

Examining consumer food waste through grocery retailers' customer data: Segments and practical implications

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Abstract

Grocery retailers have a large amount of societally relevant data on food purchases in their databases, which they have traditionally used merely for marketing purposes. However, despite the potential, the data have so far been rarely used in sustainability-related research. This study addresses a key sustainability challenge—the reduction of food waste—by using retailers' customer data and a questionnaire. This paper's purpose is to identify and analyse household food waste segments and discuss their actual purchasing behaviour patterns. By doing so, we also illustrate and exemplify the potential use of customer loyalty card data to address global challenges related to food at the consumer level. The study utilizes an extensive data set of food purchases together with a survey of self-reported reasons for food waste in households. Utilizing cluster analysis, Phase 1 identifies six household segments: no food waste; trust in date labels; safety first; occasional wasters; overpurchasers and overpreparers; and family first. These segments differ in their sociodemographic and purchase profiles. In Phase 2, these segments' purchasing behaviour is examined further by applying tree-based methods. This study contributes to food waste research and studies on sustainable retailing. It also has practical implications for how retailers can facilitate household food waste reduction.

KEYWORDS

customer data, food waste, grocery retailing

1 | INTRODUCTION

Contemporary grocery retailers have a significant volume of data on consumers' food purchases in their customer databases. Traditionally, customer data have been generated through various loyalty schemes that allow the collection and integration of point-of-sale (POS) data (i.e., what, when, and where the food products were bought) and customer demographics (who bought the products). This has provided grocery retailers with a multitude of benefits related to marketing and customer relationship management. However, the data have vast potential regarding their use for other kinds of purposes, including being used for the benefit of the customer by giving them access to their own data (Saarijärvi et al., 2016). Compared to other data collection methods such as surveys, this kind of data offers an objective and

detailed view of consumers' selection and intake of food and drink. As a result, the data have been used to study issues such as good nutrition and health (Vepsäläinen et al., 2022), which are part of the United Nations' sustainability goals.

To the authors' knowledge there is, however, little evidence on how this kind of consumer data could be harnessed to tackle other sustainability challenges related to food. In this paper, we discuss the potential of grocery retailers' customer purchase data in addressing the problem of food waste. According to the United Nations Environmental Programme (UNEP, 2021) Food Waste Index report, approximately 931 million tons of food waste were generated globally in 2019—61% of which came from households, 26% from food services, and 13% from retail. According to the definition of food waste used in the index, this amount includes food and associated inedible parts

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removed from the human food supply chain in retail, food service, and households (UNEP, 2021, p. 9). By inedible parts, the index refers to the components associated with food that are not intended to be consumed by humans (e.g., bones, rinds, and pits/stones). In addition, food is lost in the preceding stages of the food supply chain, such as in harvesting and transportation. In 2015, the United Nations' Sustainable Development Goal 12.3 set the following target for 2030: 'halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses' (United Nations, 2015). Since then, food waste reduction has garnered increasing research efforts (for a review, see Harvey et al., 2022) and political and public attention. As a result, this issue has also been added to many companies' sustainability agendas. Grocery retailers have become interested in reducing food waste in recent years, as this offers them the possibility of reducing inefficiencies in their operations while simultaneously boosting their corporate social responsibility (Aschemann-Witzel, de Hooge, et al., 2017; Devin & Richards, 2018). However, previous research has not examined the potential of retailers' use of customers' actual purchase data to address the issue of food waste. Shopping for food is tightly connected with household food waste, for example, what is bought, when, and how much (Stancu et al., 2016). Thus, having access to grocery retailers' purchase data can also offer important insights for food waste research.

This paper's purpose is to identify and analyse household food waste segments and to discuss their actual purchasing behaviour patterns. By doing so, we illustrate and exemplify the potential use of customer loyalty card data in addressing global challenges related to food at the consumer level. The paper also has implications for retailers to facilitate household food waste reduction based on the use of customer data. In addition to household food waste, another example challenge would be the need to transition from meat- to plant-based diets. Here, food retailers' loyalty card data may help in understanding patterns of consumption and identifying segments from novel perspectives. To address the purpose of this paper, we utilized an extensive customer data set from a large grocery retailer. Our research questions are as follows: 'How can households be segmented according to their food waste behavior?' and 'How can retailers' customer data be used to predict membership in food waste segments?' To answer these questions, the retailer data were combined with survey data in which customers were asked to self-report the reasons why food goes to waste in their households.

In Phase 1, we used a cluster analysis of the survey data to segment households based on the reasons for food waste. As a result, we identified six distinct segments that differed in their self-reported reasons for food waste. We further examined these segments in terms of actual purchasing behaviour in select product categories (i.e., bread, fresh fruit, and vegetables). In Phase 2, we used a tree-based classification algorithm to predict membership in food waste segments based solely on customers' backgrounds and purchasing behaviour data.

This paper contributes to studies on food waste and sustainable grocery retailing (Gravelly & Fraser, 2018; Vadakkepatt et al., 2021; Young et al., 2018). While shopping for food is tightly connected with

household food waste, exploring such behaviour through customer loyalty card data can extend the understanding of the what, when, and how of food waste (see Stancu et al., 2016). Although the loyalty card data itself do not include information on the amount of food waste, in combination with complementary survey methods, the data can provide a more objective means of investigating the various demographic and behavioural dynamics related to household food waste that extend beyond traditional empirical inquiries. Furthermore, we showcase how combining purchasing behaviour data from a loyalty card program with self-reported food waste behaviours can offer retailers the possibility of leveraging their customer data beyond their own financial interests and creating social good in society. With a data-based understanding of consumer profiles related to food waste, food retailers can design appropriate communication and take action to reduce waste, thereby serving customers in ways that go beyond the traditional scope of food retailing. Furthermore, retailers can use the data to provide feedback to their customers about their behaviour related to sustainability issues, such as food waste, which has been found to be a potential route for behaviour change (Stöckli et al., 2018; Von Kameke & Fischer, 2018).

