Exploring success factors in food waste prevention initiatives of retailers: the critical role of digital technologies

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Abstract

Purpose – Food waste is a severe problem affecting the supply chain due to its significant adverse social and environmental effects. Even if the topic is hotly debated in the literature, there is a lack of research about the success factors influencing food waste prevention initiatives retailers undertake.

Design/methodology/approach – The research analyzes how several variables (i.e. product-related variables and technology-enabling variables) might impact the success of the sales of products close to the expiration date that is sold at a discounted price. Data from 390.000 products sold at a discounted price in 2020 and 2021 by a large Italian food retailer were examined with a regression analysis.

Findings – The results highlight that both product-related and technology-enabling variables influence the success of food prevention initiatives aimed at selling products close to the expiration date at a discounted price. In particular, the authors stress the importance of digital technologies in supporting food waste prevention initiatives.

Practical implications – The study offers several practical implications for managers in structuring a waste prevention initiative. The introduction of digital technologies, the monitoring of specific variables or the ability to find synergies with other food waste prevention initiatives are discussed to support retailers in reducing food losses.

Originality/value – The paper is focused on the retailer perspective, which is barely investigated due to the difficulty in finding data.

Keywords Food waste, Waste prevention initiatives, Retail, Digital technologies, Sustainable innovation, Online shopping

Paper type Research paper

1. Introduction

Food waste is a severe issue affecting every stage of the food supply chain. Decreasing it is a top priority to lessen the environmental effect of food systems and boost its economic

efficiency (Kummu *et al.*, 2012). Due to its significant adverse social and environmental impacts, food waste is hotly debated in the literature (Vittuari *et al.*, 2016; Ojha *et al.*, 2020; Bigdeloo *et al.*, 2021). From the beginning of production to the end of consumption, food is lost across the whole food supply chain (Parfitt *et al.*, 2010) but especially in the retail and consumption phase (Jurgilevich *et al.*, 2016). Thus, food waste prevention is seen as a worldwide priority. In such a context, food waste prevention has become a global priority since the United Nations Agenda 2030 for Sustainable Development included it within the targets (target 12.3) necessary to achieve a more sustainable global scenario by developing more responsible production and consumption models (Sustainable Development Goal [SDG] 12). Retailers (as well as individual consumers) are called to action by the 2030 Agenda and are encouraged to adopt sustainable practices and integrate sustainability information into their reporting cycle (target 12.6). In this context, the digital transition of the food sector covers an essential role in addressing the SDGs (Hassoun *et al.*, 2022).

Frey *et al.* (2017) identified different initiatives retailers and consumers might implement for food waste prevention. Among those that customers could undertake, there are, for instance, food-sharing initiatives, which allow individuals to share food they will not use before it becomes damaged by donating it to other platform users. Those sharing initiatives, in recent years, soared with the support of digital technologies (Franceschelli *et al.*, 2018), such as web platforms and mobile applications (Mazzucchelli *et al.*, 2021).

From the retailer's side, there are technical solutions, such as lowering refrigerator temperatures (Eriksson *et al.*, 2016), actions aimed at advertising products that are close to the expiration date or with cosmetic defects, likely to be wasted, to be sold at a discounted price (Frey *et al.*, 2017) and the donation and redistribution of unsold food items to charities (Cicatiello *et al.*, 2019).

While a great deal of literature has explored food-sharing initiatives implemented by consumers (Michelini *et al.*, 2018; Falcone and Imbert, 2017; Ciulli *et al.*, 2020; Mazzucchelli *et al.*, 2021), those initiatives promoted by retailers are just marginally analyzed in the literature primarily due to the difficulty in finding data. Kliaugaite and Kruopiene (2017) explicitly underlined a lack of empirical studies regarding influencing factors and methods for minimizing or preventing food waste with retailers' help.

On a more practical side, retailers are also struggling to understand how to create effective waste prevention initiatives to overcome the attitude-behavior gap of consumers in terms of food waste prevention actions (Caputo *et al.*, 2018). Given the low overall margins on food products and the high operational costs, particularly at the store level, food waste poses a serious business problem for retailers and their profitability. In addition, retailers are under increasing pressure from the public to demonstrate their efforts to prevent and reduce food waste as one of priority action within the corporate social responsibility perspective (Teller *et al.*, 2018). Therefore, it is crucial to comprehend how retailers can realize effective food waste prevention initiatives and to understand better if digital technologies contribute to the success of these initiatives.

The paper, adopting the sustainable innovation lens, aims thus at filling such a gap grounding on empirical data of a waste prevention initiative (the promotion of discounted food products closed to the expiration date) implemented by a large Italian Food Retailer (IFR) with 95 stores spread across three regions. Data from 390.000 products sold at a discounted price in 2020 and 2021 by the IFR were examined with a regression analysis. Our results suggest that perishability influences the sales of such products when discounted through the waste prevention initiative and that product cost positively influences the sales of such products when discounted through the waste prevention initiative. Moreover, our results stress the importance of digital technologies in supporting initiatives aiming at advertising products close to the expiration date, likely to be wasted, to be sold at a discounted price. In more detail, we found that those discounted products sold by stores of the IFR that allow

customers to do online shopping and that implemented a specific application for supporting the waste prevention initiative have a higher probability of being sold.

The paper is organized as follows: the next section provides a brief overview of the field under analysis, and we formulated hypotheses to be tested in the area under investigation. The methodological section then includes information about the data and the methodologies used to conduct the research. Results and discussions are presented in section four, together with academic and managerial considerations. Finally, the last section provides concluding remarks and academic research avenues.

2. Literature review and hypothesis development

Sustainable innovation might play a critical role in addressing the pressing issue of food waste and retailers have been increasingly recognized as key stakeholders in these efforts. Even if it is difficult to identify a definition commonly adopted for sustainable innovation (Cillo *et al.*, 2019), it can be defined as "innovations in which the renewal or improvement of products, services, technological or organizational processes not only delivers an improved economic performance, but also an enhanced environmental and social performance" (Bos-Brouwers, 2010, p. 422).

With the increasing awareness of social, economic and environmental impacts associated with food waste, retailers have been implementing various initiatives to prevent food waste throughout the retail value chain (Kliaugaite and Kruopiene, 2017). Indeed, even though food waste can be generated in each of the supply chain steps (from production to individual consumption) (Edjabou *et al.*, 2016), food retailers assume a crucial role by influencing the adoption of food waste prevention practices along the entire supply chain (de Moraes *et al.*, 2020).

By integrating sustainability considerations into their business practices, retailers can minimize the environmental impact of food waste, generate economic benefits, improve customer loyalty and enhance their brand reputation (Yang and Yang, 2019). Retailers' food waste prevention initiatives represent a significant contribution to sustainable innovation efforts, highlighting the critical role of retailers in driving positive change toward a more sustainable and responsible food system (Reynolds *et al.*, 2019).

