food waste generation**

Variable	Perception	Reference
	Quality	
FW1	Taste	Betz et al. (2015); Mirosa et al. (2016); Painter et al. (2016); Jagau and Vyrastekova (2017); Lorenz et al. (2017); Alias et al. (2017); Qi and Roe (2017); Lorenz and Langen (2018); Youngs et al. (1983); Kuo and Shih (2016); Marais et al. (2017).
FW2	Odor	
FW3	Appearance	
FW4	Texture	
FW5	Temperature	
FW6	Preparation/Cooking	Youngs et al. (1983); Betz et al. (2015); Rizk and Perão (2015); Zotesso et al. (2016); Lorenz et al. (2017); Marais et al. (2017); Lorenz and Langen (2018).
FW7	Menu Composition	Babich and Smith (2010); Mirosa et al. (2016); Zotesso et al. (2016); Kuo and Shih (2016); Lorenz et al. (2017); Lorenz and Langen (2018).
	Portion Size	
FW8	Amount of protein served by the dining hall employees	Youngs et al. (1983); Al-Domi et al. (2011); Betz et al. (2015); Mirosa et al. (2016); Painter et al. (2016); Kuo and Shih (2016); Jagau and Vyrastekova (2017); Lorenz et al. (2017); Marais et al. (2017); Lorenz and Langen (2018).
FW9	Amount of other food served by the dining hall consumers	
	Satiety	
FW10	Degree of satiation of the consumers before they had the meal	Bankson (2009); Betz et al. (2015); Mirosa et al. (2016); Painter et al. (2016); Lorenz et al. (2017).
	Time	
FW11	Time available to consumers to have the meal	Al-Domi et al. (2011); Betz et al. (2015); Mirosa et al. (2016); Painter et al. (2016); Lorenz et al. (2017); Lorenz and Langen (2018).
	Emotion	
FW12	Consumer stress level during the meal	Randall and Sanjur (1981); Al-Domi et al. (2011); Betz et al. (2015); Mirosa et al. (2016); Lorenz and Langen (2018); Rizk and Perão (2015); Jagau and Vyrastekova (2017); Marais et al. (2017).

A five-point Likert scale was used in the second section of the questionnaire. Responses could range from 1 to 5 points, where 1 point corresponded to a less relevant alternative, and 5 points referred to an extremely relevant alternative. Consumers were asked to express their perception of each of the twelve items. Likert scales are scales of psychometric responses used predominantly in questionnaires aimed at evaluating participants' opinions about certain affirmations/questions (Joshi, Kale, Chandel, & Pal, 2015). The questionnaire is shown in Table 2.

Table 2. **Research questionnaire**

Category	☐ Scholarship Students ☐ Undergraduate & Graduate Students ☐ Administrative Officers & Trainees ☐ Professors ☐ Visitors		
Gender	☐ Male ☐ Female		
Age	☐ 18 ☐ 19 – 25 ☐ 26 – 30 ☐ 31 – 40 ☐ ≥ 41		
Which dishware did you use today in your meal?	☐ Plate ☐ Tray		
What protein did you consume today?	☐ Plant-based protein ☐ Animal		
Please answer the following questions, where: (1) poor – (2) fair – (3) good – (4) very good – (5) excellent.		***Source***	**1 2 3 4 5**
FW1: How would you rate the taste of the food offered today?		Jagau and Vyrastekova (2017)	☐ ☐ ☐ ☐ ☐
FW2: How would you rate the odor of the food offered today?		Lorenz et al. (2017)	☐ ☐ ☐ ☐ ☐
FW3: How would you rate the appearance of the food offered today?		Lorenz et al. (2017)	☐ ☐ ☐ ☐ ☐
FW4: How would you rate the texture of the food offered today?		Betz et al. (2015)	☐ ☐ ☐ ☐ ☐
FW5: How would you rate the temperature of the food offered today?		Marais et al. (2017)	☐ ☐ ☐ ☐ ☐
Please answer the following question, where: (1) strongly disagree – (2) somewhat disagree – (3) neither agree nor disagree – (4) somewhat agree – (5) strongly agree.		***Source***	**1 2 3 4 5**
FW6: In general, do you consider that the food offered today was prepared/cooked correctly?		Betz et al. (2015)	☐ ☐ ☐ ☐ ☐
Please answer the following question, where: (1) poor – (2) fair – (3) good – (4) very good – (5) excellent.		***Source***	**1 2 3 4 5**
FW7: How would you rate the menu options offered today?		Betz et al. (2015)	☐ ☐ ☐ ☐ ☐
Please answer the following questions, where: (1) insufficient – (2) somewhat insufficient (3) – neither insufficient nor sufficient – (4) somewhat sufficient – (5) sufficient.		***Source***	**1 2 3 4 5**
FW8: How would you rate the amount of protein that was served by the dining hall employees to you today?		Lorenz and Langen (2018)	☐ ☐ ☐ ☐ ☐
FW9: Regarding the other food that you served yourself with, do you consider the quantity was:		Lorenz and Langen (2018)	☐ ☐ ☐ ☐ ☐
Please answer the following question, where: (1) not hungry – (2) slightly hungry – (4) moderately hungry – (4) very hungry – (5) extremely hungry.		***Source***	**1 2 3 4 5**
FW10: Before having lunch, you were:		Mirosa et al. (2016)	☐ ☐ ☐ ☐ ☐
Please answer the following question, where: (1) insufficient – (2) somewhat insufficient (3) – neither insufficient nor sufficient – (4) somewhat sufficient – (5) sufficient.		***Source***	**1 2 3 4 5**
FW11: How would you rate the time you had available for lunch today?		Marais et al. (2017)	☐ ☐ ☐ ☐ ☐
Please answer the following question, where: (1) not at all – (2) slightly – (3) moderately – (4) very – (5) extremely.		***Source***	**1 2 3 4 5**
FW12: How would you rate your stress level today?		Mirosa et al. (2016)	☐ ☐ ☐ ☐ ☐

For the second stage of the data collection, a digital scale (5g of precision) was used as a measurement instrument. The inevitable unavoidable food waste (e.g., bones, banana and orange peel, etc.) was separated from the avoidable waste. When the participants handed back their plates or trays, two volunteers removed the cutlery and all the food that was considered to be unavoidable and inevitable waste, so only the avoidable waste was measured. To ensure participant anonymity, names were not collected during either stage. Participants were selected by simple random sampling.

Data analysis

The statistical software SPSS® (Statistical Package for the Social Sciences) version 21.0 was used in this study for data analysis. A descriptive analysis of the collected data was conducted to verify the central and dispersion tendency measures of the sample. Mean, median, standard deviation and coefficient of variation were used in this study. Daily food waste was calculated from the sum of all the food waste generated by the consumers who took part in the research. The *per capita* mean food waste was also calculated by dividing the daily food waste by the number of consumers in the sample. A T-test was conducted to compare the food waste means of consumers who used plates and trays; consumers who ate animal and plant-based proteins; and male and female consumers. Finally, Spearman's correlation was performed to establish the correlation between consumer food waste and consumer perceptions of the reasons behind the generation of food waste.

Study limitations

The limitations of this study lie in the fact that only one dining hall was analyzed, which means that the results can only be generalized for the place we studied. Data were collected on only 3 days, and involved 3 different types of menu. Moreover, by separating the types of waste (avoidable and unavoidable), only avoidable food waste was quantified. Time limitations and access to the study object made it difficult to measure unavoidable food waste and replicate the research on other days and in other facilities. As with any questionnaire research, the reliability and accuracy of the data may have been compromised by various limitations, such as the reliability of the memory and the honesty of participants (Hallström & Börjesson, 2013).

Among the major limitations of this study one stands out: the time available for collecting data. Considering the minimum sample size (342 consumers) and the time that the dining hall operates during the lunch period (2 hours and 15 minutes), it was necessary to approach at least three consumers per minute to achieve the objectives, even though we were able to count on the collaboration of a team of six people.

FOOD WASTE GENERATION AND CONSUMER PERCEPTIONS

Table 3 highlights the findings relating to the food waste generated, according to sex, choice of dishware and protein consumed. Measurement resulted in food waste of 68g per consumer. It is important to emphasize that this study only considered avoidable and possibly avoidable food waste during measurement. The literature considers that 7 to 25g of food waste per consumer/meal is common (Vaz, 2006).

Male consumers accounted for 57.04% of the sample. With regard to the dishware available, trays were used the most by the consumers (54.65%). The larger percentage for trays is an interesting result, since a number

of studies in the literature (Babich & Smith, 2010; Kim & Morawski, 2013; Lorenz & Langen, 2018; Marais et al., 2017; Mirosa et al., 2016; Painter, Thondhlana, & Kua, 2016; Qi & Roe, 2017; Thiagarajah & Getty, 2013; Wansink & Just, 2013) present cases of dining halls that, by replacing trays with plates, managed to reduce food waste by a significant amount.

Table 3. **Food waste generation**

		Results				
Variables		**Consumers (n)**	**Consumers (%)**	**Food Waste (kg)**	**Food Waste (kg)/n**	**Food Waste (%)**
Category	Scholarship Students	269	24.75	21.216	0.079	28.84
	Undergraduate & Graduate Students	746	68.63	47.286	0.063	64.28
	Administrative Officers & Trainees	53	4.88	3.915	0.074	5.32
	Professors	10	0.92	0.546	0.055	0.74
	Visitors	9	0.83	0.600	0.067	0.82
	Total	1087	100.00	73.562	0.068	100.00
Sex	Male	620	57.04	41.221	0.066	56.04
	Female	467	42.96	32.341	0.069	43.96
	Total	1087	100.00	73.562	0.068	100.00
Dishware	Tray	594	54.65	53.405	0.090	72.60
	Plate	493	45.35	20.157	0.041	27.40
	Total	1087	100.00	73.562	0.068	100.00
Protein	Plant-based protein	97	8.92	7.365	0.076	10.01
	Animal	990	91.08	66.197	0.067	89.99
	Total	1087	100.00	73.562	0.068	100.00

Although the presented result of 68g per consumer seems high, this value is similar to that found in other studies carried out in Brazilian university dining halls at lunchtime, as can be seen in Table 4. It is noteworthy that some of these dining halls have adopted measures to reduce food waste. Such is the case with the University of São Paulo, which, after an awareness campaign, reduced food waste from 83.1g to 66.7g.

Table 4. **Food waste generation in Brazilian university dining halls**

Location	***Per capita food waste generation***	**Reference**
University of São Paulo	83.1g	Siqueira et al. (2007)
South Fluminense Region (the university's name was not disclosed)	9.02g	Lopes and Fonseca (2013)
Federal University of Santa Maria (Centro)	Between 37 and 92g	Zanini (2013)
Federal Rural University of Amazon	Between 20 and 40g	Paredes, Ladeira and Sá (2014)
Federal University of Technology - Paraná (Campo Mourão)	Between 65 and 102g	Vieira (2015)
São Paulo/SP (the university's name was not disclosed)	63.30g	Domingues et al. (2016)

Source: Santos (2016), adapted by the authors.