2 | CONCEPTUAL BACKGROUND

2.1 | Reasons for household food waste and existing retailer interventions

Even though food waste is a problem that occurs throughout the food supply chain, most existing research is related to consumers and households. First, at the macro level, factors related to households' living conditions affect food waste behaviours. According to a study that utilized Eurobarometer statistical data, people living in urban areas and affluent countries in Europe tend to waste more food than countryside households and less affluent countries (Secondi et al., 2015). Furthermore, some evidence has indicated that people with higher incomes waste more food (Filipová et al., 2017). At the individual/micro level, previous research has discovered some demographic insights; for example, older generations are less likely to waste food, and women generally are likelier to engage in food waste reduction (Secondi et al., 2015). Furthermore, previous research has investigated the role of education, positing that more highly educated consumers waste more food (Secondi et al., 2015).

Another set of studies focused on cognitive and behavioural aspects in explaining the reasons for food waste. Consumers increasingly harbour more intentions to reduce food waste due to moral or environmental concerns about the problem, but they alone do not explain consumer behaviour (Stefan et al., 2013). This may be because consumers function simultaneously with multiple goals, and food waste reduction is only one of them. For instance, a survey on consumer attitudes in the United States revealed that, as consumers become more anxious about food-borne illnesses, they prefer to eat fresh food (Neff et al., 2015). Furthermore, several studies have highlighted that perceived behavioural control exerts a strong effect

on food waste behaviours (Mondéjar-Jiménez et al., 2016; Stancu et al., 2016; Stefan et al., 2013; Visschers et al., 2016). This has been measured by asking study participants to determine whether they viewed food waste as avoidable or unavoidable and easy or difficult (Stancu et al., 2016). The more perceived behavioural control participants had, the less food waste they reportedly produced. In addition to attitudes, social norms, and perceived behavioural control, a so-called 'good provider identity' can explain food waste (Visschers et al., 2016). The good provider identity phenomenon asserts that consumers sometimes prioritize providing healthy family meals over reducing food waste.

In addition to cognitive and psychological factors, routines embedded in consumers' everyday lives that are tied to the sociocultural and material contexts in which they live impact food waste behaviours (Hebrok & Boks, 2017; Hebrok & Heidenstrøm, 2019). In particular, shopping and leftover routines significantly impact food waste (Stancu et al., 2016), but planning and waste-sorting routines also influence this issue (Secondi et al., 2015). The skills needed to implement routines in ways that reduce food waste (e.g., planning and cooking skills) are important (Romani et al., 2018; Sirola et al., 2019; Stancu et al., 2016). Furthermore, consumers' lifestyles vary across different cultural contexts, impacting food-related practices. For instance, Japanese consumers are accustomed to shopping fairly often, and packaging sizes are small (Sirola et al., 2019).

On the retailer side, marketing and sales strategies, including store layout and promotions, are viewed as negatively impacting consumer food waste (Mondéjar-Jiménez et al., 2016). However, the removal of 'buy one, get one free' promotions is viewed as an effective solution to reducing overpurchasing (Calvo-Porrá et al., 2017). The Danish supermarket chain Rema 1000 began doing this to reduce food waste in 2008 and garnered publicity and goodwill, and it inspired imitators in other European countries (Aschemann-Witzel, de Hooge, et al., 2017). Consumers' interpretations of date labels also affect food waste; thus, retailers and food manufacturers should clarify date labelling (Calvo-Porrá et al., 2017). For instance, the 'use by' date sends a strong message that the product cannot be used after a certain date, while consumers interpret 'sell by' or 'fresh before' more flexibly (Neff et al., 2019; Wilson et al., 2017). Date labels are not used in all types of product packaging. Recently, retailers in the United Kingdom, for example, have started to remove 'best before' dates from fruit and vegetable packaging to cut waste (Jolly, 2022). Furthermore, Aschemann-Witzel et al. (2016) suggested that product packaging could be utilized to provide information on appropriate storage, as well as the ability to freeze the food contained in it, to reduce food waste in the household.

In addition, retailers can help households reduce food waste by communicating about it to their customers. A survey suggested that messages linked to saving money may work better than those directly linked to environmental aspects of food waste (Neff et al., 2015). Young et al. (2018) studied one grocery retailer's communication efforts regarding food waste reduction and found that repeated messages using different communication channels, especially conventional ones, were effective at reducing consumer food waste. While food

freshness traditionally has been one of the key marketing arguments (Aschemann-Witzel et al., 2016), many retailers have recently adopted the practice of selling price-reduced, suboptimal products (Aschemann-Witzel, Haagen Jensen, et al., 2017). It has been established that consumers are willing to purchase such products at a discount (Aschemann-Witzel, de Hooge, et al., 2017). Retailers have also launched campaigns to promote suboptimal fruit and vegetables, such as the French Intermarché's Inglorious fruit and vegetables in 2014, significantly raising consumer awareness of food waste (Aschemann-Witzel et al., 2016). The success factors of retailers' initiatives include timing and collaboration across the supply chain with other partners and with taking advantage of new business opportunities (Aschemann-Witzel, de Hooge, et al., 2017). Furthermore, a recent study examined the effects of shopping at different retail store formats (hypermarket, supermarket, traditional market, family store), as well as shopping frequency (Lee, 2018), and found that the longer the travel time to the store and the less frequent the purchases, the more waste in the household. Overall, these findings suggest that retailers can shape households' grocery shopping patterns and, thus, their food waste behaviour, not only through marketing communications, but also by taking account of their retail store formats and customers' purchasing frequency (Giordano et al., 2019).