In the context under investigation, sustainable innovation might involve developing and implementing novel organizational processes (Calik *et al.*, 2020) and adopting technologies (Ghobakhloo *et al.*, 2021) that aim to reduce waste generation through discounting products near the expiration date (Huang *et al.*, 2021a, b).

Therefore, framing the development of a waste prevention initiative aimed at selling products near to expiration as an example of sustainable innovation in retails, our research aims at better understanding factors that might impact the success of such an initiative. With this regard, the implementation of processes might be connected to identifying products to be sold in waste prevention initiatives and the prices to apply to those products. On the other hand, adopting technologies might be connected with using digital technologies that play an essential role in establishing real-time information exchanges among users in the network, thus stimulating the uptake of the initiative (Carmela Annosi *et al.*, 2020). The following paragraphs frame the hypotheses we aimed to test in the relevant literature in this field.

2.1 Hypothesis development

As part of sustainable innovation organizational efforts, the success of a waste prevention initiative aimed at selling products near the expiration date at a discount might be determined by product attributes to be sold at a discount. A variety of items with various attributes, including shelf life and temperature range, distinguish products sold by retailers. In many cases, products are classified by retailers based on their perishability (Mena *et al.*, 2011); we can thus distinguish between very fresh products that are perishable in 1–2 days (e.g. fresh milk),

fresh products those perishable in 2–5 days (e.g. fresh dairy products, fresh pasta, salads) and medium/long-life products such as canned foods, dry pasta, for instance (Mena *et al.*, 2011).

Some past studies suggest that consumers are more oriented to buy products with a good aspect and reject very-fresh products (e.g. fruits and vegetables) when offered at a discount because of the evident damages (Bos-Brouwers *et al.*, 2014; Garrone *et al.*, 2014). Other research stresses the fact that consumers typically reject very-fresh and fresh products (such as meat) when their expiration dates are coming up owing to concerns about food safety and risk (Qi and Roe, 2016); indeed, food safety and perceived risks are seen as crucial factors in food consumption (Galati *et al.*, 2019).

More recently, Chang and Su (2022), performing a consumer experiment, suggested that consumers' perceived value and purchase intention of expiring food is connected to the degree of food perishability. Fresh food products have lower perceived value than low-perishability foods and those products have a lower probability of being sold than others, also in discount initiatives. That result is similar to Konuk's (2018) findings, which indicated that food with a high level of perishability might trigger higher perceived risks due to consumer safety concerns and its shorter storage time than low-perishability food, thereby reducing its perceived value and probability of being sold. The higher risk of fresh products to be turned into waste is confirmed by the Retail Loss Group (ECR) which has developed a project to find solutions to increase the freshness of fresh products to increase their sales capacity even if close to the expiry date (Broekmeulen *et al.*, 2017). The results show that extending the expiration date by one day significantly reduces the share of fresh processed into waste. All the studies mentioned above aimed at analyzing consumer behaviors using consumer data gathered with either laboratory experiments or questionnaire surveys. So far, to our knowledge, there are no studies using retailers' data to understand if consumers prefer to purchase fresh or long-life products when those are sold at a discount through waste prevention initiatives.

In this context, considering the previous studies on consumer behavior suggesting that consumers would discard fresh products when near the expiration date, we aim to test the following hypothesis:

HP1. Medium/long-life products have a higher probability of being sold when discounted through waste prevention initiatives.

As part of sustainable innovation organizational efforts, the success of a waste prevention initiative aimed at selling products near the expiration date at a discount might be determined by product prices. Indeed, several factors come into play when consumers assess discounted food and make food purchases in-store (Aschemann-Witzel *et al.*, 2017). Past studies suggest that price level is often used to infer food quality (Grunert, 2007; Cao *et al.*, 2023). Price-reduced food in supermarkets is a sign of clearly shorter shelf-life or minor defects (Aschemann-Witzel *et al.*, 2017).

Recent studies have explored how price dynamics might influence the purchase of products sold at discounts. For instance, Chang and Su (2022) empirically demonstrated that the size of the price discount was a factor in consumers' overall perception of expiring food and purchase willingness. In such context, the authors support that higher prices increase consumers' perceived value of expiring food more than lower prices. Also, Cao *et al.* (2023), in a survey with customers, showed that when the price is too low, or the discount is considered deceptive, consumers will think that there are quality problems in the suboptimal food itself. Similar results were achieved by Huang *et al.* (2021a, b), who contended that the lack of authenticity and quality assurance results in the final purchase of suboptimal food that is not worth the price and, therefore, refuses to purchase it.

Also, in this case, most of the research mentioned relied on self-reported or experimental consumers' data; thus, we aim at better understating general food discounted dynamics when products are offered through the waste prevention initiative relying on data of actual

purchases. Considering such premises, we would expect that food products with higher prices have a greater probability of being sold at the discounted price, considering that price might signal a greater quality or safety of the food purchased. Thus, we aim to test the following hypothesis:

HP2. Costlier products are more likely to be sold when discounted through the waste prevention initiative.

Digital technologies have been recognized as a critical enabler of sustainable innovation in various domains, including retail (Cane and Parra, 2020). In the context of food waste prevention initiatives, retailers have increasingly turned to digital technologies to optimize their operations and engage with customers. One specific digital technology that has gained prominence is online shopping, which allows customers to conveniently purchase products from retailers' websites and has been recognized as an enabling factor for food prevention initiatives (Cane and Parra, 2020). According to data from the IFIC (2020), online grocery shopping has increased by 16% of grocery delivery after COVID-19. E-commerce represents an alternative opportunity for food retailers to sell products directly to consumers. Indeed, e-commerce platforms facilitate virtual interactions and enhance the exchange of product information (Li *et al.*, 2020). However, buying online presents issues because consumers cannot directly examine products leading to product uncertainty (Song *et al.*, 2020).

In this regard, online shopping can determine food waste due to a shorter shelf life (Spada *et al.*, 2018) and online retailer customer guarantee of the perishable product (Göbel *et al.*, 2015). Rodrigues *et al.* (2021) highlighted that retailers applying promotional strategies to products close to expiration could disturb the demand for other fresh products. On the other hand, Roe *et al.* (2021) argued that online shopping can prevent consumers from storing food and contextually reduce food waste.