Food waste generated by male (66g) and female (69g) consumers was analyzed statistically by way of a T-test. When performing the T-test for equality of means, the p-value identified was higher than 0.05 (p-value (2-tailed) = 0.550). Therefore, with a 95% confidence level, the food waste generated by male and female consumers cannot be considered to be different. Similarly, after comparing food waste from consumers of plant-based (76g) and animal (67g) protein, with a 95% confidence level (p-value (2-tailed) = 0.260), the T-test for equality of means showed that there was no difference in the waste generated by either. However, when comparing the mean food waste generated by consumers who used trays (90g) and plates (41g), with a 95% confidence level (p-value (2-tailed) = 0.000), the T-test outcome confirms that the amount of food wasted in the dining hall was greater for consumers using trays rather than plates.

Consumer perceptions

Consumer perceptions as to the reasons behind the food waste generated, and the mean, standard deviation, coefficient of variation, median, maximum and minimum values were calculated and are shown in Table 5.

Table 5. **Consumers' perception on the reasons behind food waste generation**

Variable	Likert Scale - Consumers (%)					Standard Deviation	Coefficient of Variation	Median
	1	2	3	4	5			
Taste	1.29	23.64	47.01	24.84	3.22	0.814	0.267	3.00
Odor	1.66	24.29	52.81	17.30	3.96	0.800	0.268	3.00
Appearance	3.22	24.01	43.51	24.10	5.15	0.903	0.297	3.00
Texture	2.85	25.85	45.35	22.26	3.68	0.862	0.289	3.00
Temperature	1.20	16.47	44.80	29.71	7.82	0.868	0.266	3.00
Preparation/Cooking	1.01	6.07	14.26	36.61	42.04	0.939	0.227	4.00
Menu Composition	4.32	26.13	41.03	23.18	5.34	0.938	0.314	3.00
Amount of protein served by the dining hall employees	7.18	22.17	57.77	8.83	4.05	0.849	0.303	3.00
Amount of other food served by the dining hall consumers	1.47	7.08	79.39	8.83	3.22	0.587	0.192	3.00
Degree of satiation of the consumers before they had the meal	0.58	25.02	41.40	18.68	4.32	0.999	0.356	3.00
Time available to consumers to have the meal	1.29	6.35	42.32	29.25	20.79	0.926	0.256	4.00
Consumer stress level during the meal	20.24	31.09	27.87	11.50	9.29	1.198	0.463	2.00

The coefficient of variation values for 11 out of 12 variables were higher than 20%, which means that there was no homogeneity in the responses obtained. The maximum and minimum values corroborate the explanation of the coefficient of variation values. All maximum response values were 5 points, and the minimum values, 1 point. This means that there were respondents who considered both extremely irrelevant and highly relevant alternatives for all variables. For the descriptive analysis, the median was considered to be a measure of central tendency.

The variables of taste (FW1), odor (FW2), appearance (FW3), texture (FW4) and temperature (FW5) gave a median value of 3, which is considered good according to the questionnaire alternatives. Food preparation/cooking (FW6) obtained a median value of 4, which indicates that the dining hall consumers partially agreed that the food was properly cooked/prepared. Menu composition (FW7) was assessed as being good. Both the amount of protein served by the dining hall employees (FW8) and the amount of other food that consumers served themselves (FW9) were considered neither insufficient nor sufficient.

The degree of satiation of consumers before they had the meal (FW10) obtained a median of 3, indicating that consumers considered themselves to be moderately hungry before having lunch. Regarding the availability of time for the meal (FW11), the consumers' responses obtained a median value of 4, meaning that consumers usually had more than enough time to eat. Finally, when verifying the emotional stress (FW12) of the participants, it is possible to observe from the median that users had lower levels of stress.

The degree of association of the variables and waste was measured using the Spearman correlation coefficient (ρ). The Spearman correlation (ρ) considers a range from +1 to -1. In this study, correlations with a statistical significance of $p \leq 0.05$ were considered. Those outcomes that consider just the significant correlations are shown in Table 6.

Table 6. **Spearman correlation of consumer's perceptions and waste amount**

	Variables							
	Taste	Odor	Appearance	Texture	Temperature	Preparation/Cooking	Menu Composition	Degree of satiation of the consumers before they have the meal
Spearman Correlation (ρ)	-.132**	-.108**	-.067**	-.088**	-.094**	-.124**	-.112**	-.078*
p-valor	.000	.000	.027	.004	.002	.000	.000	.010

Notes: *Significant correlation for $p < 0.05$; **Significant correlation for $p < 0.01$.

DISCUSSION

The correlation analysis found that the relationship between food waste and the variables identified in the literature was the possible cause of waste in the dining hall. The outcomes revealed that the correlations were a mostly weak and weak to moderate relationship, with a negative sense of covariance. These correlations can be explained by elements found in the literature.

Correlations of taste, odor, appearance, texture and temperature corroborate the studies of Alias, Mokhlis and Zainun (2017), Betz, Buchli, Göbel and Müller (2015), Jagau and Vyrastekova (2017), Kuo and Shih (2016), Lorenz and Langen (2018), Lorenz, Hartmann and Langen (2017), Marais et al. (2017), Mirosa et al. (2016), Painter et al. (2016), Qi and Roe (2017) and Youngs, Nobis and Town (1983), all of who highlight these five variables as potential causes of food waste in dining halls. Such negative correlations indicate that when an item was assessed as being satisfactory, food waste tended to be lower, at a significance level of 5%

Sensory responses to the taste, odor, appearance, texture and temperature of food have a tendency to determine consumer food preferences, and their acceptance or rejection habits (Bhuiyan, 2015). Considering, therefore, how the different sensorial characteristics of food influence food behavior contributes to the development of new meals and eating habits that could be used to promote a reduction in food waste (McCrickerd & Forde, 2016).

The correlation between taste and waste supports the studies of Mirosa et al. (2016), who pointed out that taste is the main cause of the behavior that causes food waste. Different sensory receptors in the tongue are responsible for tasting, which plays an important role in the conclusions drawn about each type of food (Mennella, 2014). Taste is one of the most important sensory characteristics influencing food choice/disposal. The consumers in our study who assessed taste to be satisfactory tended to waste less food.

Consequently, the relationship between taste and odor is one of the main determinants of food preferences. The characteristics of the food - mainly taste, but also odor and appearance - are a central dimension of quality for consumers (Ensaff et al., 2015; McCrickerd & Forde, 2016). The correlation of waste and odor complements what was discussed by Boesveldt and Graaf (2017). Odor mainly plays an anticipatory and appetizing role in food behavior, as it is able to generate a specific appetite for the food in question, and depending on other external or internal factors, to develop food preferences (Boesveldt & Graaf, 2017).

As identified by the correlations, appearance can also be considered in the discussion of food waste (Aschemann-Witzel, Hooge, Amani, Bech-Larsen, & Oostindjer, 2015). The appearance of food is a key factor that influences food preferences (Laan, Ridder, Viergever, & Smeets, 2012; Vilaro et al., 2018). The appearance of food is the first impression a consumer gets. The impact of color on the consumer's perception of quality was widely studied by Francis (1995). Francis (1995) noted that color, as an aspect of appearance, has to be within an expected range for the food to be accepted, and the degree of acceptability is judged within that range. If the color is unacceptable, other major quality factors, such as taste and texture, are unlikely to be considered.

Texture includes the physical properties of food, including shape (Gibson & Cooke, 2017; Jeltem, Beckley, & Vahalik, 2015). The correlation between waste and the consumers' perceptions of texture is in line with what was discussed in the studies of Chambers and Bowers (1993) and Aschemann-Witzel et al. (2015). Today's consumers are much more sensitive to subtle differences in texture than in taste, and tend to use texture as the main limiting factor for the acceptability of food (Aschemann-Witzel et al., 2015; Chambers & Bowers, 1993).

As observed, waste was also correlated with the temperature of the food. These results indicate that the temperature of the food has implications for food consumption preferences, which is reinforced by the studies

of Zellner, Stewart, Rozin and Brown (1988) and Stroebele and Castro (2004). These studies demonstrate that the temperature at which food is consumed is affected primarily by the individual preference of each consumer. Consumers can accept certain foods at certain temperatures, but not at others. Temperature preferences are a reflection of an experience with a particular product. According to Zellner et al. (1988), these preferences may be based on a direct taste experience, socially disclosed information about taste, or general ideas about food.

In addition to these correlations, waste was associated with food preparation/cooking, meaning that there was a tendency among consumers who positively assessed this variable to waste less food, as confirmed by Betz et al. (2015), Lorenz and Langen (2018), Lorenz et al. (2017), Marais et al. (2017), Rizk and Perão (2015), Youngs et al. (1983) and Zotesso, Cossich, Colares and Tavares (2016).

This correlation can also be justified by what was discussed by Murimi, Chrisman, McCollum and Mcdonald (2016), who tried to understand consumer perceptions about menu options and to determine what could influence their food choices. The study found that in addition to consumers wanting the food to be properly prepared/cooked and always served hot, there was a concern that employees would not comply with food safety guidelines.

The correlation between menu composition and waste supported the findings of the studies of Babich and Smith (2010), Kuo and Shih (2016), Lorenz and Langen (2018), Lorenz et al. (2017), Mirosa et al. (2016) and Zotesso et al. (2016). In these studies, the authors consider that waste observations can help identify which food consumers avoid eating. The negative correlation indicated that consumers who judged the food to be satisfactory, tended to waste less. This information allows managers and/or nutritionists to modify the menu to satisfy consumers and, consequently, generate less waste.

The correlation between waste and the time that consumers had for eating their meal corroborates what was found in the studies of Al-Domi et al. (2011), Betz et al. (2015), Lorenz and Langen (2018), Mirosa et al. (2016) and Painter et al. (2016). According to these studies, the amount of time available for lunch is directly related to food waste. This correlation also complements the results of the Bergman, Buergel, Joseph and Sanchez (2000) research, which found that students with a shorter lunch period wasted, an average, 43.5% of their food, while those with a longer lunch period wasted 27%.

POTENTIAL INTERVENTIONS FOR FOOD WASTE REDUCTION

In our study, waste is strongly related to the amount of protein that is placed in a standard quantity on the consumer's plate by an employee. This study recommends therefore, that portion sizes be reduced. Employees can ask those eating if the amount of food served is actually sufficient. The literature indicates that large portion sizes are related to unconscious increases in food consumption and increases in waste left in dishes (Al-Domi et al., 2011; Betz et al., 2015; Jagau & Vyrastekova, 2017; Lorenz et al., 2017; Marais et al., 2017; Mirosa et al., 2016; Painter et al., 2016).

The descriptive analysis exposed that variables of taste, odor, appearance, texture, temperature, and menu composition were assessed as being good by consumers, indicating that improvements can still be made. Improving the quality of meals is a way to reduce avoidable food waste in dining halls (Betz et al., 2015; Lorenz et al., 2017; Marais et al., 2017; Mirosa et al., 2016; Painter et al., 2016; Zotesso et al., 2016). Periodic quality reviews of the food can be a way of reducing waste. Choice of suppliers also influences quality and food waste (Zotesso et al., 2016). Therefore, suppliers should be chosen according to pre-established quality standards. Improving

menu composition has already been mentioned in other studies (Betz et al., 2015; Marais et al., 2017; Mirosa et al., 2016; Painter et al., 2016). According to Betz et al. (2015), food waste is reduced when menus are flexible.