2.2 | Using customer data in retailing

In the digitized retailing environment, companies' abilities to collect, analyse, and translate customer data into a source of competitive advantage is becoming increasingly important (Krafft et al., 2021). Using customer data helps retailers achieve more effective category management (Dhar et al., 2001) and cross-selling (Liu-Thompkins & Tam, 2013), thereby building customer retention (Reinartz et al., 2008), tailoring marketing communications, developing appropriate segmentation, and identifying the most profitable and unprofitable customer segments (Payne & Frow, 2005). A common characteristic of retailers' customer data use has been a desire to maximize customer lifetime value, that is, to determine which customers buy what and when to help retailers design more effective ways to influence customers' future purchasing behaviour, build more profitable customer relationships, and manage supply chains and related processes accordingly.

We argue that the vast societal potential related to customer data remains largely untapped. Many customer data initiatives aim to address retailers' needs—that is, collecting data and converting it into information that benefits the retailer first and foremost. Recently, many initiatives have showcased how the retailer-centric perspective of using customer data is being extended through a customer-centric perspective. Retailers have developed mobile services that offer customers relevant information about their purchases. For example, the Finnish grocery chain S Group has introduced an application that provides customers with information about expenditures on different food groups, total and food group-based carbon dioxide emissions, and the basic nutrient content of purchases. Similarly, Kesko Group,

another major retailer in Finland, has initiated an app that, for example, helps customers set goals for themselves and provides suggestions on how to meet these goals by purchasing food.

Importantly, in both of the examples above, the information is based on customers' own longitudinal purchase data, but traditional customer loyalty program data (POS and demographic data) are enriched by additional information related to the nutritional values of food products, their assessed carbon dioxide emissions, or domesticity level. As issues related to food healthfulness and sustainability increasingly have become important for consumers and society at large, gaining access to information related to these themes—based on consumers' own purchases—can be a source of additional value for many consumers today. This type of information, resulting from the reverse use of customer data (Saarijärvi et al., 2014), can be viewed as an additional resource that consumers can use in their transformative quests towards healthier diets, weight loss, becoming more conscious consumers, or favouring domestic products (Saarijärvi et al., 2016). Consequently, these types of initiatives focus first on leveraging customer data to benefit the customer and, as suggested by C. Lim et al. (2019, p. 105), 'using data to advance service'. Furthermore, moving beyond a focus on customer relationships, the potential of large-scale customer data to address sustainability issues at the societal level remains an unrealized opportunity that is addressed in the current paper.

3 | DESIGN AND METHODS

The present study is part of a larger research project, 'Locard' (Nevalainen et al., 2018; Vuorinen et al., 2020), conducted in cooperation with S Group in Finland. S Group is the market leader in grocery retailing in Finland (market share: 46.4% in 2018) (Finnish Grocery Trade Association, 2019). S Group's loyalty card database covers 2.4 million households, or 88% of Finland's households. Whenever a customer uses their loyalty card, their purchase data become registered in S Group's database.

S Group contacted customers via email and invited them to participate in this research project, which involved asking for their consent to allow S Group to release their purchase data for research purposes, as well as asking them to fill out an online survey. The data were pseudonymized before the researchers received access. Ethical approval for this novel collaborative initiative was obtained from the University of Helsinki Review Board in the Humanities and Social and Behavioural Sciences (Statement 21/2018). A contract between the research group and S Group was signed upon data transfer, ensuring the independence of the research and scientific publishing exclusive of business interests.

Data collection from an online questionnaire took place from June through August 2018. All consenting participants were asked to fill out the questionnaire concerning their sociodemographic variables: education, marital status, size of household, number and age of children, occupational status, and income. The background data from the questionnaire were complemented by participants' gender, age, and

postal code, obtained from the retailer's database. We also asked all participants to estimate their degree of loyalty to S Group, measured by the share of purchases made in their shops and supermarkets. Participants reported their degree of loyalty using a five-item ordinal scale: 0%–20%, 21%–40%, 41%–60%, 61%–80%, or 81%–100%. For each participant, purchase data covered a time frame comprising the preceding 12 months from the date of response to the online questionnaire. A data record for each purchase included a customer pseudonym, item description, time stamp, quantity (i.e., weight, volume, or number of packages), and price paid for each item.

Furthermore, using the questionnaire, the participants were asked, 'In your household, which are the most typical situations where food may end up in a bin or organic waste container? What are the situations in which you most frequently throw food into the bin or into organic waste?' The participants could select one to three of the most common situations. We designed the statements so that they reflected various situations based on previous literature regarding the reasons for food waste in households (see Table 1). We deliberately chose not to ask about the quantity of food waste in households, as it has been found problematic to measure this reliably with a self-reported survey (Giordano et al., 2018) and because knowledge about the causes of food waste provides retailers with more insight into how to impact the problem.

For the purposes of this study, purchase data were pre-processed from the individual product/item information to the product category level. The product categories 'fresh vegetables', 'fruit and berries', 'multigrain bread', 'rye bread', and 'wheat bread' were selected. All of the studied food categories are sold fresh, where the risk of becoming wasted is larger. The chosen categories are also those that most often go to waste in households in Finland (Silvennoinen et al., 2014) and other countries (De Laurentiis et al., 2018; Hanssen et al., 2016). Differences may be seen across country contexts regarding which product categories are most important in food culture. In Finland, bread plays a prominent role, as reflected in the large assortments available at stores (Leipätiedotus, 2022). Selecting these product groups provided a reliable view of the study phenomenon and helped illustrate the potential of using purchase data to address the study's purpose.

3.1 | Sample characteristics

The process of recruiting participants involved S Group sending invitations to about half of its customers (1.1 million people), of which 47,066 agreed to participate. Of these, 15,602 were randomly assigned to fill out the food waste questionnaire. As a result, 12,187 participants (78%) answered the questionnaire and agreed to release their purchase data for research use (see Vuorinen et al., 2020, for more detailed information on the process). Of the participants, 8095 (66%) were women, with a mean age of 48.3 (*SD* 15.1) and a mean household size of 2.4 (*SD* 1.3). The mode of categorized household income was 3000–4499 €/month (23% of participants), and 47% of participants' households earned more than that. Participants tended to be highly educated, with 37% reporting an upper secondary school

TABLE 1 Statements for food waste emergence.