These contrasting dynamics boost the discussion about the role of online purchasing in food waste prevention actions (Rodrigues *et al.*, 2021). Therefore, retailers implementing well-designed food waste management practices such as price reduction for near-expiry date products can avoid any possible demand disturbances of food products due to online purchasing (von Kameke and Fischer, 2018). Thus, the third hypothesis tested in this study is:

HP3. Allowing customers to conduct online shopping in the retails in which the initiative is implemented positively influences the sales of products discounted through the waste prevention initiative

In the context of sustainable innovation also, mobile applications might enhance customer awareness and engagement, provide convenient access to discounted products and streamline the purchasing process, thus incentivizing customers to participate in the waste prevention initiative and purchase discounted products. Consumers might not be aware of last-minute price reductions for products sold by retailers nearly before the suggested expiration date, making them ineffective (Aschemann-Witzel, 2018). Those price reductions are typically offered one or two days before perishables expire, giving consumers little time to take advantage of them (Theotokis *et al.*, 2012). However, in the recent few years, the opportunities associated with digital technologies have brought the introduction of several food-sharing mobile applications that promote responsible food consumption (Harvey *et al.*, 2020; Dressler and Paunovic, 2020; Morella *et al.*, 2021); while retailers are introducing smart technology solutions to sell discounted products close to the expiry date (Cane and Parra, 2020; Michelini *et al.*, 2020).

Despite the recent and increasing introduction of digital solutions in the food sector, there is a lack of evidence about their impact on organizational practices for preventing food waste (Kache and Seuring, 2017). Recently, Huang *et al.* (2021a, b) have identified the desirable interaction between the offering of food nearing the expiry date in-store and the availability of mobile application collecting all information about the products in promotion because they are

close to their expiration date. Indeed, anecdotal evidence suggests that the applications mentioned above can solve consumers' reluctance to buy discounted products close to the expiry date by providing information about these products (Dora *et al.*, 2021). However, empirical research is still missing (Aschemann-Witzel *et al.*, 2019) and, to our knowledge, there is no evidence that waste prevention initiatives aimed at selling products near the expiration date at a discount supported by a mobile application work better than the same initiative not being supported by a mobile application. Thus, the following hypothesis is tested:

HP4. Supporting the waste prevention initiative with a mobile application has a positive influence on the sales of products discounted through the waste prevention initiative

The hypotheses to be tested are presented in Figure 1.

3. Methodology

3.1 Case description

The analysis focuses on a large IFR. The IFR is located in central Italy, and it counts 3.840 employees and 95 stores spread across three regions. The 95 stores (about 105.500 sq m. in total) have a large variety in terms of dimension (from 120 square meters to 5.000) and in terms of offered services. The IFR is strongly oriented toward integrating sustainability practices into its business strategies. Indeed, the IFR has voluntarily drawn up its sustainability report for 18 years. In this document, IFR communicates to its stakeholders all the actions taken to reduce its impact on sustainability's economic, social and environmental dimensions. Among the steps taken, IFR has developed several projects to reduce the amount of food waste produced.

Since 2003, the IFR has developed a food waste prevention project to donate goods unsuitable for sale but in excellent condition for human consumption to local humanitarian associations. The project involves 74% of the stores, which has shown a growing impact on the amount of food saved.

In 2017, IFR enlarged its commitment to reducing produced food waste by developing a project that also directly involves the consumers. The IFR has reserved space within all its stores dedicated to selling products close to their expiry date. These products are purchased with a discount on the sale price. The initiative has been strengthened through the gradual introduction of the MyFoody app, which is currently available in 18 stores. The app is a free downloadable app for iOS and Android, allowing consumers to discover expiring products with a discount of up to 50% and stores to save food surpluses.
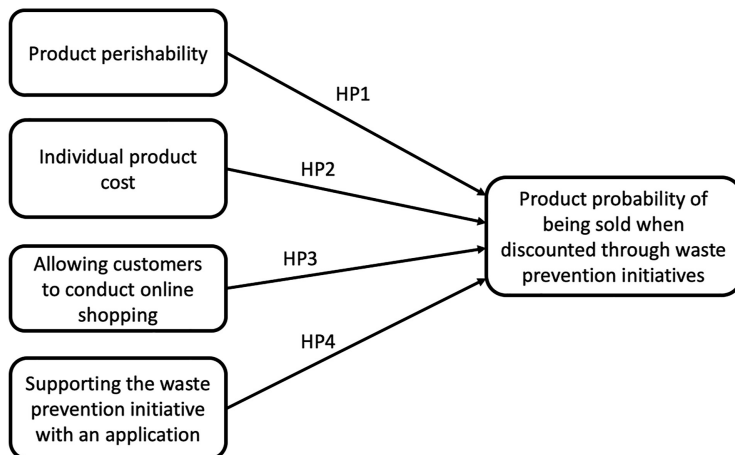

Figure 1.
Hypotheses to be tested

Source(s): Authors work

The app has introduced a digitalization process within the IFR that was fully developed during the pandemic. Indeed, in 2019 the IFR was defining a set of collaborations aimed at introducing the online-shopping service for its stores. The pandemic sped up this process and led the IFR to define an e-commerce system currently available at 11 stores.

3.2 Data description

Data to test the hypotheses presented above were provided by the IFR itself. In more detail, the company provided us with a dataset containing all the products made available to customers in such waste prevention activity, the number of products sold made available to customers in such waste prevention activity, and the number of products made available to customers in such waste prevention activity that was not sold. Data acquired were available for the years 2020 and 2021.

In particular, the dataset contained several variables related both to the products made available through the initiative (i.e., the perishability of the product and the individual product cost) and enabling technology variables related to the stores adopting such waste prevention initiative (i.e., availability of online shopping facility in the stores in which the product was made available to customers, availability of Myfoody application to support the initiative, etc.). The following paragraphs briefly describe the variables and how those were measured.

The perishability of a product is a categorical variable aimed at distinguishing products based on their shelf life. Such variable assumes the value of 3 for long-life products (e.g. canned foods, dry pasta), it takes the value of 2 for fresh products (those products that are perishable in 2–5 days; e.g. fresh dairy products, fresh pasta, etc.), or assumes the value of 1 for very fresh products (those products that are perishable in 1–2 days; e.g. fresh milk, salads, etc.).

Individual product cost is a continuous variable measuring the costs of each product expressed in euros.

The availability of an online shopping facility in the stores where the product was made available to customers is a binary variable assuming the value of 0 for those stores that do not support online shopping and taking the value of 1 for those adopting such an initiative.

Finally, the availability of the Myfoody application to support the initiative is a binary variable assuming the value of 0 for those stores that are not adopting a mobile application for promoting the waste prevention initiative and taking the value of 1 for those adopting such an application.

Descriptive statistics are presented in Tables 1 and 2.