Another recommended potential intervention is to eliminate the use of trays and use only plates. As shown in Table 3, it has been confirmed statistically that consumers who take trays instead of plates waste more food. The substitution of trays for plates was investigated in other studies (Babich & Smith, 2010; Lorenz & Langen, 2018; Marais et al., 2017; Mirosa et al., 2016; Painter et al., 2016; Qi & Roe, 2017; Wansink & Just, 2013). Thiagarajah and Getty (2013), for example, identified a reduction in food waste of 23g/consumer in the Indiana University dining hall.

Providing nutritional information about the food available on menus can also be a way of reducing food waste. Nutritional information may allow consumers to align their behaviors according to the interpretation of value-based information. The implementation of information campaigns is believed to be a sustainable way of informing consumers about the negative impacts of food waste (Jagau & Vyrastekova, 2017; Lorenz & Langen, 2018; Lorenz et al., 2017; Marais et al., 2017; Rizk & Perão, 2015).

Zawawi, Rosli, Bustami, Mispan and Ramli (2015) have suggested starting campaigns that emphasize the importance of reducing, recycling and reusing. Dining halls can use campaigns to advise consumers to take only what they really want to eat. Since there are no extra costs to the consumer if they do waste food, there is no incentive for them to be conscientious in the amount of food they place on their plate. Here, we also suggest the implementation of information campaigns as a way of verifying the amount of food waste that could be reduced from what we have presented.

Coercion is suggested. There are several methods of coercion, initiatives that seek to increase the possibility that consumers will not leave leftover food on their plates. We suggest that caution is exercised before implementing penalties in dining halls. Given the importance of the benefits that consumers derive from the dining experience, some stress could be caused as a consequence of the introduction of a penalty system, which might compromise any benefits derived. To conclude, food waste management interventions can be used and involve techniques, such as composting (Babich & Smith, 2010; Zawawi et al., 2015), thus enabling economic and environmental impacts to be minimized.

CONCLUSIONS

Food waste has significant economic, environmental and social impacts. The magnitude and complexity of this problem has been addressed by several studies. Literature and empirical evidence emphasize the significant importance of assessing the amount of food waste that occurs in subsidized food service establishments. Underlying causes need to better understood, and the potential interventions that can be introduced to encourage behavioral changes should be identified. The objective of this study was to examine food waste in a Brazilian university dining hall.

In order to study food wasted in the dining hall, the uneaten food from the plates and trays of the consumers was measured. Structured questionnaires were used to identify the characteristics of the sample and the consumer perceptions regarding the variables that are considered the possible causes of food waste. Knowing the amount of food wasted by each consumer and verifying their respective perceptions corroborated the differentials of this research.

The amount of food wasted was 68g/consumer, on average, over the three days of the study. This amount is higher than is considered acceptable in the literature (7 to 25g per consumer), but is similar to other Brazilian university dining halls. One of the most expressive findings of this study is that the use of trays contributes more to food waste than plates. It was suggested that only plates be made available to consumers. Removing trays also brings other benefits for the dining hall, since this not only reduces food waste, but also the amount of energy, and the water and chemical products used during the washing and sanitizing phases.

Future research should help expand the data to include other types of restaurants and different menu options. It is also important to emphasize that the results of the correlation analysis represent a trend, and not necessarily a cause and effect. Thus, we consider that there is a demand for new research to investigate the reasons for the situation we found.

Analysis of the waste from overproduction and unprepared food that never reaches the consumer and the causes of this can be included in future work. This study can also be replicated in other public sector food services, such as hospitals, schools, etc. Aspects related to the impact of food waste on the environment may also be topics of interest in future studies for improving university sustainability. Finally, it is suggested that studies be carried out of the action-research type, with the aim of verifying a possible reduction in food waste due to the application of better service practices and consumer awareness campaigns.

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AUTHORS CONTRIBUTIONS

Lucas Rodrigues Deliberador worked on the conceptualization and theoretical-methodological approach, theoretical review, data collection, and data analysis. Mário Otávio Batalha and Aldara da Silva César were the supervisors of the work and collaborated on the conceptualization and theoretical-methodological approach, and the theoretical review. The theoretical review was also conducted by Michelle Chung. All authors worked together in the writing and final revision of the manuscript.

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THE SHARING ECONOMY IN PRACTICE: AN EXPLORATORY STUDY OF THE ACCEPTANCE AND USE OF DIGITAL PLATFORMS IN FOOD WASTE REDUCTION

Economía compartilhada na prática: Um estudo exploratório sobre aceitação e uso de plataformas digitais para a redução do desperdício de alimentos

La economía compartida en la práctica: Un estudio exploratorio sobre la aceptación y el uso de plataformas digitales para reducir el desperdicio de alimentos

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ABSTRACT

This article addresses the issue of reducing food waste by way of digital sharing economy platforms, which promote sharing by donating, selling and exchanging surplus food among institutions, commercial establishments and end consumers, thus boosting accessibility and improving food security. In order to succeed, these platforms need to be accepted by the market, but little is known about the acceptance and use factors of these platforms. Therefore, the study presented in this article identifies the factors that influence the acceptance and use of such platforms. The Extended Unified Theory of Acceptance and Use of Technology (UTAUT2) was used as a theoretical basis for developing an embedded case study on the Ecofood platform. In addition to secondary data collection, interviews and direct observations were carried out in two cities in Southern Brazil. Effort expectancy was identified as the key factor for use behavior, and two new factors (trust and gratefulness) were identified as factors that influence intention behavior and use of the platform. Three propositions were developed to summarize the findings and guide future research.

KEYWORDS | Sharing economy, digital business platforms, food waste reduction, UTAUT2, embedded case study.

RESUMO

Este artigo aborda a questão da redução do desperdício de alimentos por meio de plataformas digitais de economia compartilhada, as quais promovem o compartilhamento por meio da doação, venda e troca de alimentos excedentes entre instituições, estabelecimentos comerciais e consumidores finais, melhorando a acessibilidade e a segurança alimentar. Para ter sucesso, essas plataformas precisam ser aceitas pelo mercado, mas pouco se sabe sobre os fatores de aceitação e uso dessas plataformas. Portanto, o estudo apresentado neste artigo identifica os fatores que influenciam a aceitação e o uso de tais plataformas. A Teoria Unificada Estendida de Aceitação e Uso de Tecnologia (UTAUT2) foi utilizada como base teórica para o desenvolvimento de um estudo de caso incorporado na plataforma Ecofood. Além da coleta de dados secundários, foram realizadas entrevistas e observações diretas em duas cidades do Sul do Brasil. A expectativa de esforço foi identificada como principal fator para o comportamento de uso, e dois novos fatores (confiança e gratidão) foram identificados como fatores que influenciam o comportamento intencional e uso da plataforma. Três proposições foram desenvolvidas para resumir as descobertas e guiar pesquisas futuras.

PALAVRAS-CHAVE */ Economia compartilhada, plataformas digitais de negócios, redução do desperdício de alimentos, UTAUT2, estudo de caso incorporado.*

RESUMEN

Este artículo aborda el tema de la reducción del desperdicio de alimentos a través de plataformas digitales de economía compartida, que promueven el compartir a través de la donación, venta e intercambio de alimentos excedentes entre instituciones, establecimientos comerciales y consumidores finales, mejorando la accesibilidad y la seguridad alimentaria. Para tener éxito, estas plataformas deben ser aceptadas por el mercado, pero se sabe poco sobre la aceptación y los factores de uso de estas plataformas. Por tanto, el estudio presentado en este artículo identifica los factores que influyen en la aceptación y uso de tales plataformas. Se utilizó la Teoría Unificada Extendida de Aceptación y Uso de Tecnología (UTAUT2) como base teórica para el desarrollo de un estudio de caso incrustado en la plataforma Ecofood. Además de recolectar datos secundarios, se llevaron a cabo entrevistas y observaciones directas en dos ciudades del sur de Brasil. La expectativa de esfuerzo fue identificada como el factor principal para el comportamiento de uso, y dos nuevos factores (confianza y gratitud) fueron identificados como factores que influyen en el comportamiento intencional y el uso de la plataforma. Se desarrollaron tres propuestas para resumir los hallazgos y guiar la investigación futura.

PALABRAS CLAVE */ Economía compartida, plataformas digitales de negocios, reducción del desperdicio de alimentos, UTAUT2, estudio de caso incrustado.*

INTRODUCTION

According to the UN's Food and Agriculture Organization (FAO 2011, 2017), every year about 1.3 billion tons of food are lost or wasted globally, an amount that could feed 2 billion people. Instead, 821 million people go hungry everyday around the world, and food insecurity in Latin America has risen from 7.6% in 2016 to 9.8% in 2017 (World Food Programme, 2019; FAO, 2018). Because of the severity of the problem, food is mentioned in several of the 17 Sustainable Development Goals of the United Nations, such as zero hunger and responsible consumption and production. Goal 12.3 in particular proposes: "by 2030, halve per capita global food waste at the retail and consumer levels and reduce food loss along production and supply chains, including post-harvest losses".

Therefore, identifying ways to reduce food loss and waste is empirically relevant for its contribution towards reducing hunger, food insecurity and the overuse of natural resources. Digital platforms can be a part of the food waste solution, as they can promote consumer awareness and facilitate surplus food transactions between people, which complies with the two priorities suggested by the hierarchy proposed by the US Environmental Protection Agency (EPA) that uses the "reduce, reuse, recycle" approach (NRDC, 2017).

The high waste that occurs at the end of the food supply chain can be understood as excess resources that are available to some consumers, and that must be used and shared, since these resources are perishable and have different expiry dates, depending on the type of food and its storage conditions (Parfitt, Barthel & Macnaughton, 2010). Platforms of the sharing economy can, therefore, optimize the excessive capacity of these goods through information technology (Gan *et al,* 2018), thus increasing access to healthy food, and encouraging resource efficiency (Muñoz & Cohen, 2017).

Even though there is a significant gap in our understanding of the implications of food waste in fast-developing countries, such as the BRICs (Brazil, Russia, India and China) (Parfitt, Barthel & Macnaughton, 2010), there are few academic studies about food waste in Brazil (Henz & Porpino, 2017), and no study has ever analyzed the acceptance and use factors of these platforms. For this reason, the study in this article used the Extended Unified Theory of Acceptance and Use of Technology (UTAUT2), developed by Venkatesh, Thong and Xu (2012) to analyze the factors that influence the acceptance and use of Digital Platforms for Reducing Food Waste (food platforms, for short). The application of the UTAUT2 in different countries and different technologies is also relevant, according to Venkatesh, Thong and Xu (2012), and there are only two Brazilian studies that have used this theory, and food platforms were not addressed.

The project aimed to identify which factors influence the users' acceptance and use of food platforms. As secondary objectives, we sought to identify: (i) different types of food platform, and (ii) key factors related to the acceptance and use of food platforms. Because of this, we undertook an embedded case study of the Ecofood platform.

The results show that all the factors pointed out by the UTAUT2 model were found in the field, but some adaptations were necessary due to the specificity of the case and the context. The analyses uncovered trust and gratefulness as factors that influence intention behavior and use of the food platforms. We also identified a new relationship between effort expectancy and use behavior, which may be a contribution to the UTAUT2 model, summarized in three research propositions.