Statement in the questionnaire	Statement name	Examples of previous studies identifying the item
The date on the date label has passed.	DATE LABEL	Neff et al., 2019; Silvennoinen et al., 2014; Wilson et al., 2017
The package size of the food I bought does not meet my needs, and some food is left over.	PACKAGING SIZE	Petit et al., 2020; Wilson et al., 2017
Fruit and vegetables spoil before I can use them.	SPOILED GREENS	De Laurentiis et al., 2018; Hanssen et al., 2016; Silvennoinen et al., 2014
Bread dries up or becomes mouldy before I can use it.	SPOILED BREAD	Hanssen et al., 2016; Silvennoinen et al., 2014
I prepare too much food at one time.	OVERCOOKING	Hanssen et al., 2016; Hebrok & Boks, 2017; Silvennoinen et al., 2014
I am not sure whether I can still eat the food, so I throw it away just to be safe.	SAFETY	Evans, 2011; Silvennoinen et al., 2014
Frozen products are left in the freezer for too long.	FORGOT IN FREEZER	Hebrok & Boks, 2017; Mattila et al., 2019
I do not want to eat the same kind of food for several days in a row.	PREFERENCES	Porpino et al., 2016; Silvennoinen et al., 2014
Food bought at a discount was not used.	DISCOUNTS	Giordano et al., 2019; V. Lim et al., 2017; Parizeau et al., 2015
Children leave food uneaten.	CHILDREN	Hebrok & Boks, 2017; Lehtokunnas et al., 2022; Porpino et al., 2016
I buy ingredients for a recipe, and some of them are left unused.	RECIPES	Evans, 2011; V. Lim et al., 2017
I buy food that I later do not fancy eating.	MOOD	Hebrok & Boks, 2017; Porpino et al., 2016
It is difficult to manage my family's different diets and preferences.	DIETS	Parfitt et al., 2010; Parizeau et al., 2015
There is no food waste created in my household.	NO WASTE	
Other reason	OTHER	

education and 57% reporting more than that (bachelor's or master's degree or higher).

3.2 | Data analysis

Our data analysis comprised two phases. In Phase 1, we employed Ward's hierarchical clustering algorithm on the food waste questionnaire data to identify households with similar food waste profiles. For this, the complete sample ($N = 12,187$) was used. The clustering algorithm used all 15 items from the questionnaire. As the responses were binary, and one to three reasons could be selected, the Jaccard coefficient was used to measure similarities in participants' responses (Anderberg, 1973, pp. 89, 115, 117). The Jaccard coefficient is defined as the number of items that are coded '1' for both participants, divided by the number of items coded '1' for either or both participants; that is, the index for two participants was equal to unity when identical reasons were selected on the questionnaire, and it equaled zero when no options were selected. The Jaccard coefficient is often used in market basket analysis to compute the share of common items in the basket. The choice of the number of segments was based on the height of consecutive steps in the resulting dendrogram, as well as on the segments' interpretability. As a result, we chose six segments to represent heterogeneity in the data.

Next, we analysed the six segments' purchase data, including the means, standard deviations, and medians for different product group purchases. In addition, we compared the distributions of food purchases between the segments by fitting an analysis of covariance model, which included segment as a factor and household size as a covariate. Thus, the differences in means estimated from this model reflect the average difference in food purchases between two segments in households of the same size. Multiple comparisons in estimating pairwise differences and their confidence limits were adjusted using the Bonferroni method.

In Phase 2, we used tree-based models (Breiman et al., 1984; Hastie et al., 2009) to identify customer attributes that could indicate differential food waste segments. We decided to focus our analysis on customers who had sufficient information on their household's purchasing behaviour, defined as a self-reported loyalty of at least 61%, having made purchases at least 10 times, and having spent at least €1000 during the preceding 12 months. According to Statistics Finland, the average annual consumption of groceries and nonalcoholic drinks amounts to approximately 3000 €/year (Tilastokeskus, 2017). These criteria resulted in $N = 8549$. This decision to limit the analysis to those customers who made a relatively large share of their household purchases from S Group was made to provide a more reliable view of the studied phenomenon.