3.3 Regression analysis

A regression analysis was performed to test the hypotheses and better understand the success of the waste prevention activity. Regression analysis examines the correlations

Costs of products	Euros	Products perishability	n of products	% of products
Average product price	3.672	Long-life products	76.537	39.32
Standard deviation of product price	2.302	Fresh products	33.102	17.00
Max product price	20.96 (800 g of smoked Norway salmon)	Very fresh products	85.007	43.67
Min product price	0.23 (a cube of fresh yeast)	Total	194.646	100
Source(s): Authors work				

Table 1. Costs of products and perishability of products, descriptive statistics

between a dependent variable and multiple independent factors, determining if the independent variables have a meaningful relationship with the dependent variables and the relative strength of that relationship. For such reasons, regression analysis is generally adopted as the dominant methodology to test different hypotheses empirically.

Research has shown that regression analysis is a proper statistical method for investigating the likelihood of a discounted food product being sold (Friedman, 2001; Dominici *et al.*, 2021). By identifying significant predictors such as price and discount percentage, a regression analysis enables quantifying the impact of these factors on the probability of a sale (Končar *et al.*, 2019). Moreover, regression analysis has been used in previous studies to help businesses to develop targeted pricing and inventory management strategies that minimize food waste and promote sustainability (Riesenegger and Hübner, 2022; Sakoda *et al.*, 2019).

The nature of the variables enabled us to perform a linear regression analysis computed with SPSS24.

According to Peterson and Harrell (1990), one of the assumptions of regression models is that the cumulative odds ratio for any two values of the covariates is constant across response categories. We positively tested this assumption by applying a likelihood ratio test, where the null hypothesis is that there is no difference in the coefficients among models.

Two variables may be in perfect linear combination in regression analysis. Multicollinearity is a phenomenon that causes the coefficient to become unstable and the standard errors for the coefficient to be exaggerated as the regression model estimates increase. As O'Brien (2007) proposed, collinearity was tested for both models by computing the tolerance and variance inflationary factors (VIFs) for all variables. Multicollinearity was absent in the empirical model, as evidenced by low variance inflation factors and a VIF of less than 5. Moreover, to test the robustness of our model, we computed two other models. The results of such a test are presented in Appendix.

4. Results and discussion
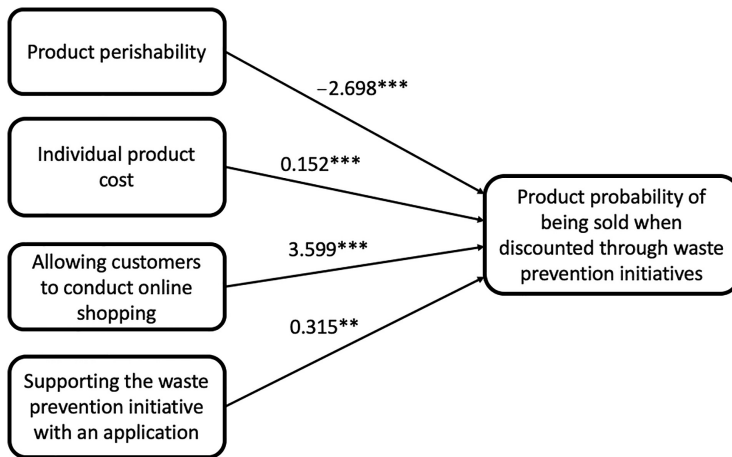The results of the regression analysis are presented in Figure 2.

According to the results in Figure 2, HP1 is rejected as being negative and statistically significant in all models tested. In other words, medium/long-life products do not have a higher probability of being sold when discounted through waste prevention initiatives; on the contrary, according to our data, very fresh products (those products that are perishable in 1–2 days) are those with a higher probability to be sold in waste prevention initiatives.

Our results are in contrast with studies (Chang and Su, 2022; Konuk, 2018) conducted with surveys and experiments on customers, thus quite surprising. Retailers' data indeed suggest that very fresh products are more likely to be sold in waste prevention initiatives. Managing perishable food products near expiration may be challenging, and consumers' ability to properly handle, store and prepare becomes essential (Horoś and Ruppenthal, 2021). For instance, cooking skills are needed when dealing with a fresh or very-fresh product that has to

	N of retails adopting the initiative	% of retails adopting the initiative	N of retails not adopting the initiative	% of retails not adopting the initiative
Online shopping	12	12.6	83	87.4
Myfoodie App	18	18.9	77	81.1
Source(s): Authors work				

Table 2.
Initiatives conducted in stores, descriptive statistics

Note(s): ** $p < 0.05$; *** $p < 0.000$
Source(s): Authors work

be consumed quickly. This may imply that such products are less valuable and of interest to a consumer concerned just with convenience.

Food shopping habits vary widely among consumers, with some individuals opting to shop for groceries daily while others shop weekly. Daily shoppers make smaller, more frequent purchases and are more likely to buy fresh produce and perishable items (Zheng *et al.*, 2020). These shoppers often have greater control over their food choices and may prioritize factors such as freshness (Zheng *et al.*, 2020). Our results, together with the previous literature, seem to underline that customers participating in waste prevention initiatives involving discounted product sales are mostly those conducting daily shopping able to properly handle, store and prepare fresh food next to the expiration date. Such a result is essential also because our data were not coupled with traditional consumers' shopping records. Thus we can also infer some characteristics of the customers mostly participating in this kind of waste prevention initiative.

The second hypothesis (HP2) we tested is supported by being statistically significant in the model tested. In particular, individual product costs resulted in being positive and statistically significant. In other words, products with a higher price have a greater probability of being purchased by customers in waste prevention initiatives involving discounted product sales. In this case, our finding that higher-priced food products are more likely to be purchased by customers corroborates and complements previous research grounded mostly on consumer data (Chang and Su, 2022; Cao *et al.*, 2023). Moreover, previous research has found that consumers associate higher food prices with higher food quality (Aschemann-Witzel *et al.*, 2017). This association between price and quality, together with our results, suggest that consumers choose more expensive products, thus providing greater value for their money, also when participating in waste prevention initiative involving discounted product sales.

HP3 is also supported. In other words, allowing customers to conduct online shopping in the retails where the initiative is implemented positively impacts the sales of discounted products through the waste prevention initiative. Our results contribute to disentangling the mixed effects available in the academic literature about food waste and online grocery shopping. For instance, it has been suggested that the inability of consumers to select specific

items via online interfaces may limit the purchase of quickly perishable products (Pitts *et al.*, 2018). Our result seems to contrast with such results, suggesting that a digital interface like online shopping is quite effective in promoting and selling products near the expiration day. Online grocery shopping has become increasingly popular in recent years, with consumers valuing its convenience and time-saving benefits (Stenius and Eriksson, 2023). Moreover, online grocery shopping has increased purchase frequency and basket size compared to traditional in-store shopping (Lu *et al.*, 2022). This could explain why HP3 is supported in our study. It is likely that offering online shopping as an option for purchasing discounted products in waste prevention initiatives can expand the customer base and increase sales.