In the following sections, we present the theoretical background, the methodology used for mapping out the food platforms, and the embedded case study on Ecofood. The results are then shown, followed lastly by the conclusion.

THEORETICAL BACKGROUND

This section presents the food waste problem, food platforms as a possible solution for this problem, and the UTAUT2 used to analyze the acceptance and use of food platforms.

The food waste problem

The FAO (2014) estimates that the total cost of food waste could reach $ 1 trillion a year, but a further $ 700 billion relating to the environmental impact, and $ 900 billion associated with social costs. In short, food waste negatively impacts access to consumption due to increasing food prices, which reduces the economic gains of food chains and increases food insecurity (Lipinski *et al*, 2013; CAISAN, 2018; Dunning, Johnson & Boys, 2019; Gromko & Abdurasalova, 2018; Papargyropoulou *et al*., 2014; Brancoli, Rousta & Bolton, 2017).

It is also estimated that the world's population is expected to grow from 7.7 billion in 2019 to 9.7 billion in 2050 (United Nations, 2019), and in order to feed the entire population food production needs to increase by 70% (FAO, 2009, 2017), with demand for animal food also increasing by approximately 70% by 2050 (Searchinger *et al*., 2018), requiring more resources than plant-based products. Unfortunately, the approach used to feed the growing global population in recent centuries has been based on chemical fertilizers and pesticides in tandem with the growth in arable land (Garcia-Garcia, Woolley & Rahimifard, 2015). These facts are worrying, since the increase in food demand is the main factor of deforestation and land degradation worldwide (Gromko & Abdurasalova, 2018), while food waste is the third largest emitter of greenhouse gases in the world, after China and the United States (Food Loss and Waste Protocol, 2016).

Thus, reducing food loss and waste is the most efficient and sustainable way of feeding the entire population. To this end, it is extremely important to adopt more sustainable approaches to production and consumption, by addressing food waste consciously, and avoiding CO_2 emissions, which will require the involvement of public, private and civil society bodies (Papargyropoulou *et al.,* 2014; Thi, Kumar & Li, 2015).

There is, however, both controversy and disagreement in the literature as to the definition of food loss and waste. The first discrepancy is that some authors separate loss from waste (FAO, 2011; WRAP, 2009), while others use the term waste to represent all lost and wasted food in the chain (FUSIONS, 2014). This study adopts the FAO (2011, p. 2) definition, so "food losses take place at production, postharvest and processing stages in the food supply chain (...) Food waste occurring at the end of the food chain (retail and final consumption) which relates to retailers' and consumers' behavior". Exhibit 1 shows the causes and impacts of food waste, as well the solutions for reducing food waste that are found in the literature.

Despite the FAO (2011) pointing out that developed countries waste more food than developing countries, the study performed by Porpino *et al* (2018) shows that Brazil is one of the countries with the highest levels of food waste in the world, with an average family waste of 128.8 kg per year, which is higher than in some developed countries. Despite the relevance of this fact, there is a lack of studies on food waste in Brazil (Henz & Porpino, 2017), so this study focused on food platforms that redistribute surplus food for human consumption, and promote awareness of the issues.

Exhibit 1. **Summary of causes, impacts and solutions for food waste reduction**

	Descriptions	Authors
Causes	Consumer behavior, as stringent high quality and esthetic standards. Lack of planning and carelessness of consumers regarding the expiry date of food. A large monthly purchase, hampering the management of the food in stock Prioritization of food abundance and freshness, performing the bountiful preparation of food and discarding leftovers. Cultural behaviors. Poor recycling systems Lack of adequate awareness education programs for reducing waste. Lack of private sector participation and funding to improve services aimed at reducing loss and waste. Lack of coordination among supply chain stakeholders. Sales contracts between producers/farmers and buyers can also lead to crop waste	Thi, Kumar and Li (2015), FAO (2011), CAISAN, (2018), Parfitt, Barthel and Macnaughton (2012), Brancoli, Rousta and Bolton (2017), Porpino et al (2018), WRAP (2009).
Impacts	Increased production to compensate for loss and waste (natural overuse) Water waste (agriculture accounts for 70% of the world's annual use of water resources). Inefficient use of natural and financial resources Food insecurity Negative impacts on consumer access due to rising food prices. Reduces the economic gains of food chain actors Increased use of fertilizers. Deforestation, loss of biodiversity and natural ecosystems. Terrestrial acidification and aquatic eutrophication Methane and carbon dioxide emissions that cause climate change The carbon-related impact embedded in the earlier stages of the food life cycle that has been wasted.	Lipinski et al (2013), FAO (2014, 2017), CAISAN (2018), Food Loss and Waste Protocol (2016), Gromko and Abdurasalova (2018), NRDC (2017), Papargyropoulou et al. (2014), Brancoli, Rousta and Bolton, (2017), FUSIONS, (2014), Garcia-Garcia, Woolley and Rahimifard (2015).
Solutions for reducing food waste	Consumer awareness strategies (public campaigns, changing the labeling and packaging system, portion reduction in restaurant dishes, purchase planning and proper storage, among others). Research and development of technological innovations to reduce food waste New business models that connect stakeholders in the chain through information technology. Greater coordination among stakeholders, improving communication, process and operations in the supply chain. Redistribution of edible and healthy food for human consumption The amendment and implementation of laws and regulations that promote and facilitate food donations. Production of animal feed with food being diverted from the food chain Bioenergy generation Composting, creating a nutrient-rich organic fertilizer. Anaerobic digestion Incineration, and disposal on landfill sites or as sewage.	FUSIONS (2014), NRDC (2017), Papargyropoulou et al. (2014), Garcia-Garcia, Woolley and Rahimifard (2015), Lipinski et al. (2013), Gromko and Abdurasalova (2018), FAO (2011), Parfitt, Barthel and Macnaughton (2010), CAISAN (2018), Searchinger et al. (2018), Porpino et al (2018), Henz and Porpino (2017), Thi, Kumar and Li (2015)

Source: The author

Digital platforms for reducing food waste

The concept of sharing has its origin in the old days, when relatives and close friends shared resources (Belk, 2014). The act of sharing food is observed in several species and was first documented anthropologically in primitive hunter-gatherer societies. Surplus food was generally shared to avoid wasting resources (Morone *et al.*, 2018).

Despite sharing being an old concept, it has been improved due to advances in information and communication technology, which allow scale sharing (Cohen & Kietzmann, 2014). Only in the early 2000s, however, did the sharing concept start being used more widely in commercial activities due to the scarcity of natural resources, and driven by the use of the internet, which increased connectivity between the online and offline world (Botsman & Rogers, 2010). The technological advances made possible the proliferation of web and mobile platforms for food sharing (Michelini, Principato & Iasevoli, 2018), mainly because information technology connects people who wish to share food, thus increasing the effectiveness of sharing practices (Morone *et al.*, 2018).

In literature the term 'sharing economy' has synonyms, such as collaborative consumption, peer-to-peer economy, collaborative economy, gig economy and shared economy. Despite the fast expansion of the term in recent years, there is no consensus regarding the definition of the sharing economy (Koopman, Mitchell & Thierer, 2015; Kumar, Lahiri & Dogan, 2018; Muñoz & Cohen, 2017). For this reason, in this article we have adopted the Koopman, Mitchell and Thierer (2015) definition, which considers the sharing economy as the coordination of people to acquire or distribute any kind of underutilized resources in exchange for monetary or non-monetary benefits. Thus, food platforms include the exchange, sale and even the donation of food (D'Ambrosi, 2018). These platforms define food waste as an optimization problem, which is understood as being inefficient consumer coordination (Harvey *et al.*, 2019).

In short, food platforms allow access to surplus food, avoid waste and hyper-consumption, and move the global economy towards sustainability (Cohen & Kietzmann, 2014). In essence, this business model reduces the cost of accessing food, meets customers' needs and allows for greater resource efficiency (Muñoz & Cohen, 2017; Botsman & Rogers, 2010). However, even though food sharing practices have increased due to consumer awareness of socio-environmental and ethical problems caused by food waste, there are still few individuals who know and use food platforms (D'Ambrosi, 2018).

According to Kumar, Lahiri and Dogan (2018) and Piscicelli, Ludden and Cooper (2018) there is a triadic dynamic between service enablers (platforms), service providers (those that host the resources and provide the service, like suppliers) and clients (who consume and pay for the resources and services, the end consumer) in the sharing economy. The benefits for consumers who interact on the platform increase with the number of suppliers, and vice versa. The sustainable economic success of these platforms, however, depends on the acquisition and retention of users (Kumar, Lahiri & Dogan, 2018). Currently, the reasons for sharing food found in the specialized literature are varied and complex (Harvey *et al,* 2019), as shown in Exhibit 2.

Extrinsic factors (economic, social and environmental) constitute the advantages promoted by food platforms that are more or less attractive to users. Intrinsic factors, on the other hand, are inherent to the individual, as ideals or desires that may propel them to use food platforms, or not. Considering that the study by Kumar, Lahiri and Dogan (2018) found there to be a high turnover of customers and suppliers in these business models, we first need to understand the causes of user acceptance and use of food platforms from a theoretical perspective.

Exhibit 2. **Factors that influence the acceptance and use of food platforms.**

EXTRINSIC FACTORS	ECONOMIC	Cost reduction to end consumers Immediate gratification after sale Income from the sale of surplus food Better adjustment to seasonal demand
	ENVIRONMENTAL	Lower environmental pollution Saving natural resources, automotive resources and labor Better use of food, avoiding waste and food shortage. Waste management laws and rules imposed by governments.
	SOCIAL	Increases food availability and access More social and cultural interactions Ease to use (providing minorities inclusion) Social inclusion Waste management laws and rules
INTRINSIC FACTORS	PERSONAL IDEALS	Pleasure to be part of the platform Social and environmental concern Cooperation spirit, empathy and solidarity. Networking and socialization
	PERSONAL DESIRES	Independence Autonomy Convenience of food service

Source: created based on Koopman, Mitchell and Thierer (2015), Kumar, Lahiri and Dogan (2018), Muñoz and Cohen (2017), D'Ambrosi (2018), Gan et al. (2018) and Cohen and Kietzmann (2014).