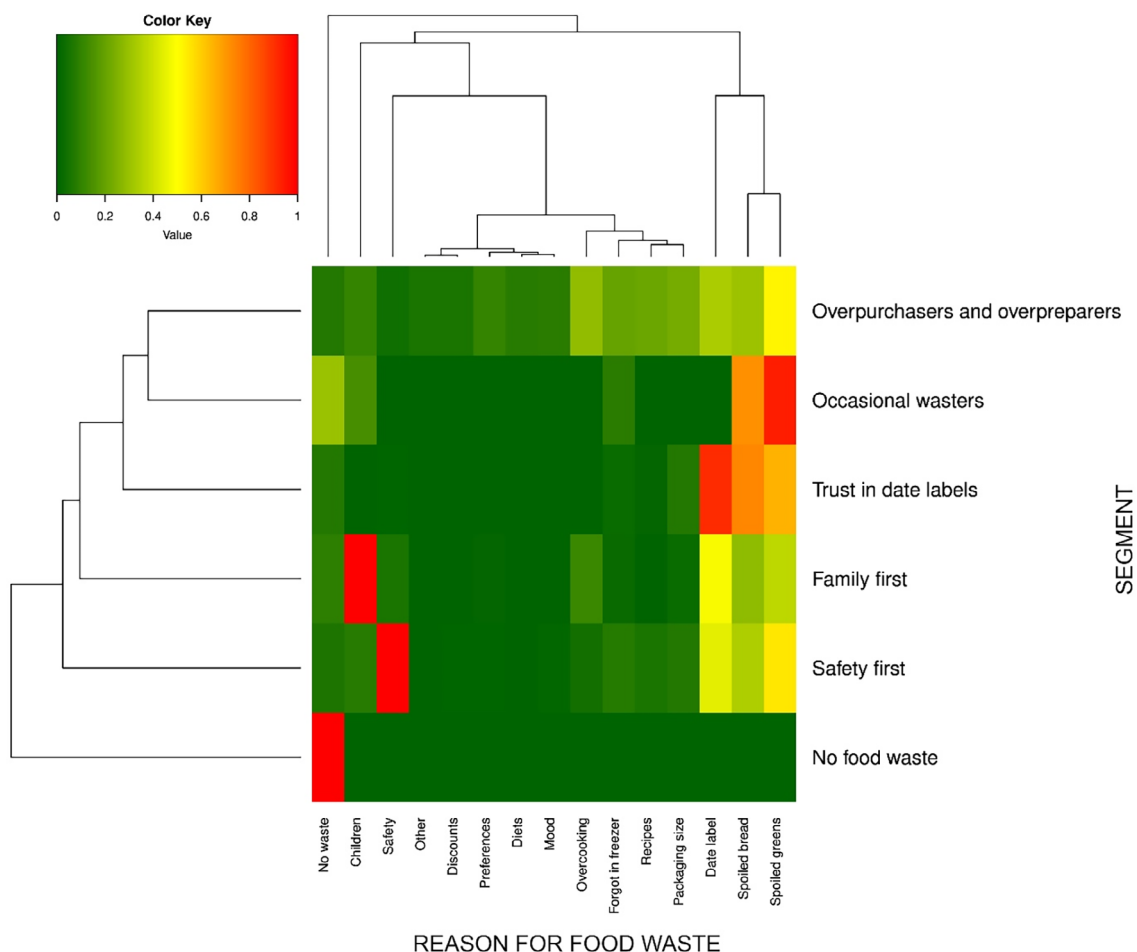


FIGURE 1 The food waste segment heatmap. Each rectangle's colour and intensity reflect the proportion of segment (rows) members reporting the particular reason for food waste (columns).

To build a single decision tree, we used recursive partitioning of the data set and sequentially split it into nonoverlapping subsets of households. At each step, the 'parent' nodes were partitioned by finding the variable with the best predictive value and the best cutoff point in that variable so that the responses (food waste segments) in the 'child' nodes were as similar as possible. This process was continued until the stopping criteria were satisfied for each 'terminal' node. Predictor variables used to build the tree were age, gender, purchase frequency, amount spent (in €) during the preceding year, and purchases (in kg per €1000 spent) of the selected product categories (i.e., rye, wheat, and multigrain bread; fruit and berries; and vegetables). Alternative methods (a multinomial model and random forest algorithm) were also tried, but they performed similarly. The relative scale was used to reduce the roles of household size and degree of loyalty. Participants with missing values were assigned to the node with the most similar attributes. The analysis was weighted by the inverse of the segment size to find a balanced decision tree for the segments. The method's performance was assessed by 10-fold cross-validation, and the splits were chosen using cost-complexity pruning. We implemented the same procedure for single-person households in the data ($N = 2, 112$) to further examine an interesting consumer

group that has been found to differ in its food waste behaviours (Aschemann-Witzel et al., 2018; Silvennoinen et al., 2014). In addition, we ran a random forest analysis (i.e., multiple decision trees as a result of resampling steps; see Breiman, 2001) as a supplemental analysis to gain further insight into the variables' predictive importance, but the gain in predictive power was relatively small compared to the single decision tree.

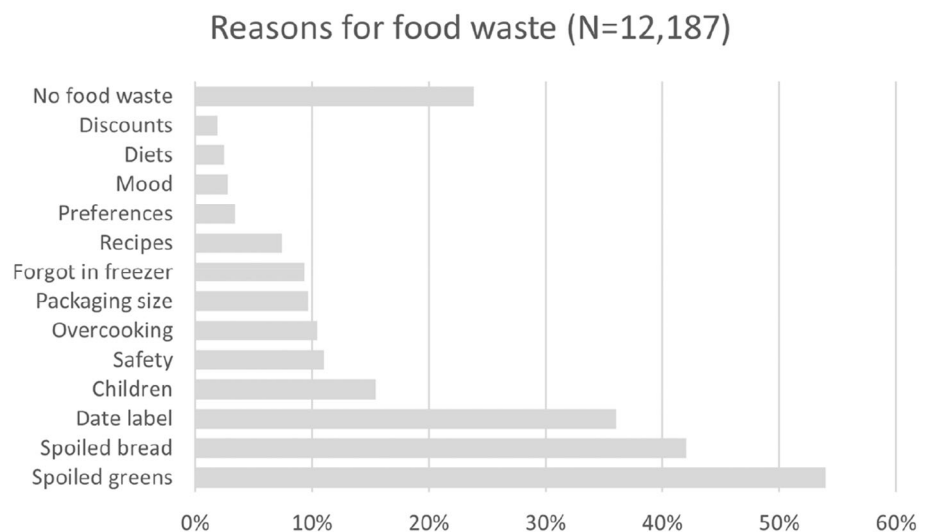
4 | RESULTS

4.1 | Phase 1: Identifying food waste segments

The six identified food waste segments are presented in the heatmap in Figure 1. Next, we describe the segments in more detail.

As can be seen in Figures 1 and 2, some statements were selected often, including SPOILED GREENS, SPOILED BREAD, DATE LABEL, CHILDREN, and SAFETY. However, some of the food waste statements were not selected as often as others, including statements that could impact retailers and food producers (e.g., PACKAGING SIZE and DISCOUNTS) and that were related to consumers' personal

FIGURE 2 The reasons for food waste selected by all participants.



preferences and mood (e.g., PREFERENCES and MOOD). The fact that the participants did not choose these statements often does not necessarily mean that they failed to explain their food waste behaviour. However, they were not viewed as decisive reasons why food was thrown away. The fact that preferences and moods were not selected also indicates that participants were not careless about wasting food, as also evidenced in previous food waste studies (e.g., Evans, 2011). Earlier studies have established that, in Finland, awareness of food waste is already quite high, as this has been visible in policymaking and as Finnish retailers have made efforts to remedy the problem (Mesiranta et al., 2022).