Finally, the Myfoody application's availability to support the initiative is statistically significant in all the models tested; thus, HP4 is retained. In other words, supporting the waste prevention initiative with a mobile application positively influences the sales of products discounted through the waste prevention initiative. Our results thus support that digital platforms play a critical role in boosting the efficiency of last-minute discounts by connecting retail businesses and customers by forging the required connections (Ciulli *et al.*, 2019). In contrast with the early research conducted by Frey *et al.* (2017), suggesting that multiple players in food-sharing platforms might have generated a high fragmentation of users among several platforms, we might suggest that users can distinguish between those platforms and make use of them. Those platforms (at least retailer-oriented platforms) can reach a critical mass of users and successfully tackle the problem of food waste.

Our study makes several contributions to the literature, adding to current efforts to comprehend retail store-consumer interactions in the fight against food waste, which is scarcely addressed in recent research (Kliaugaite and Kruopiene, 2017). The study also contributes to a better understanding of sustainable innovation adoption in businesses. Our results support the importance of novel organizational processes and practices, such as identifying products to be sold in waste prevention initiatives; then reaffirming that sustainable innovation also relies on novel practices developed by businesses (Gupta *et al.*, 2020). Moreover, we underscore the significance of digital technologies in driving sustainable innovation in the retail sector and align with the growing body of literature on the role of digital technologies in addressing social and environmental challenges, including food waste prevention (Cane and Parra, 2020). In this regard, innovation practices seem as crucial as digital technologies in stimulating sustainable innovation in businesses.

In addition, our study offers practical implications for managers. Firstly, the study underlines that retailers should be aware that product-related variables and technology-related variables influence the success of food prevention initiatives aimed at selling products close to the expiration date at a discounted price. In particular, our study highlights the importance of tracking and analyzing real-time sales data to gain insights into consumer behavior and preferences. Retailers can use this information to make more informed decisions about inventory management and pricing strategies. Data enables an organization to make the best decisions possible and business intelligence coupled with big data analysis techniques might also be required to deal with those types of initiatives. In particular, retailers, leveraging big data and business intelligence, can optimize their pricing and marketing strategies for products approaching their expiration date by offering discounts tailored to the product's perishability and cost to increase the likelihood of selling these products before they become unsellable. We suggest coupling data collection related to waste prevention initiatives with traditional consumers' shopping records. By doing so, retailers can also leverage those data to offer personalized discounts based on individual customer purchase histories and preferences, increasing the effectiveness of their discounting strategies in waste prevention initiatives.

In addition, leveraging data collection and analysis might also allow a better understanding of how to make synergies with other food waste prevention initiatives.

A better understanding of which products customers buy might allow retailers to address other products close to the expiration date towards caritative food waste prevention initiatives. By doing so, a retailer can shrink the food waste produced and, at the same time, reduce its costs related to the waste management of expired products.

Moreover, our results suggest that developing a waste prevention initiative digitally enabled is much more effective than a traditional one. Retailers can leverage digital technologies to reach a wider audience with discounted products.

In this context, our results suggest that allowing customers to conduct online shopping in retail positively influences the sales of discounted products through the waste prevention initiative. Within this regard, an appropriate suggestion for retailers is to invest in a user-friendly and intuitive e-commerce platform that enables customers to easily browse and purchase products close to the expiration date at a discounted price. Since more and more users are shopping with desktop and mobile platforms (Chai and Yat, 2019), retailers should ensure the platforms are optimized for both devices.

Moreover, online and mobile platforms can advertise these products to a more extensive customer base, including those who may not have been aware of the in-store promotions. A suggestion for retailers is to establish a deeper interaction with consumers, for instance, by using push notifications to inform people of discounted products near the expiration date. Retailers can also incorporate geolocation technology into their mobile applications to target customers who are close to their stores. This can be a valuable feature for promoting discounted products nearing expiration dates. Moreover, applications for advertising products sold at a discount in waste prevention initiatives can also be used to promote discounted products and easy-to-make recipes that use the discounted perishables items.

5. Conclusions
The paper, adopting the sustainable innovation lens, aims to understand the success factors influencing retailer waste prevention initiatives targeted at selling products close to the expiration date at a discounted price. Our results suggest that the perishability and the cost of products influence the sales of those products when sold at a discount. Moreover, our results stress the importance of digital technologies in supporting initiatives aiming at advertising products close to the expiration date, likely to be wasted, to be sold at a discounted price.

The results presented in our research represent a contribution both for retailers that want to prevent food waste creation, for academics that are observing the phenomena and for policymakers that aim at reducing the amount of wasted food according to global sustainability priorities and at fostering retailers towards food waste management practices. The results contribute also to developing the literature about sustainable innovation and identifying factors that might contribute to the development of successful sustainable innovation initiatives in businesses.

Even if the results presented in our research are relevant, some limitations must be acknowledged. First, data collected and used would require other variables to completely interpret the phenomenon. Variables related to customers, for instance demographics, individual household composition and socioeconomic status, are indeed missing in our investigation. We must also acknowledge that the study is based on a sample of retailers in a specific geographic area, which may limit the generalizability of the results to other world regions or contexts. Another potential limitation is related to the fact that data were collected during the pandemic period. Indeed, this might have influenced the analysis; however, data collected during such a time frame might correctly suggest a change in consumer behavior toward groceries shopping. Thus, more research in this respect is needed. Indeed, although the COVID-19 outbreak immediately caused a modification in some consumption patterns,

inevitable consequences could linger for years due to dynamics that develop in the months and years that follow.

Future research, for instance, might explore other variables impacting waste prevention initiatives promoted by retailers. For example, how trust in the retailer might allow consumers to participate in such initiatives. Moreover, considering the importance of technologies, future research might also better understand how to build synergies with other technologies (e.g. the Internet of Things (IoT), which might allow dynamic pricing) to improve even more food waste reduction by retailers.

References

Aschemann-Witzel, J. (2018), "Helping you to waste less? Consumer acceptance of food marketing offers targeted to food-related lifestyle segments of consumers", *Journal of Food Products Marketing*, Vol. 24 No. 5, pp. 522-538.

Aschemann-Witzel, J., Varela, P. and Peschel, A.O. (2019), "Consumers' categorization of food ingredients: do consumers perceive them as 'clean label' producers expect? An exploration with projective mapping", *Food Quality and Preference*, Vol. 71, pp. 117-128.

Aschemann-Witzel, J. and Zielke, S. (2017), "Can't buy me green? A review of consumer perceptions of and behavior toward the price of organic food", *Journal of Consumer Affairs*, Vol. 51 No. 1, pp. 211-251.

Bigdeloo, M., Teymourian, T., Kowsari, E., Ramakrishna, S. and Ehsani, A. (2021), "Sustainability and circular economy of food wastes: waste reduction strategies, higher recycling methods, and improved valorization", *Materials Circular Economy*, Vol. 3 No. 1, pp. 1-9.