The Extended Unified Theory of Acceptance and Use of Technology (UTAUT2)

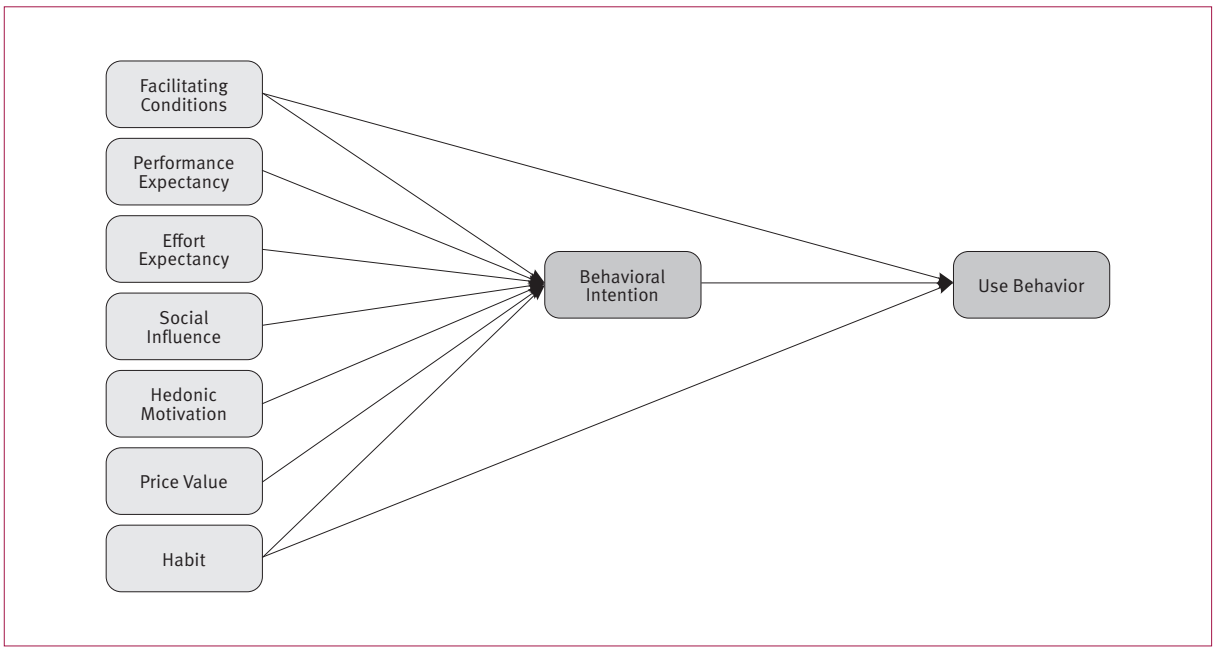
Samaradiwakara and Gunawardena (2014) compared 14 technology acceptance theories and concluded that UTAUT is an "improved theory", since it is the theory with the highest explained variance. The development of the UTAUT was based on eight technology acceptance and use models for understanding employee acceptance and use of technology (Venkatesh *et al,* 2003). UTAUT2, by extension, was developed to examine consumer acceptance and use of technologies. Hence, there is a greater explained variance than in the original UTAUT (Venkatesh, Thong & Xu, 2012).

This study used UTAUT2, since platform users (suppliers and end consumers) are understood to be platform consumers. Venkatesh, Thong and Xu (2012, p. 159) define the four determinants of UTAUT as:

> *performance expectancy* is defined as the degree to which using a technology will provide benefits to consumers in performing certain activities; *effort expectancy* is the degree of ease associated with consumers' use of technology; *social influence* is the extent to which consumers perceive that important others (e.g., family and friends) believe they should use a particular technology; and *facilitating conditions* refer to consumers' perceptions of the resources and support available to perform a behavior.

The new determinants included in the UTAUT2 model are hedonic motivation, price value and habit. *Hedonic motivation* is characterized as the fun or pleasure an individual derives from using technology, and is the intrinsic motivation of the model. *Price Value* is an important factor for consumers with regard to decision making about intention and the use of technology, because consumers bear the price of using technology. *Habit* is characterized by the way individuals perform behaviors automatically, and is a critical factor that drives the use of technology (Venkatesh, Thong & Xu, 2012). Figure 1 illustrates the UTAUT2 model.

Figure 1. **UTAUT2 model**



Source: Venkatesh, Thong & Xu (2012).

Another important change in Venkatesh, Thong & Xu's (2012) model is that *facilitating conditions* are directly related to *use behavior*, because a consumer who has access to favorable conditions is more likely to use the technology. Although the model is constructed quantitatively, other studies have used the UTAUT in a qualitative way (Batane & Ngwako, 2017; Knoblock-Hahn & LeRouge, 2014; Bixter *et al*, 2019; Mejia & Torres, 2017; Lo, Jenkins & Choobineh, 2017; Sovacool, 2017), as does this study. Venkatesh, Thong and Xu (2012) also suggest the application of the model in different countries and technologies, so applying the UTAUT2 in the Brazilian context of food platforms is timely.

METHODOLOGY

Our study was based on qualitative exploratory research (Richardson, 2007). The method was divided into two phases: (i) mapping out food platforms and; (ii) developing an embedded case study (Yin, 2003), both described below.

Phase 1: Mapping out food platforms

In order to select a single relevant and representative case to be studied in depth, so as to respond to the first specific study objective, we mapped out existing food platforms. This process took place during the first three months of 2019, as Table 1 describes. We only selected platforms that fit the concept adopted by the study, which is: food platforms that bring together at least two user groups, and explicitly address solutions for the problem of food waste.

We identified 773 companies, of which 60 are food platforms, and excluded those platforms that are replicated in the different databases.

Table 1. **Number of platforms for food waste reduction found in databases**

Database	Keywords	Total Analyzed	Total of food platforms
CrunchBase	"Sharing Economy", "Food and Beverage"; Food Processing"; "Food Delivery"; "Organic Food"; "Snack Food"; "Food Truck" / "Food sharing"	30	5
AngelList	"Sharing Economy"; "Food sharing"	120	15
FoodTech Movement	"Recycling and Waste"	10	3
App Store	"Food sharing" and "desperdício"	105	20
Google Play	"Food sharing" and "desperdício"	501	25
Liga Ventures	"Reuse of Waste and Discards"	7	5
Total		773	60

Source: The authors.

To understand the different types of food platform better, we analyzed and divided the 60 platforms into groups considering their: purpose (donation, sale, sale and donation, exchange, or awareness); types of user (retailers, farmers/food producers, restaurants, NGOs, neighbors, needy people, final consumers, etc.); and transaction model (B2B, B2C or C2C). This analysis enabled us to identify five different types, as detailed in Exhibit 3.

Exhibit 3. **Types of Food Platforms**

SALES PLATFORMS	
Local Markets	
- Homemade meals to final consumers (C2C)	Mapha Food Share, Dinnrtime.com, Nomnom, Watscooking.com, Alimentto and Foodly
- Local producers to buyers (B2B)	FreshSpoke, Farmily and Ugly
- Local producers to consumers (B2C)	Share.Farme, Earthineer, PULL UP A SEAT, Freshist and Wastee
Conventional Markets	
- Business to business (food close to expiry date)	Saveadd and Food Finder
- Business to consumer (food close to expiry date)	Wesaveeat, Ecomida, YourLocal, Fairmeals, Pratododia, Food Flow, Ecofood, Desperdício Zero and Ndays
- Schedule the meal sale	RefService

Continue

Exhibit 3. Types of Food Platforms

Concludes

DONATION PLATFORMS	
Donation from companies	
- NGOs	Food4All and No Food Waste
- Not necessarily needy people	Share Your Food
-Needy people (sometimes hungry students)	Unsung and Share Meals
Donation from individuals	
- Not necessarily needy people (between neighbors)	Ratatouille, Yo No Desperdicio, pApperplate and Findwhatsleft
- Needy people (sometimes there are volunteers as users)	Share Food Online
Donation from individuals and companies	
- Not necessarily needy people	OLIO, Comida Invisível and Shusha.exactscores.com
- Needy people (sometimes there are food banks and volunteers as users)	Community Fridge, Food2Share, Sharing Food and Happiness, Food4needy and Frigo Solidale
Food donation through monetary donations	
- Needy people	ShareTheMeal
SALES AND DONATION PLATFORMS	
- Food purchase app (a percentage of sales is donated to charitable organizations)	NeighbourFood
- Sale or donation of homemade food (between natural people)	Eathentica
- Donation or sale at a reduced price (always from business to final consumer)	All You Can Share and CropMobster
- Donation or sale of food by natural or legal people	foodonate and Ripelist
EXCHANGE PLATFORMS	
- Between B2B	Gurbi and Grow Share
- Between C2C	SwapEat
AWARENESS PLATFORMS	
- Shopping list and pantry management	BEEP, Spesa Facile App and Groceree.
- Food management (shopping list and pantry) and exchange	Share Food and EatBy App
- Recipes to avoid food waste	Kozinhar

Source: The authors.

From the typology presented in Exhibit 3, we can observe that most were *sales platforms* (26 platforms), while the largest number of sub-types was the *sale of food near the expiry date from business to consumer* (nine platforms). The relatively high number of platforms for this kind of purpose indicated that this was the best-developed type at that moment. We then analyzed these platforms in more detail to identify the ideal business to consumer (B2C) type for the focus of our case study. As can be seen in Table 2, we extracted our case from a stratified sample (Flyvbjerg, 2006).

Table 2. **Sales Platforms for food near the expiry date from business to consumer (B2C)**

Platforms	Origin	Download	Instagram followers	Facebook followers
Wesaveeat	Spain	10.000+	1.058	635
Ecomida	Chile	(not found)	444	3.321
YourLocal	Denmark	10.000+	2.286	3.931
Fairmeals	Portugal	1.000+	890	1.390
Pratodia	Brazil	100+	640	304
Food Flow	Brazil	10+	930	354
Ecofood	Brazil	10.000+	11.300	1.746
Desperdício Zero	Brazil	(not found)	1.437	84
Ndays	Brazil	*	71	9.007

Source: data extracted from Google Play, Facebook and Instagram in 2019 July.

*Web app: it means that this platform operates on the website, and is not an app offered by App Store or Google Play.

Phase 2: Case study development

To select the best developed and most relevant food platform for our research, we analyzed the number of downloads of mobile apps, and the number of followers on two social media platforms, Facebook and Instagram (see Table 2). As a result, the platform we selected was EcoFood, which can be considered a "critical case", i.e.: what applies to this case will possibly also apply to other cases in the same subcategory (Flyvbjerg, 2006).

EcoFood is a platform that connects businesses that often generate surplus food (restaurants, bakeries, candy stores and small and medium-sized grocery stores, etc.) with consumers who might be interested in buying it at reduced prices. Such transactions would, therefore, reduce food waste. Users post and order food on the platform, and must pick it up within the period required by the establishment, since EcoFood does not have a delivery service. The platform used to operate in seven cities in Brazil: Londrina, Campo Mourão, Arapongas, Rolândia, Ibiporã and Maringá in Paraná, and Balneário Camboriú in Santa Catarina. However, due to contractual problems in 2019, it reduced its operations in Paraná to just three cities: Londrina, Maringá and Campo Mourão.

We analyzed the acceptance and use of Ecofood in two different cities where this platform operates, which enabled a comparison between cities, and increased the validity of the study. We collected data from users that

have surplus food (suppliers) and users interested in acquiring this food (consumers). The embedded case study, therefore, had two units of analysis (data from two cities) and two subunits (data from suppliers and end users) in each analysis unit. We also analyzed secondary data, performed direct observation, conducted interviews, and triangulated data to develop more consistent and elaborate propositions (Eisenhardt, 1989). Data were collected in Londrina, where the app received the most acceptance from users, and Balneário Camboriú, where the app was the least well-accepted. These two cities were chosen precisely because they represented the market extremes for the company.

We interviewed both the suppliers with highest and lowest ratings in the app, as well as frequent users and those who had used the app to buy food just once, or never. Again, the collection of data at the extremes allowed us to better assess the reasons for using (or not using) the platform. Exhibit 4 summarizes the data collection.