The first segment (see Figure 1), labelled 'No food waste', comprised customers who stated that they did not generate any food waste in their households (statement NO WASTE; 100% of participants in this segment selected this). However, this refers to the respondents' own opinions of the issue rather than an objective view, and thus may suffer from social desirability bias. Altogether, 13% of the participants belonged to this segment (see Table 2). This segment had the oldest participants (mean age: 55.7) and contained the highest percentage of participants with the lowest household incomes (11.2%) and the lowest education levels (10.9%). Household size was the smallest of all the segments (2.0 members in the household). These results support earlier food waste research that identified older consumers and consumers with lower education levels who are less likely to waste food (Filipová et al., 2017; Secondi et al., 2015).

The second segment comprised customers who most frequently selected the statements DATE LABEL (91%), SPOILED BREAD (73%), and SPOILED GREENS (65%). We labelled this segment 'Trust in date labels', as it reflected customers' tendency to throw food away based on the expired date label. This was the second-largest segment identified in the data, representing 19% of all participants. This finding supports previous research on the crucial role of expiry date labels in discarding food both in the United States (Neff et al., 2019) and in Europe (Toma et al., 2020).

The third segment comprised customers who responded most frequently to the statements SAFETY (100%), SPOILED GREENS

(55%), and SPOILED BREAD (34%). We labelled this segment 'Safety first'. This segment was the second smallest, comprising 9% of the participants. Of all segments, this one had the smallest share of women (60.3%). The customers in this segment seemed to be concerned about food safety and wanted to avoid the risk of food poisoning or other health issues (see also Watson & Meah, 2012). The level of perceived behavioural control, such as whether a person feels that they can assess edibility, has been found to impact food waste behaviours (Visschers et al., 2016). Similar to the 'No food waste' segment, these customers had the lowest household income (11% belonged to the lowest income group).

The fourth segment comprised customers who most frequently selected the statements SPOILED GREENS (94%), SPOILED BREAD (71%), and NO WASTE (31%). We labelled this segment 'Occasional wasters', as the statement NO WASTE was selected alongside the two other situations by a third of the participants. Thus, the customers in this segment perhaps waste less food in general but sometimes discard food, especially certain foods like vegetables or bread. This may be due, for example, to a lack of planning or unpredictability in everyday life, as explained by previous food waste studies (Romani et al., 2018; Secondi et al., 2015; Sirola et al., 2019; Stancu et al., 2016). This segment was the third-largest segment, representing 18% of the participants.

The fifth segment comprised customers who most frequently selected the statements SPOILED GREENS (52%), DATE LABELS (34%), SPOILED BREAD (31%), and OVERCOOKING (28%). We labelled this segment 'Overpurchasers and overpreparers'. This segment was the largest (32% of participants). As can be seen from the heatmap in Figure 1, a large variety of statements were selected by some customers in this segment. Thus, several different reasons resulted in food waste behaviours in this segment. Overcooking was the most prominent in this segment compared with the other segments. This segment also had more women than the other segments (72.8%).

The sixth segment comprised customers who selected the statements CHILDREN (100%), DATE LABELS (49%), and SPOILED

TABLE 2 Each segment's sociodemographics.

N = 12,187	1. No food waste	2. Trust in date labels	3. Safety first	4. Occasional wasters	5. Overpurchasers and overpreparers	6. Family first
Most often selected statements (percentage of respondents)	NO WASTE (100%)	DATE LABEL (91%), SPOILED BREAD (73%), SPOILED GREENS (65%)	SAFETY (100%), SPOILED GREENS (55%), SPOILED BREAD (33%)	SPOILED GREENS (94%), SPOILED BREAD (71%), NO WASTE (31%)	SPOILED GREENS (52%), DATE LABEL (34%), SPOILED BREAD (31%), OVERCOOKING (28%)	CHILDREN (100%), DATE LABEL (49%), SPOILED GREENS (37%)
N (%)	1634 (13%)	2264 (19%)	1133 (9%)	2207 (18%)	3871 (32%)	1078 (9%)
Age (mean)	55.7	47.7	46.6	50.4	47.1	40.2
No. of people in household (mean)	2.0	2.3	2.3	2.3	2.3	3.7
% of women ($df = 5$, $\chi^2 = 120.0667$, $p < .0001$)	63.3	62.6	60.3	63.8	72.8	68.0
% in the lowest household income group (<1500 €/month) ($df = 35$, $\chi^2 = 172.1501$, $p < .0001$)	11.2	8.5	11.0	8.7	9.5	4.6
% with the lowest education level (high school) ($df = 15$, $\chi^2 = 90.2974$, $p < .0001$)	10.9	6.0	6.0	5.8	5.6	3.7

TABLE 3 Purchases of selected product categories for each segment.