Bos-Brouwers, H.E.J. (2010), "Corporate sustainability and innovation in SMEs: evidence of themes and activities in practice", *Business Strategy and the Environment*, Vol. 19 No. 7, pp. 417-435.

Bos-Brouwers, H.E.J., Soethoudt, J.M., Canali, M., Östergren, K., Amani, P., Aramyan, L., Sijtsema, S.J., Korhonen, O. and O'Connor, C. (2014), "Drivers of current food waste generation, threats of future increase and opportunities for reduction", *FUSIONS N FP7-KBBE-2012-6-311972*.

Broekmeulen, R.A., Sternbeck, M.G., van Donselaar, K.H. and Kuhn, H. (2017), "Decision support for selecting the optimal product unpacking location in a retail supply chain", *European Journal of Operational Research*, Vol. 259 No. 1, pp. 84-99.

Calik, E., Badurdeen, F. and Bal, A. (2020), "Cooperation networks and organizational factors on sustainable innovation", *Journal on Innovation and Sustainability RISUS*, Vol. 11 No. 1, pp. 94-121.

Cane, M. and Parra, C. (2020), "Digital platforms: mapping the territory of new technologies to fight food waste", *British Food Journal*, Vol. 2020 March 23.

Cao, S., Gong, S. and Bai, L. (2023), "Situational variables that affect consumers' suboptimal food purchasing behavior in China", *British Food Journal*, Vol. 125 No. 1, pp. 145-166.

Caputo, V., Sacchi, G. and Lagoudakis, A. (2018), "Traditional food products and consumer choices: a review", *Case Studies in the Traditional Food Sector*, January 1, pp. 47-87.

Chang, H.H. and Su, J.W. (2022), "Sustainable consumption in Taiwan retailing: the impact of product features and price promotion on purchase behaviors toward expiring products", *Food Quality and Preference*, Vol. 96, 104452.

Carmela Annosi, M., Brunetta, F., Capo, F. and Heideveld, L. (2020), "Digitalization in the agri-food industry: the relationship between technology and sustainable development", *Management Decision*, Vol. 58 No. 8, pp. 1737-1757.

Chai, L.T. and Yat, D.N.C. (2019), "Online food delivery services: Making food delivery the new normal", *Journal of Marketing advances and Practices*, Vol. 1 No. 1, pp. 62-77.

Cicatiello, C., Secondi, L. and Principato, L. (2019), "Investigating consumers' perception of discounted suboptimal products at retail stores", *Resources*, Vol. 8 No. 3, 129.

Cillo, V., Petruzzelli, A.M., Ardito, L. and Del Giudice, M. (2019), "Understanding sustainable innovation: a systematic literature review", *Corporate Social Responsibility and Environmental Management*, Vol. 26 No. 5, pp. 1012-1025.

Ciulli, F., Kolk, A. and Boe-Lillegraven, S. (2019), "Digital platforms for food waste recovery".

Ciulli, F., Kolk, A. and Boe-Lillegraven, S. (2020), "Circularity brokers: digital platform organizations and waste recovery in food supply chains", *Journal of Business Ethics*, Vol. 167 No. 2, pp. 299-331.

de Moraes, C.C., de Oliveira Costa, F.H., Pereira, C.R., da Silva, A.L. and Delai, I. (2020), "Retail food waste: mapping causes and reduction practices", *Journal of Cleaner Production*, Vol. 256, 120124.

Dominici, A., Boncinelli, F., Gerini, F. and Marone, E. (2021), "Determinants of online food purchasing: the impact of socio-demographic and situational factors", *Journal of Retailing and Consumer Services*, Vol. 60, 102473.

Dora, M., Biswas, S., Choudhary, S., Nayak, R. and Irani, Z. (2021), "A system-wide interdisciplinary conceptual framework for food loss and waste mitigation strategies in the supply chain", *Industrial Marketing Management*, Vol. 93, pp. 492-508.

Dressler, M. and Paunovic, I. (2020), "Converging and diverging business model innovation in regional intersectoral cooperation–exploring wine industry 4.0", *European Journal of Innovation Management*, Vol. 24 No. 5, pp. 1625-1652, Emerald Publishing.

Edjabou, M.E., Petersen, C., Scheutz, C. and Astrup, T.F. (2016), "Food waste from Danish households: generation and composition", *Waste Management*, Vol. 52, pp. 256-268.

Eriksson, M., Strid, I. and Hansson, P.A. (2016), "Food waste reduction in supermarkets–Net costs and benefits of reduced storage temperature", *Resources, Conservation and Recycling*, Vol. 107, pp. 73-81.

Falcone, P.M. and Imbert, E. (2017), "Bringing a sharing economy approach into the food sector: the potential of food sharing for reducing food waste", *Food Waste Reduction and Valorisation*, Springer, Cham, pp. 197-214.

Franceschelli, M.V., Santoro, G. and Candelo, E. (2018), "Business model innovation for sustainability: a food start-up case study", *British Food Journal*, Vol. 120 No. 10, pp. 2483-2494, doi: 10.1108/ BFJ-01-2018-0049.

Frey, M., Gusmerotti, N.M., Corsini, F. and Sarti, S. (2017), "Food sharing: Making sense between new business models and responsible social initiatives for food waste prevention", *Food Sharing: Making Sense Between New Business Models and Responsible Social Initiatives for Food Waste Prevention*, pp. 123-134.

Friedman, J. (2001), "Greedy function approximation: a gradient boosting machine", *Annals of Statistics*, Vol. 29 No. 5, pp. 1189-1232.

Galati, A., Moavero, P. and Crescimanno, M. (2019), "Consumer awareness and acceptance of irradiated foods: the case of Italian consumers", *Food Research International*, Vol. 119, pp. 291-296.

Garrone, P., Melacini, M. and Perego, A. (2014), "Surplus food recovery and donation in Italy: the upstream process", *British Food Journal*.

Ghobakhloo, M., Iranmanesh, M., Grybauskas, A., Vilkas, M. and Petraitė, M. (2021), "Industry 4.0, innovation, and sustainable development: a systematic review and a roadmap to sustainable innovation", *Business Strategy and the Environment*, Vol. 30 No. 8, pp. 4237-4257.

Gupta, H., Kusi-Sarpong, S. and Rezaei, J. (2020), "Barriers and overcoming strategies to supply chain sustainability innovation", *Resources, Conservation and Recycling*, Vol. 161, 104819.

Göbel, C., Langen, N., Blumenthal, A., Teitscheid, P. and Ritter, G. (2015), "Cutting food waste through cooperation along the food supply chain", *Sustainability*, Vol. 7 No. 2, pp. 1429-1445.

Grunert, K.G. (2007), "How consumers perceive food quality", in Frewer, L. and van Trijp, H.C. (Eds), *Understanding Consumers of Food Products*, Woodhead, Cambridge, pp. 181-199.