Exhibit 4. **Summary of data collection**

Data source	Description	Period	Role
Exploratory interviews	Conducted with the owners, by calls and a face-to-face meeting, to understand the field and align expectations.	From July to August 2019.	Helped develop the semi-structured script, which was tested and reformulated once, making the questions open and simple to understand by all education levels
Semi-structured interviews	Interviews with the consumers and suppliers adopted many forms, such as face-to-face, by video conference, e-mail, call and instant messages. In total, 26 individuals were interviewed: 14 suppliers and 12 consumers. All interviews were recorded and transcribed.	From August to November 2019.	Main source of data, enabling an understanding of the main factors of acceptance and use of food platforms.
Secondary data	Analysis of 12 newspaper reports, 3 purchase reports provided by EcoFood, in addition to 114 posts, 1.347 comments and 265 ratings from Facebook, Instagram, Google Play and the App Store.	From January to December 2019.	Understanding the perspective of users and corroborating and validating the data provided by the interviewees.
Direct observations	Observations of food collection from establishments and the experience as a platform consumer in Londrina. Altogether, 13 direct observations were registered.	From August 21st to August 24th and from October 16th to October 23rd, 2019.	Understanding the interactions between users and how the technology works.

Source: The authors.

We analyzed the data using the NVIVO software, according to the techniques and procedures proposed by Strauss & Corbin (2008). The first phase consisted of open coding, allowing new concepts and ideas to emerge from the field, which was a more inductive phase of analysis that focused on the raw data. Axial coding then allowed emerging concepts and ideas to be grouped together. The findings were compared with the UTAUT2 reflexively. The last phase consisted of selective coding, when the categories and subcategories created during the analysis were refined. The software helped with the analysis process, and facilitated resumption of the raw data and the storage of the logical process performed by way of notes made in memos.

Finally, we analyzed the data for each city separately, compared them in order to identify patterns and differences in the same platform, and prepared our propositions (Eisenhardt, 1989). In order to increase the validity and reliability of the study, we made a study validity table (Exhibit 5), as suggested by Yin (2003).

Exhibit 5. **Study validity table**

Tests	Definition	Research strategies
Construct validity	Correct operational measurement for concepts, requiring multiple data input sources for triangulation.	Literature review about Food Loss and Waste, Sharing Economy Business Platforms and UTAUT2. Identification of user acceptance and use factors through the interviews involving the two user groups on the platform, and also by way of secondary data and direct observation. Validate the factors discovered through data analysis with the previous literature.
Internal validity	Establish a non-spurious causal relationship, seeking evidence for the reason behind relationships.	Data triangulation, through interviews, direct observation and secondary data collection. Search for patterns in subgroups of analysis (between the two user groups in each city).
External validity	Establish the domain for generalization (research drawing).	Data from different cities (Londrina in Paraná and Balneário Camboriú in Santa Catarina) were analyzed, and the different users involved in the platform (suppliers and consumers) were interviewed, which validates the findings at each of the different points of the platform. Proposition elaboration from the cross analysis between the cities (based on literature).
Reliability	Reliability of case study operations, to enable the repetition.	Recording and transcription of the interviews, archiving the field notes from the direct observation and secondary data, as well as the analysis file made in NVIVO.

Source: The authors.

RESULTS

Initially the data for each city were analyzed separately and later cross-analyzed, enabling differences to be identified. Exhibit 6 summarizes the analyses for each city.

Exhibit 6. **Cross-analysis of the data from the two cities**

	Londrina		Balneário Camboriú	
	Consumers	**Suppliers**	**Consumers**	**Suppliers**
Performance Expectancy	- Good quality service and good relationship - Lack of product variety and establishments registered - Long service time due to communication failures - Suitable to the user's lifestyle - More product accessibility	- Food waste reduction in the establishment and reduction of financial losses - Promotion of the establishment through the app - Acquisition of new customers	- Mutual benefits for establishments and consumers. - Lack of variety of products and establishments registered. - Good quality service and agility - Lack of internal communication in the establishment - Inappropriate to the user's lifestyle	- Food waste reduction in the establishment and reduction in financial losses - Promotion of the establishment through the app
Effort Expectancy	- Ease of use - Lack of delivery - Restricted pick-up time	- Ease of use - Previous experience with other apps - Easy to implement	- Easy to use - Lack of delivery - Restricted pick-up time	- Easy to use - Previous experience with other apps - Management effort to keep the right product availability on the app
Social Influence	- Influenced by people and establishments - Users become influencers	- Platform's owners contact them - Employee indication or media - Image improvement	- Instagram and social media - Digital influencers - Users become influencers	- Platform's owners contact them - Image improvement
Facilitating Conditions	- Cordial support - Good informal communication channel - Lack of formal communication channels (only by email, not convenient for users who prioritize practicality and response speed) - Good compatibility with smartphone systems - Clause for allergy sufferers in the adhesion term - Payment form (only by credit card)	- Training offered by platform - Cordial support - Good communication (though e-mail, phones, text messages, and even personal contact) - Usability problems (impossibility of correcting information released on the day, and problems with incorrect voucher validation)	- Cordial support - Need more payment options - Failure in the communication channel (most of the consumers interviewed did not know that the app had stopped operating in the region).	- Training offered by platform - Cordial support - Failure in the communication channel (failure in the sales notification and some establishments unaware of app operations discontinued).
Hedonic Motivation	- Environmental awareness	- Environmental awareness - Social awareness	- Environmental awareness - Social awareness	- Environmental awareness - Social awareness
Price Value	- Financial savings promoted by platform - Time savings (no need to cook) - High quality products - Large portions delivered	- Revenue increase	- Financial savings promoted by platform - High quality products	- Revenue increase - Absence of monthly fees
Habit	- Intermediate use frequency - Habit of searching for offers on the app	- High use frequency	- Low use frequency - Users forgot the platform	- Low use frequency

Source: The authors

As can be seen in Exhibit 6, communication between users and the platform is very different in each city, especially with regard to suppliers. In Balneário Camboriú, many suppliers claimed they were demotivated because of low sales and dissatisfaction with failures in sales notification. They were also not notified about the app being discontinued. In Londrina, on the other hand, a relationship of proximity and friendship between the suppliers and the platform has resulted in a more personalized service, which promotes satisfaction and motivates suppliers to continue using the platform. These findings are in line with Morone *et al*. (2018) and D'Ambrosi (2018) who claim that the lack of direct social contact between users and platforms can cause distrust and fear in using it, thus negatively affecting food sharing.

In both cities, consumers complained about the effort needed to collect food at restricted times, and the lack of variety in the establishments and the products registered. This fact has reduced the frequency of use of consumers in Londrina, and made it difficult to acquire and retain users in Balneário Camboriú.

This indicates that: (i) in order to retain suppliers, it is necessary to maintain efficient communication and a personalized service, and; (ii) in order to retain consumers, it is necessary to offer more establishment and product options, in addition to a delivery service.

Through the analyses in the two cities, we adapted the UTAUT2 items to better suit the context and technology we studied. Exhibit 7 describes these adaptations.

Exhibit 7. **Factors and components adapted to food platforms**

Factors	Components	Descriptions
Performance Expectancy	Usefulness perceived	User's perception regarding the usefulness of the platform in their routine (for end consumers and establishments).
	Advantage perceived	Advantages pointed out by users when using the platform, whether financial, due to waste reduction or some other factor.
	Quality of service	User's perception of the service offered by the establishment, and the speed of the service.
	Variety	Perception of variety of registered products and establishments, and the perception of users consumption variety via the platform.
	Lifestyle	The perception that the platform suits the lifestyle of the end consumer or the establishment's routine operations.
Effort Expectancy	Easy to use	How users perceive the platform usability, if the system is easy and intuitive. In this case, previous experience, a simple system and similarity of the platform with other platforms facilitated its use.
	Delivery	How users perceive the effort needed for pick up the food, and the restrictions with regard to collection times. In this case, both users reported dissatisfaction with the lack of delivery.
	Implementation effort	Perception of effort made by the establishments to implement the platform, either due to a change in production or in the employees' operations for the use of the platform.
	Availability management	Efforts made by the establishments to maintain the correct information on the platform system, avoiding the incorrect release of vouchers.

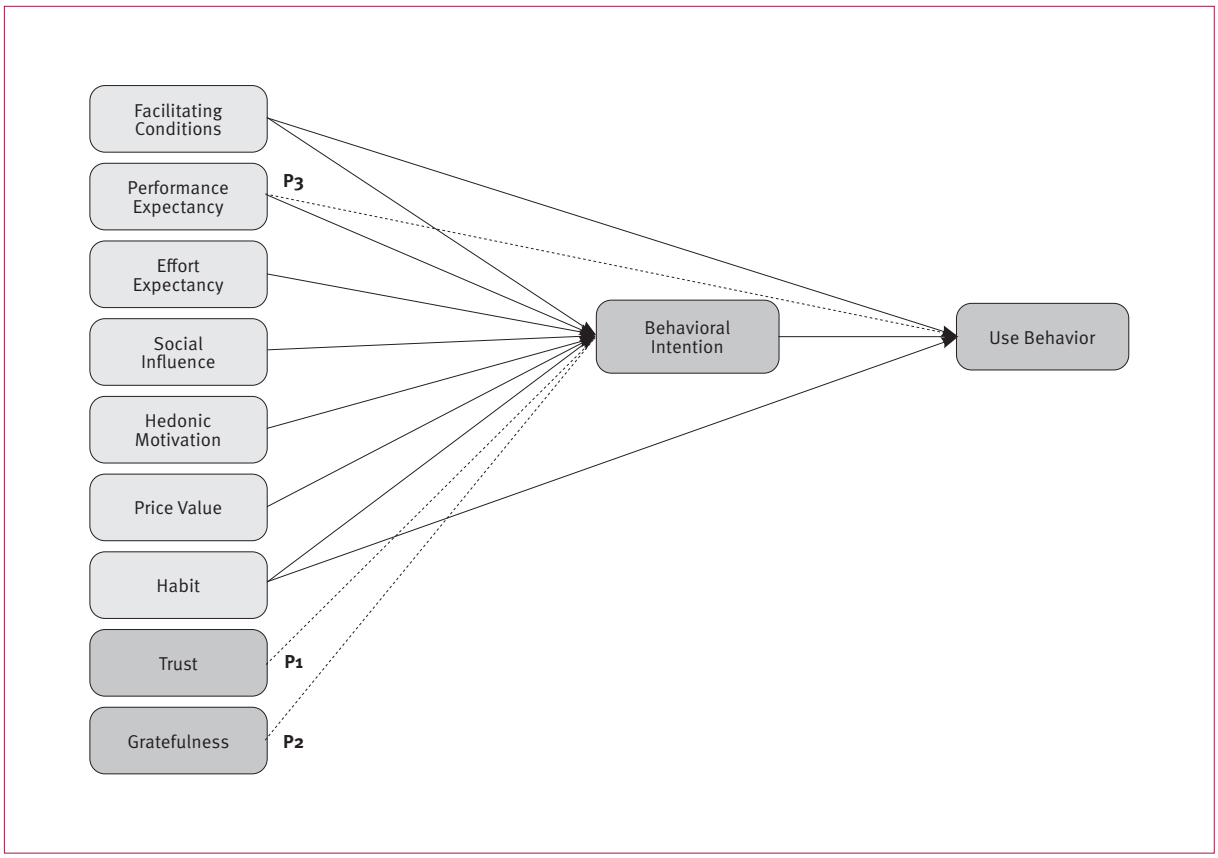
Exhibit 7. Factors and components adapted to food platforms