Segment	N	Product category	Purchases per year (kg)				Difference to segment NO WASTE ^a (95% adjusted CI)		
			Mean	SD	MD	Est. mean at average household size	Est.	Lower	Upper
1. No food waste	1634	Fresh vegetables	44.4	50.5	28.3	47.0	N/A	N/A	N/A
		Fruit and berries	61.5	69.2	12.8	64.7	N/A	N/A	N/A
		Rye bread	12.4	15.0	7.2	13.2	N/A	N/A	N/A
		Wheat bread	1.9	4.1	0.6	2.3	N/A	N/A	N/A
		Multigrain bread	9.2	11.8	4.9	10.4	N/A	N/A	N/A
2. Trust in date labels	2264	Fresh vegetables	33.3	36.0	21.8	34.0	-13.0	-15.8	-10.2
		Fruit and berries	52.3	59.6	34.1	53.3	-11.40	-15.2	-7.5
		Rye bread	10.2	12.0	6.3	10.4	-2.8	-3.6	-2.0
		Wheat bread	2.8	4.6	1.3	2.9	0.7	0.4	0.9
		Multigrain bread	10.6	12.7	6.0	10.9	ns	ns	ns
3. Safety first	1133	Fresh vegetables	34.8	42.9	22.1	35.2	-11.8	-15.1	-8.5
		Fruit and berries	52.8	57.9	34.2	53.2	-11.4	-16.0	-6.9
		Rye bread	10.1	12.5	5.7	10.2	-3.1	-4.0	-2.1
		Wheat bread	2.4	3.8	1.1	2.4	0.1	-0.2	0.5
		Multigrain bread	10.3	12.1	6.5	10.4	ns	ns	ns
4. Occasional wasters	2207	Fresh vegetables	38.7	43.8	26.2	39.0	-8.0	-10.8	-5.2
		Fruit and berries	54.8	58.7	36.3	55.3	-9.4	-13.2	-5.6
		Rye bread	10.9	12.7	6.9	11.0	-2.3	-3.0	-1.5
		Wheat bread	2.4	4.6	1.0	2.5	0.2	-0.1	0.5
		Multigrain bread	10.7	13.3	6.4	10.8	ns	ns	ns
5. Overpurchasers and overpreparers	3871	Fresh vegetables	37.2	42.5	26.0	37.8	-9.2	-11.8	-6.7
		Fruit and berries	52.6	55.7	35.4	53.4	-11.3	-14.8	-7.8
		Rye bread	9.8	11.2	6.2	10.0	-3.3	-4.0	-2.5
		Wheat bread	2.7	4.4	1.2	2.8	0.6	0.3	0.8
		Multigrain bread	10.3	12.1	6.3	10.6	ns	ns	ns
6. Family first	1078	Fresh vegetables	46.7	55.6	33.1	37.9	-9.1	-12.6	-5.6
		Fruit and berries	69.8	70.3	51.0	58.3	-6.4	-11.3	-1.5
		Rye bread	12.4	13.6	8.3	9.7	-3.6	-4.6	-2.6
		Wheat bread	3.6	5.5	2.0	2.4	0.1	-0.2	0.5
		Multigrain bread	14.2	14.0	10.6	10.2	ns	ns	ns

^aAdjusted for household size.

GREENS (37%). We labelled this segment 'Family first'. This segment was characterized by a large household size (mean: 3.7 people), explaining why all in this segment reported discarding food because children leave it uneaten. This segment was the smallest, with 9% of all participants. This segment had the youngest participants (mean age: 40.2), the highest share of participants in the highest household income group (7.6% earning at least 9000 €/month), and the smallest share of participants in the lowest household income group (4.6%) and in the lowest education level (3.7%).

An examination of means (kilogrammes of purchases per year) across different product categories for each segment (see Table 3)

revealed that the segment 'Family first' had the highest volume of purchases across all product categories. This is because the number of people in the households was highest in this segment. Customers in the 'No food waste' segment purchased more fresh vegetables, fruit, and berries (see Figure 3), and rye bread than customers in the other segments, excluding those in 'Family first' (see Figure 4). In contrast, all other segments purchased more wheat and multigrain bread than the 'No food waste' segment.

Adjusting this analysis to family size revealed further insights into the differences between the segments (see Table 3 and Figure 5). For fresh vegetables ($p < .0001$) and fruit and berries ($p < .0001$),

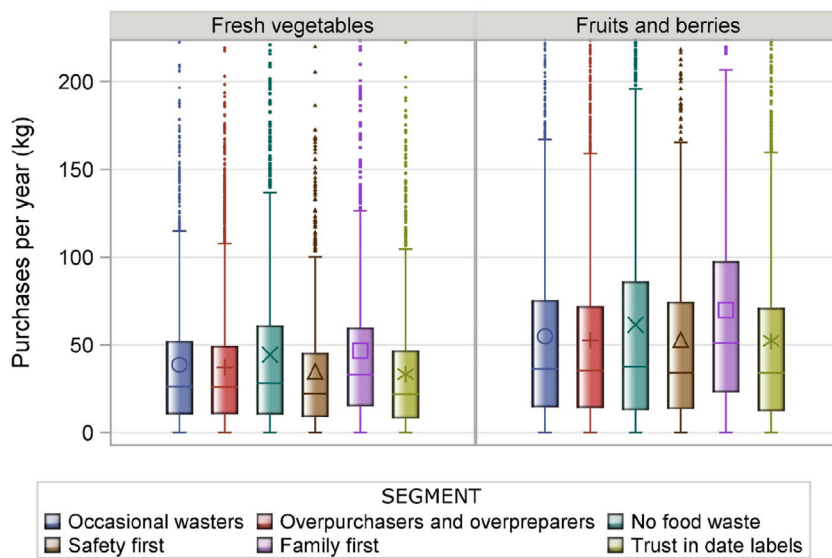


FIGURE 3 Distribution of purchases of fresh vegetables and fruit and berries for each segment.

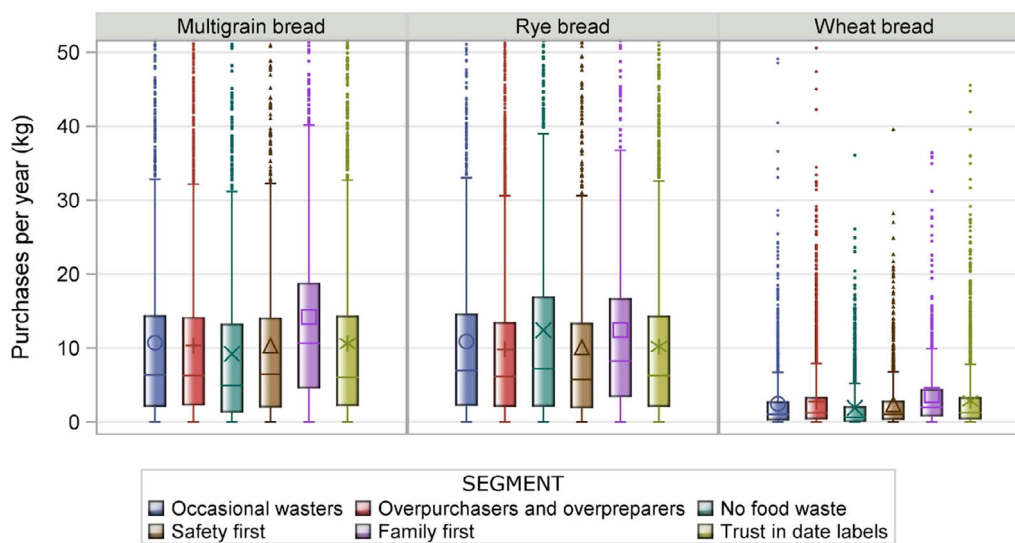


FIGURE 4 Distribution of purchases of different kinds of bread for each segment.