Harvey, J., Smith, A., Goulding, J. and Illodo, I.B. (2020), "Food sharing, redistribution, and waste reduction via mobile applications: a social network analysis", *Industrial Marketing Management*, Vol. 88, pp. 437-448.

Hassoun, A., Prieto, M.A., Carpena, M., Bouzembrak, Y., Marvin, H.J., Pallarés, N., Barba, F.J., Bangar, S.P., Chaudhary, V., Ibrahim, S. and Bono, G. (2022), "Exploring the role of green and Industry 4.0 technologies in achieving sustainable development goals in food sectors", *Food Research International*, October 20, 112068.

Horoś, I.K. and Ruppenthal, T. (2021), "Avoidance of food waste from a grocery retail store owner's perspective", *Sustainability*, Vol. 13 No. 2, p. 550.

Huang, I.Y., Manning, L., James, K.L., Grigoriadis, V., Millington, A., Wood, V. and Ward, S. (2021a), "Food waste management: a review of retailers' business practices and their implications for sustainable value", *Journal of Cleaner Production*, Vol. 285, 125484.

Huang, W.S., Kuo, H.Y., Tung, S.Y. and Chen, H.S. (2021b), "Assessing consumer preferences for suboptimal food: application of a choice experiment in citrus fruit retail", *Foods*, Vol. 10 No. 1, p. 15.

International Food Information Council [IFIC] (2020), "A consumer survey on plant alternatives to animal meat 2.0".

Jurgilevich, A., Birge, T., Kentala-Lehtonen, J., Korhonen-Kurki, K., Pietikäinen, J., Saikku, L. and Schösler, H. (2016), "Transition towards circular economy in the food system", *Sustainability*, Vol. 8 No. 1, 69.

Kache, F. and Seuring, S. (2017), "Challenges and opportunities of digital information at the intersection of big data analytics and supply chain management", *International Journal of Operations and Production Management*, Vol. 37 No. 1, pp. 10-36.

Kliaugaite, D. and Kruopiene, J. (2017), "Food waste generation and prevention measures in retail sector: a comparative study", *Environmental Research, Engineering and Management*, Vol. 73 No. 4, pp. 7-20.

Končar, J., Grubor, A. and Marić, R. (2019), "Improving the placement of food products of organic origin on the AP Vojvodina market", *Strategic Management*, Vol. 24 No. 3, pp. 24-32.

Konuk, F.A. (2018), "The role of risk aversion and brand-related factors in predicting consumers' willingness to buy expiration date-based priced perishable food products", *Food Research International*, Vol. 112, pp. 312-318.

Kummu, M., de Moel, H., Porkka, M., Siebert, S., Varis, O. and Ward, P.J. (2012), "Lost food, wasted resources: global food supply chain losses and their impacts on freshwater, cropland, and fertiliser use", *Science of the Total Environment*, Vol. 438, pp. 477-489.

Li, X., Zhao, X. and Pu, W. (2020), "Measuring ease of use of mobile applications in e-commerce retailing from the perspective of consumer online shopping behaviour patterns", *Journal of Retailing and Consumer Services*, Vol. 55, 102093.

Lu, M., Wang, R. and Li, P. (2022), "Comparative analysis of online fresh food shopping behavior during normal and COVID-19 crisis periods", *British Food Journal*, Vol. 124 No. 3, pp. 968-986.

Mazzucchelli, A., Gurioli, M., Graziano, D., Quacquarelli, B. and Aouina-Mejri, C. (2021), "How to fight against food waste in the digital era: key factors for a successful food sharing platform", *Journal of Business Research*, Vol. 124, pp. 47-58.

Mena, C., Adenso-Diaz, B. and Yurt, O. (2011), "The causes of food waste in the supplier–retailer interface: evidences from the UK and Spain", *Resources, Conservation and Recycling*, Vol. 55 No. 6, pp. 648-658.

Michelini, L., Grieco, C. and Iasevoli, G. (2018), "The financial attractiveness of sharing business models", *Transformative Business Strategies and New Patterns for Value Creation*, Vol. 63, p. 14.

Michelini, L., Grieco, C., Ciulli, F. and Di Leo, A. (2020), "Uncovering the impact of food sharing platform business models: a theory of change approach", *British Food Journal*.

Morella, P., Lambán, M.P., Royo, J. and Sánchez, J.C. (2021), "Study and analysis of the implementation of 4.0 technologies in the agri-food supply chain: a state of the art", *Agronomy*, Vol. 11 No. 12, 2526.

Ojha, S., Bußler, S. and Schlüter, O.K. (2020), "Food waste valorisation and circular economy concepts in insect production and processing", *Waste Management*, Vol. 118, pp. 600-609.

O'brien, R.M. (2007), "A caution regarding rules of thumb for variance inflation factors", *Quality and Quantity*, Vol. 41 No. 5, pp. 673-690.

Parfitt, J., Barthel, M. and Macnaughton, S. (2010), "Food waste within food supply chains: quantification and potential for change to 2050", *Philosophical Transactions of the Royal Society B: Biological Sciences*, Vol. 365 No. 1554, pp. 3065-3081.

Peterson, B. and Harrell, F.E. Jr (1990), "Partial proportional odds models for ordinal response variables", *Journal of the Royal Statistical Society: Series C (Applied Statistics)*, Vol. 39 No. 2, pp. 205-217.

Pitts, S.B.J., Ng, S.W., Blitstein, J.L., Gustafson, A. and Niculescu, M. (2018), "Online grocery shopping: promise and pitfalls for healthier food and beverage purchases", *Public Health Nutrition*, Vol. 21 No. 18, pp. 3360-3376.

Qi, D. and Roe, B.E. (2016), "Household food waste: multivariate regression and principal components analyses of awareness and attitudes among US consumers", *PloS One*, Vol. 11 No. 7, e0159250.

Reynolds, A., Mann, J., Cummings, J., Winter, N., Mete, E. and Te Morenga, L. (2019), "Carbohydrate quality and human health: a series of systematic reviews and meta-analyses", *The Lancet*, Vol. 393 No. 10170, pp. 434-445.

Riesenegger, L. and Hübner, A. (2022), "Reducing food waste at retail stores—an explorative study", *Sustainability*, Vol. 14 No. 5, 2494.

Rodrigues, V.S., Demir, E., Wang, X. and Sarkis, J. (2021), "Measurement, mitigation and prevention of food waste in supply chains: an online shopping perspective", *Industrial Marketing Management*, Vol. 93, pp. 545-562.

Roe, B.E., Bender, K. and Qi, D. (2021), "The impact of COVID-19 on consumer food waste", *Applied Economic Perspectives and Policy*, Vol. 43 No. 1, pp. 401-411.