Factors	Components	Descriptions
Social Influence	Influenced	How users were influenced to use the platform, and how they discovered the platform, via friends, social media, relatives, etc.
	Influencers	How users of the platform influence others to use it.
	Image	Changing others' perceptions of platform users, whether the user's image changed after starting to use the platform or not.
Facilitating Conditions	Cordial support	Quality, readiness and attention given by the platform support.
	Compatibility	Platform compatibility with the different devices and operating systems (IOS and Android).
	Communication channels	Variety of communication channels maintained by the platform, and their good functioning for adequate information flow.
	Payment	Payment options available via the platform, which may facilitate or hinder consumer use.
	Training	Training offered by the platform for establishments, and the quality and clarity of the training.
	Conditions for allergy sufferers	Clauses in the adhesion term to better serve users who have food restrictions due to food allergies.
Hedonic Motivation	Environmental awareness	Concern shown by users regarding environmental causes.
	Social awareness	Concern shown by users regarding social causes.
Price Value	Financial savings	Perception of cost reductions for the final consumer.
	Revenue increase	The establishment's perception of increased revenue from the sale of surplus food.
	Time saving	Perception of reduced time for preparing meals by end consumers.
	Product quality	Quality and value perceived by consumers with regard to the food offered through the platform.
	Monthly payment	The absence of a monthly fee for using the platform, which is seen as positive by the establishments.
Habit	Use frequency	The number of times and the frequency with which the platform is used by the users.
	Open the app	Habit to open the application and search for offers, otherwise, the user may forget the platform.

Source: The authors

Analysis of the data that emerged from the two cities enabled us to identify two new factors that influence behavioral intentions and the use of the technology (trust and gratefulness), and that modify the association of an existing factor that influences the use of the technology (effort expectancy). Figure 2 presents the modified version of the UTAUT2, according to the recognizably limited results of our research. Indeed, the development of the following three propositions serve this exact purpose: they can be used as the starting point for future research.

Figure 2. **Adapted UTAUT2 model**



Source: Venkatesh, Thoung & Xu (2012) adapted by the authors.

P1: Trust influences behavioral intention and use of food platforms

According to Flavián, Guinalíu and Gurrea (2006, p. 2) "trust is defined as a group of beliefs held by a person derived from his or her perceptions of certain attributes", considering the brand, products and services on offer, the point of sale and the cordiality of the sellers, among other factors. The authors emphasize that trust is multidimensional, and depends on the honesty, benevolence and competence perceived by the consumer in relation to the seller's actions and products. Trust is crucial to online shopping, as consumers are required to trust the privacy and data security system of the platform on which they make their purchases and to which they entrust their personal and even credit card details (Hoffman, Novak & Peralta, 1999).

In analyzing the empirical data of the case, we realized that ***consumer trust*** relates to the perception of: data security, the quality of the food delivered (due to the reputation of the establishments registered on the

platform), the food delivered being good and safe to eat, and the platform being honest and correctly transferring the value of the sales to the establishments' bank accounts.

Hence, the first components of trust relate to ***data security***, the feeling of security when registering his or her personal and credit card details, as explained by the quote from consumer E: "the card is registered there and nothing was ever charged, unless I bought it". Users trust that the platform will not charge incorrect amounts to their cards, and will keep their data safe. The second component of trust relates to the ***quality and reputation of the supplier.*** The user believes in the quality of the food delivered because of the reputation of the establishment that is registered on the platform (either because of the user's prior knowledge, or the platform's internal reputation system). The third component is ***confidence in the food delivered.*** Users know and are confident that the food delivered is safe and good for consumption, even if it is not so fresh or attractive appearance-wise. The fourth component of trust is ***confidence in the payment system.*** Suppliers are sure that the platform will transfer the money from the sales payment to them. In the beginning, the platform's owners had to personally contact each business to build confidence that the platform would not steal from them. Later, they began to trust the platform due to the reputation of the restaurants that were already registered.

P2: Gratefulness influences the behavioral intention and use of food platforms

Being grateful is defined as being: "appreciative of benefits received or expressing gratitude" (Merriam-Webster, n.d.). By extension, in the case in question, **gratefulness** can be understood as the user's perception of satisfaction with using the platform, and their feeling of thankfulness and pleasure at being part of the change that the platform proposes. **User satisfaction** is caused by good experiences and expectations being met, as supplier I reported: "On the contrary. In fact, we only have good things (to say about the platform)" and supplier J substantiated this view by saying: "What I see is that it's good in this way (...) Expectations are being met". **Gratitude** is expressed by being thankful for the service provided by the platform, as supplier B stated: "In fact, I have to thank Ecofood for giving me this opportunity". Finally, consumer I said: "I just really thank you for the initiative". The feeling of being part of the change also seems to keep users engaged and active on the platform.

P3: Effort expectancy influences the use behavior of food platforms

According to the analyses, most users stopped using the platform because of the perception that the effort needed to use the app was excessively high (effort expectancy). In practice, restricted times for consumers to collect the food and automatic release failures in the system were seen as being a lot of effort by users at both ends (suppliers and consumers). Thus, effort expectancy seemed to be the main factor for continued use of the platform (in technical jargon, *user retention* by the platform owner). In other words, even if users are hedonically motivated, and have a positive perception of performance expectancy, price value, facilitating conditions, and social influence, these are not sufficient to guarantee that the user will effectively engage with the platform.

Finally, the analysis indicated there was little hedonic motivation, social influence or habit. Perhaps social influence and hedonic motivation are not so relevant for food platforms; we expected that most users of this type of platform would have significant environmental and social concerns. Most of them, however, use the app

because of financial savings (for consumers) and increase in revenue (suppliers). Habit and social influence were seldom mentioned. Some interviewees reported knowing the app via digital influencers, but this did not make them frequent users. Explanations for this fact seem to relate to the perception of value generated by the user (performance expectancy), the effort necessary to use the app (effort expectancy), the communication and support provided by the platform owner (facilitating conditions) and the price value. In summary, the most important constructs seem to be performance expectancy, effort expectancy, facilitating conditions, and price value.

CONCLUSION

In this article we identified which factors influence the acceptance and use of food platforms, first by identifying and classifying the different types of food platform, and then, the key acceptance and use factors via an embedded case study.

Although Michelini, Principato and Iasevoli (2018) classified the food sharing platforms mentioned in academic literature and found on Google Play and App Store, their search focused only on food redistribution platforms, i.e., they did not include other types of food platform, such as consumer awareness platforms and food exchange platforms. Therefore, by identifying different types of food platform, our study contributes to the literature on digital business platforms.

The study also contributes to the academic literature by discussing how digital platforms in the sharing economy can reduce food waste, and the key factors that influence the acceptance and use of such platforms. According to our research, the main constructs are performance expectancy, effort expectancy, facilitating conditions, and price value. Perhaps the combination of these constructs generates habit, which is something to be pursued in future research. Correspondingly, the results of our research also indicated that social influence and hedonic motivation do not appear to be relevant when it comes to accepting and using food platforms. Analysis of the case study also allowed us to identify two new constructs (*trust* and *gratefulness*) and to add a new relationship between *effort expectancy* and *use behavior*. We summarized these findings in three research propositions. Our study also contributes to the evaluation and adaptation of an existing theory (UTAUT2) to a new technology (food platforms) and context (Southern Brazil).

The main limitation of the study refers to the single case study method. Limited external validity does not allow the theoretical model to be generalized and extended to include all other types of digital business platforms. In this regard, we hope that further research investigates this theme, so as to validate or refute the suggested adaptations to the UTAUT2. Both quantitative and qualitative studies, as well as studies to verify the specificities of other platform types listed by the mapping out process should be pursued. Finally, studies aimed at understanding the relationship between users, intermediated by platforms, are also required, either through relational theories or network analysis.

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AUTHORS' CONTRIBUTIONS

Laís Moltene performed the theoretical-methodological construction and the collection and analysis of the data. Laís Moltene and Renato J. Orsato worked together in the final revision of the manuscript.

PERSPECTIVES

Invited article

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METHODOLOGICAL APPROACHES TO TACKLING FOOD WASTE: MOVING THE AGENDA FORWARD

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INTRODUCTION

COVID 19 disrupted food supply chains worldwide. Existing problems, such as food and nutrition insecurity, increased exponentially. It has become imperative to move to a more sustainable and equitable food system. In this sense, the challenge in researching food losses and waste (FLW) and proposing solutions mobilizes transdisciplinary approaches and processes to transform food supply chains in an effective manner. Understanding how much food we produce and consume is no easy task. So many different geographical, cultural and societal contexts and levels of economic development and urbanization result in quantitative and qualitative limitations.

According to Corrado et al. (2019), accounting for food waste is a central element in designing an FLW policy and the interventions that are proposed. The methodology adopted when accounting for waste is key to monitoring the progress made towards reducing targets. There is no best way of tackling food losses and waste, but many relevant and rigorous attempts are made using different methods. Some of them are discussed in this paper, which suggests a methodological agenda for business and management researchers who are interested in this challenge.

BACKGROUND LITERATURE

Food loss and waste can be defined as a decrease in the quantity or quality of food along the food supply chain. Empirically, it considers food losses as occurring along the whole food supply chain from harvest/slaughter/catch right up to, but not including the retail level. Food waste, on the other hand, occurs at the retail and consumption levels (Food and Agriculture Organization of the United Nations [FAO], 2019, p. 14).

The causes of FLW are connected across food supply chains, from primary production to final consumption (Bilska, Wrzosek, Kołożyn-Krajewska, & Krajewski, 2016; Canali et al., 2017). Consequently, research into FLW has emerged as a priority issue for both academics and practitioners. Much of the research, however, focuses on just one activity in the food supply chain, not on the interactions between the different stakeholders, or on the complex phenomenon of FLW. FLW is a transdisciplinary topic, but a large area of interest in business and management comes from marketing (the majority of studies that analyze consumer food waste) and operations management literature. These two units of analysis and the methodological trends used in studying them are discussed below.

Consumer side

Different methods are used for measuring consumer food waste, such as self-report surveys, food waste diaries, photo coding, and waste composition analysis (Quested, Palmer, Moreno, McDermott, & Schumacher, 2020). Given the need to standardize quantification across different countries as a means of tracking achievement of its Sustainable Development Goal 12.3, the United Nations Environment Programme suggests using waste composition analysis, and direct measurement in households via scales, or diaries. Diaries are useful for food that goes down the sewer, is composted at home, or is fed to animals (UNEP, 2021). Interviews and surveys, a common method in academic studies, should not be used in isolation, because of a large element of underestimation (Herpen, Lans, Holthuysen, Nijenhuis-de Vries, & Quested, 2019). Matzembacher, Brancoli, Maia and Eriksson (2020) identified a discrepancy between stated and actual behavior in relation to consumer food waste. This involves methodological questions, with a series of studies being based on consumer perceptions and reports. Therefore, interviews and surveys should be combined in a mixed-method approach.

In a developing world context, waste composition analysis is challenging because organic and inorganic waste is not sorted in certain regions. Furthermore, direct measurement at home requires considerable investment and the need to train participants to sort the waste in order to quantify it accurately. To overcome this drawback, a potential solution is to utilize bulk sampling with randomized grab sub-sampling to cover a representative sample of the municipal waste collected, as undertaken by Oelofse, Muswema and Ramukhwatho (2018) who quantified household food waste in South Africa.

The degree of underestimation of food waste in diaries ranges from 7% to 40%, compared to waste composition analysis, according to Quested et al. (2020). Compared to surveys, however, diaries perform better in estimating consumer food waste (Giordano, Alboni, & Falasconi, 2019). As such, a feasible method by which developing countries can measure food waste would be to rely on mixed-method approaches, which combine diaries, especially those using digital platforms, with photo uploads to double-check the amount of waste informed, and analysis of waste composition in those areas in which organic waste is collected separately.

In a national quantification of consumer food waste in Brazil, which was part of a project funded by the Sector Dialogues European Union– Brazil, diaries were used via a mobile platform on which consumers could indicate via a simple form indicating portions which food was wasted, and the amounts. The app could also be used to upload photos to compare if the foods and amounts were precisely informed (Porpino, *Lourenço*, Araújo, & Bastos, 2018). Van Herpen et al. (2019) consider that photo coding has the potential for improving the accuracy of measurements, but is time consuming and may not be feasible for large samples.

Food waste quantification is a baseline for fostering science-based urban food policies, but the value of qualitative approaches for understanding the root causes of consumer food waste better should not be underestimated in academic studies. Apart from the theoretical contributions, qualitative methods are useful, for instance, for guiding the development of communication campaigns aimed at changing behavior.

At-home observations combined with laddering interviews are a rich qualitative method for uncovering food waste behaviors that are not easily identified in self-reports, such as surveys. However, the application of these qualitative approaches requires well-trained researchers, and the ability to perform interviews without influencing respondents to give the desired answers. As such, laddering techniques, in which respondents are exposed to "why" type questions, are important for obtaining a deeper understanding of consumer behavior (Veludo-de-Oliveira, Ikeda, & Campomar, 2006).

In terms of theoretical contributions, grounded theory can also be applied for identifying those behaviors that result in food waste. Grounded theory coding (Corbin & Strauss, 2015), as used by Porpino, Wansink, and Parente (2016) to investigate food waste in lower-middle income families, and by Papargyropoulou et al. (2016) to study food waste in the hospitality sector, is suitable for generating theoretical contributions and providing insights in policy-oriented strategies, such as nutritional education and sustainable consumption campaigns. It is also used for identifying relevant concepts for framing messages aimed at influencing food choices in retail settings or food pantries, for instance.

Stangherlin, Barcellos and Basso (2018) recently studied the effect of social norms on driving suboptimal food consumption in Brazil. Social norms represent the common and accepted behavior in a specific situation that directly affects attitudes, intentions, preferences, and choices (Cialdini, Reno, & Kallgren, 1990). Consumers prefer not to buy fruit and vegetables with an unusual appearance, or products whose packaging is damaged, or those that are close to their expiry date; these are usually called suboptimal food products (Aschemann-Witzel, Hooge, Amani, Bech-Larsen, & Oostindjer, 2015; Hooge et al., 2017; Loebnitz & Grunert, 2015; Loebnitz, Schuitema, & Grunert, 2015). This pattern of behavior and the consequent demand for "cosmetically perfect" food contributes to high levels of food waste (Godfray et al., 2010; Gustavsson, Cederberg, Sonesson, Otterdijk, & Meybeck, 2011) and interventions aimed at encouraging the purchase of suboptimal food. The study also tested if awareness of the food waste problem is the underlying mechanism in the relationship between social norms and intention to buy suboptimal food. Results show that appeals that employ social norms have a positive effect on the intention to purchase products with an unusual appearance, or products with damaged packaging. Awareness of the food waste problem also mediates the effect of social norms on the intention to purchase a product with an unusual appearance. In theoretical terms, the study analyzed the effect of stimulus in suboptimal food consumption by applying the theory of normative influences. Practical implications indicate strategies for increasing the acceptance of suboptimal food products. The decision making of consumers can be positively influenced if appropriate messages are provided by retailers and food marketers. A suggestion would be to develop interventions at the point-of-purchase that show the sensory and organoleptic characteristics of the products. Nudge marketing, consumer education campaigns, and the use of trustworthy celebrities to endorse consumption are strategies that could lead to increasing intentions to consume suboptimal food products. Consumer-level change, therefore, must be systemically supported by education and different initiatives that can lead to a substantial decline in waste food going to landfill sites, thereby saving public and private resources, and contributing to achieving the SDGs.

Supply chain side

Morgan, Hawkes, Dangour and Lock (2019) characterize food and nutrition value chain studies to identify opportunities for reducing waste throughout the chain. While most of the time the supply chain framework overlaps the value chain, the former emphasizes the logistics of product flow. Governance mode and the extent of the supply chain are factors that influence FLW.

Studies focusing on supply chain cases take a more systemic approach in that they try to understand how interorganizational relationships can mitigate FLW. There are two main theories for understanding supply chain governance. Transaction cost economics (TCE) is the theoretical analysis of relationships between supply chain agents that enables the analysis of governance to be split into three types: hierarchy, market and hybrid. A hybrid or collaborative relationship between buyer and supplier can reduce the costs involved in the transaction (Williamson, 2000). Relationships are often not purely collaborative or opportunistic, however, so TCE can be used in conjunction with other approaches.

The second theoretical background is the relational view (RV), which can be considered an extension of the resource-based view (RBV). While RBV focuses on internal resources of the company, RV suggests that idiosyncratic relationships exist between organizations. These theories can lead to a complementary perspective of formal and informal governance mechanisms in a supply chain (Cislaghi, Wegner, & Vieira, 2021). The main assumption of these theories is that collaborative relationships within the supply chain can have an influence on awareness of food waste and, consequently, reduce it. In this perspective, food waste is an economic cost related to waste management practices.

These theoretical approaches support case studies that have a firm or a dyad as the unit of analysis, such as Mena, Adenso-Diaz and Yurt (2011), who adopted a buyer-supplier approach when gathering data in two countries. This research extended to include Mena, Terry, Williams and Ellram (2014) with the aim of understanding the main causes of FLW in the two product categories with highest demand in the UK grocery sector. It used mixed methods, such as the use of quantitative data to assess the impact of waste. It then carried out multiple case studies using an inductive and theory building approach with open questions. Cross-checking the case studies puts forward propositions aimed at making theoretical contributions to the natural-resource-based view (NRBV). Richards, Hurst, Messner and O'Connor (2021) expanded the unit of analysis to include the whole horticultural supply chain in an attempt to identify existing paradoxes, and they used semi-structured and open questions and secondary data to do so. This study tries to take a more holistic view and avoid pointing out where the food is wasted, to indicate how and why it is wasted. Matzembacher, Vieira and Barcellos (2021) argue that a multistakeholder perspective is needed, and that not just the supply agents should be investigated, but other intervening stakeholders as well, such as NGOs, public agencies, academia, etc.

Within this context, SCM has been evolving from being an isolated investigation perspective dealing with the interfaces between environmental and economic topics, to a vision of corporate social responsibility applied to the supply chain. These studies (Matzembacher et al., 2021; Mena et al., 2014; Richards et al., 2021) exemplify an advance in the research, from focusing on a single point, or on one relationship within the supply chain, to a more holistic analysis. While there are several limitations when it comes to measuring or generalizing in this kind of research, it engages multiple stakeholders in the task of tackling FLW. The use of a multistakeholder approach brings research closer to the real world. In many real cases, reducing FLW to a

single point (production, processing, distribution) results in transferring the waste to the next link in the supply chain; it does not tackle the problem.

When seeking to understand more of the data on the quantification and impact that FLW has, life cycle assessment (LCA) is a very relevant methodology to use. LCA is a systematic approach for assessing environmental impact throughout a product's or a process's life, from extracting the raw material to disposal. Eriksson and Spångberg (2017) conducted some interesting research in this regard. The LCA methodology is widely used for examining environmental impacts associated with FLW management. This is important for decision-making processes and when preparing public policy. LCA analyses can also incorporate a holistic analysis. As Omolayo, Feingold, Neff and Romeiko (2021) propose, rather than focusing just on one or a few activities, it is interesting to include all stages of the food supply chain within the system boundary to capture in more detail the influence of the whole process on the interventions, and to identify key leverage points within the food supply chain for effectively reducing the environmental impacts of FLW.

FOOD FOR THOUGHT

As FLW research is still divided between consumers and the supply chain, which are analyzed separately, it should move towards adopting an integrated approach that positions the consumer in the context of the supply chain. The challenge is to develop theories and methods that allow this interface between marketing and operations management, with mix methods and units of analysis.

The role of applied research in tackling FLW is key to providing effective solutions. Evidence-based policies (Oliver & Boaz, 2019) and evidence-based management (Pfeffer & Sutton, 2006) can provide space for interventions in the short term and a consistent change in behavior in the long term. Researchers are challenged to transform research findings into policies or management practices in order to make a positive impact on reducing FLW. Policies might include a good mix of regulatory and voluntary measures, while economic and financial measures are limited. Managerial tools and solutions are required to support the implementation of voluntary measures and the achievement of the SDGs with regard to reducing FLW.

A holistic approach can expand the unit of analysis to include multiple stakeholders and the use of mixed methods, such as undertaking mini-surveys and using techniques, such as social network analysis to understand which stakeholder influences another when it comes to changing behaviors. LCA analytics can also seek to provide a more general picture of the entire supply chain, thereby seeking a more holistic view.

A future research agenda could consider moving away from the "unit" view, whether that be adopting single-actor analysis of the supply chain/consumer level, or using a single methodology. FLW is a complex problem, interconnected at the supply and consumption levels, in which the action of one agent has an impact on others. Each methodology has its strengths and weaknesses when used alone. Given this complexity, it is suggested that a more holistic approach be integrated into research agendas, either by way of multi-stakeholder analysis, or by combining methodologies in order to have a deeper and more concise vision of the FLW problem, and achieve a more integrated impact with the solutions proposed.

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Luciana Marques Vieira, Marcia Dutra de Barcellos, Gustavo Porpino de Araujo and Daniele Eckert Matzembacher worked on the conceptualization and theoretical-methodological approach. The theoretical review was conducted by Luciana Marques Vieira, Marcia Dutra de Barcellos,Gustavo Porpino de Araujo e Daniele Eckert Matzembacher Data collection was coordinated by Luciana Marques Vieira, Marcia Dutra de Barcellos,Gustavo Porpino de Araujo e Daniele Eckert Matzembacher Data analysis included Luciana Marques Vieira, Marcia Dutra de Barcellos,Gustavo Porpino de Araujo e Daniele Eckert Matzembacher. All authors worked together in the writing and final revision of the manuscript.