Sakoda, G., Takayasu, H. and Takayasu, M. (2019), "Data science solutions for retail strategy to reduce waste keeping high profit", *Sustainability*, Vol. 11 No. 13, 3589.

Song, W., Li, W. and Geng, S. (2020), "Effect of online product reviews on third parties' selling on retail platforms", *Electronic Commerce Research and Applications*, Vol. 39, 100900.

Spada, A., Conte, A. and Del Nobile, M.A. (2018), "The influence of shelf life on food waste: a model-based approach by empirical market evidence", *Journal of Cleaner Production*, Vol. 172, pp. 3410-3414.

Stenius, M. and Eriksson, N. (2023), "What beliefs underlie decisions to buy groceries online?", *International Journal of Consumer Studies*, Vol. 47 No. 3, pp. 922-935.

Teller, C., Holweg, C., Reiner, G. and Kotzab, H. (2018), "Retail store operations and food waste", *Journal of Cleaner Production*, Vol. 185, pp. 981-997.

Theotokis, A., Pramatari, K. and Tsiros, M. (2012), "Effects of expiration date-based pricing on brand image perceptions", *Journal of Retailing*, Vol. 88 No. 1, pp. 72-87.

Vittuari, M., Azzurro, P., Gaiani, S., Gheoldus, M., Burgos, S., Aramyan, L., Valeeva, N., Rogers, D., Östergren, K., Timmermans, T. and Bos-Brouwers, H. (2016), "Recommendations and guidelines for a common European food waste policy framework", *Fusions*, Vancouver.

von Kameke, C. and Fischer, D. (2018), "Preventing household food waste via nudging: an exploration of consumer perceptions", *Journal of Cleaner Production*, Vol. 184, pp. 32-40.

Yang, C.Y. and Yang, C.H. (2019), "The impact of sustainable environmental management in the food and beverage industry on customer loyalty: a view of brand attitude", *Ekoloji*, Vol. 28 No. 107, pp. 965-972.

Zheng, Q., Chen, J., Zhang, R. and Wang, H.H. (2020), "What factors affect Chinese consumers' online grocery shopping? Product attributes, e-vendor characteristics and consumer perceptions", *China Agricultural Economic Review*, Vol. 12 No. 2, pp. 193-213.

Further reading

Buzby, J.C., Hyman, J., Stewart, H. and Wells, H.F. (2011), "The value of retailand costomer-level fruit and vegetable losses in the United States", *Journal of Consumer Affairs*, Vol. 45 No. 3, pp. 492-515.

Carayannis, E.G. and Alexander, J. (1999), "Winning by co-opeting in strategic government university-industry R&D partnerships: the power of complex, dynamic knowledge networks", *The Journal of Technology Transfer*, Vol. 24 Nos 2-3, pp. 197-210.

de Hooge, I.E., van Dulm, E. and van Trijp, H.C. (2018), "Cosmetic specifications in the food waste issue: supply chain considerations and practices concerning suboptimal food products", *Journal of Cleaner Production*, Vol. 183, pp. 698-709.

Gruber, V., Holweg, C. and Teller, C. (2016), "What a waste! Exploring the human reality of food waste from the store manager's perspective", *Journal of Public Policy and Marketing*, Vol. 35 No. 1, pp. 3-25.

Hartmann, C., Siegrist, M. and van der Horst, K. (2013), "Snack frequency: associations with healthy and unhealthy food choices", *Public Health Nutrition*, Vol. 16 No. 8, pp. 1487-1496.

Lebersorger, S. and Schneider, F. (2014), "Food loss rates at the food retail, influencing factors and reasons as a basis for waste prevention measures", *Waste Management*, Vol. 34 No. 11, pp. 1911-1919.

Lee, K.C. (2018), "Grocery shopping, food waste, and the retail landscape of cities: the case of Seoul", *Journal of Cleaner Production*, Vol. 172, pp. 325-334.

Lee, J.-Y., Fang, E., Kim, J.J., Li, X. and Palmatier, R.W. (2018), "The effect of online shopping platform strategies on search, display, and membership revenues", *Journal of Retailing*, Vol. 94 No. 3, pp. 247-264.

Lubberink, R., Blok, V., Van Ophem, J. and Omta, O. (2017), "Lessons for responsible innovation in the business context: a systematic literature review of responsible, social and sustainable innovation practices", *Sustainability*, Vol. 9 No. 5, 721.

Marx-Pienaar, N.J. and Erasmus, A.C. (2014), "Status consciousness and knowledge as potential impediments of households' sustainable consumption practices of fresh produce amidst times of climate change", *International Journal of Consumer Studies*, Vol. 38 No. 4, pp. 419-426.

Passetti, E.E., Battaglia, M., Bianchi, L. and Annesi, N. (2021), "Coping with the COVID-19 pandemic: the technical, moral and facilitating role of management control", *Accounting, Auditing and Accountability Journal*, Vol. 34 No. 6, pp. 1430-1444.

Stangherlin, I.D.C., Duarte Ribeiro, J.L. and Barcellos, M. (2019), "Consumer behaviour towards suboptimal food products: a strategy for food waste reduction", *British Food Journal*, Vol. 121 No. 10, pp. 2396-2412.

Tromp, S.O., Haijema, R., Rijgersberg, H. and van der Vorst, J.G. (2016), "A systematic approach to preventing chilled-food waste at the retail outlet", *International Journal of Production Economics*, Vol. 182, pp. 508-518.

Völckner, F. and Hofmann, J. (2007), "The price-perceived quality relationship: a meta-analytic review and assessment of its determinants", *Marketing Letters*, Vol. 18 No. 3, pp. 181-196.

Appendix
Models tested

We decided to assess the robustness of our results testing additional models. In particular:

(1) In model 1 (i.e. the original model) we tested all variables considering data from the years 2020 and 2021;

(2) In model 2 we tested all variables considering only data from the year 2020;

(3) In model 3 we tested all variables considering only data from the year 2021;

Variables name	Model 1 Coef. (P > z)	Model 2 Coef. (P > z)	Model 3 Coef. (P > z)
Product perishability	−2.698 (0.000)***	−2.639 (0.000)***	−2.755 (0.000)***
Individual product cost	0.152 (0.000)***	0.145 (0.002)**	0.159 (0.003)**
Online shopping	3.599 (0.000)***	3.932 (0.000)***	3.265 (0.000)***
Myfoodie App	0.315 (0.003)**	0.282 (0.050)**	0.347 (0.023)**
Constant	3.887 (0.000)***	4.005 (0.000)***	3.768 (0.000)***
Pseudo R2	0.481	0.462	0.474
LRchi2	***	***	***

Note(s): *** $p < 0.000$; ** $p < 0.05$
Source(s): Authors work

Table A1.
Models tested

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