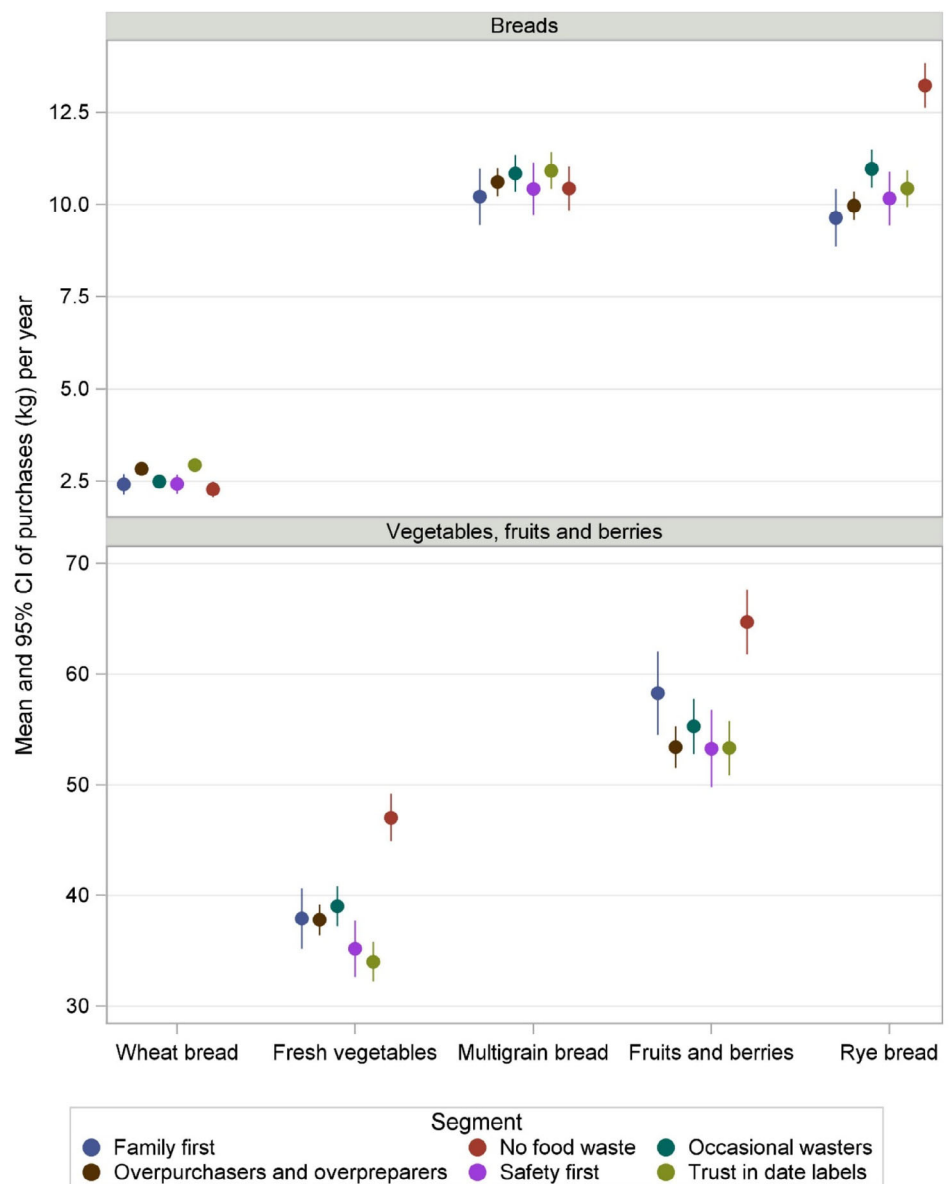
customers in the 'No food waste' segment bought the highest amount overall, whereas 'Family first' bought the second-highest amount. The difference between the two segments was pronounced regarding fresh vegetables (47.0 kg/year for 'No food waste' vs. 37.9 kg/year for 'Family first'). The 'Trust in date labels' segment bought fresh vegetables least often compared with the other segments (34.0 kg/year). The 'No food waste' segment also purchased significantly more rye bread (13.2 kg/year) than the other segments ($p < .0001$), whereas 'Family first' purchased the least amount of rye bread (9.7 kg/year). Regarding wheat bread, the segments 'Trust in date labels' (2.9 kg/year) and 'Overpurchasers and overpreparers' (2.8 kg/year) bought more than households of similar size in other segments ($p < .0001$). The 'No food waste' segment purchased the least amount of wheat bread (2.3 kg/year), but this difference was

smaller, and only one of the pairwise comparisons turned out to be statistically significant. After adjusting for family size, purchases for multigrain bread revealed no significant differences between segments ($p = 0.570$). To summarize, Figure 5 shows that the 'No food waste' segment stood out from the other segments with the highest amount of purchases of rye bread, fresh vegetables, and fruit and berries compared to households of similar size.

4.2 | Phase 2: Tree-based analysis of segments' purchase data

A tree-based analysis was conducted to address the question of whether the purchase data and background data could predict the

FIGURE 5 Adjusted means and 95% CIs for all products for each segment. Adjusted means were estimated at average household size.

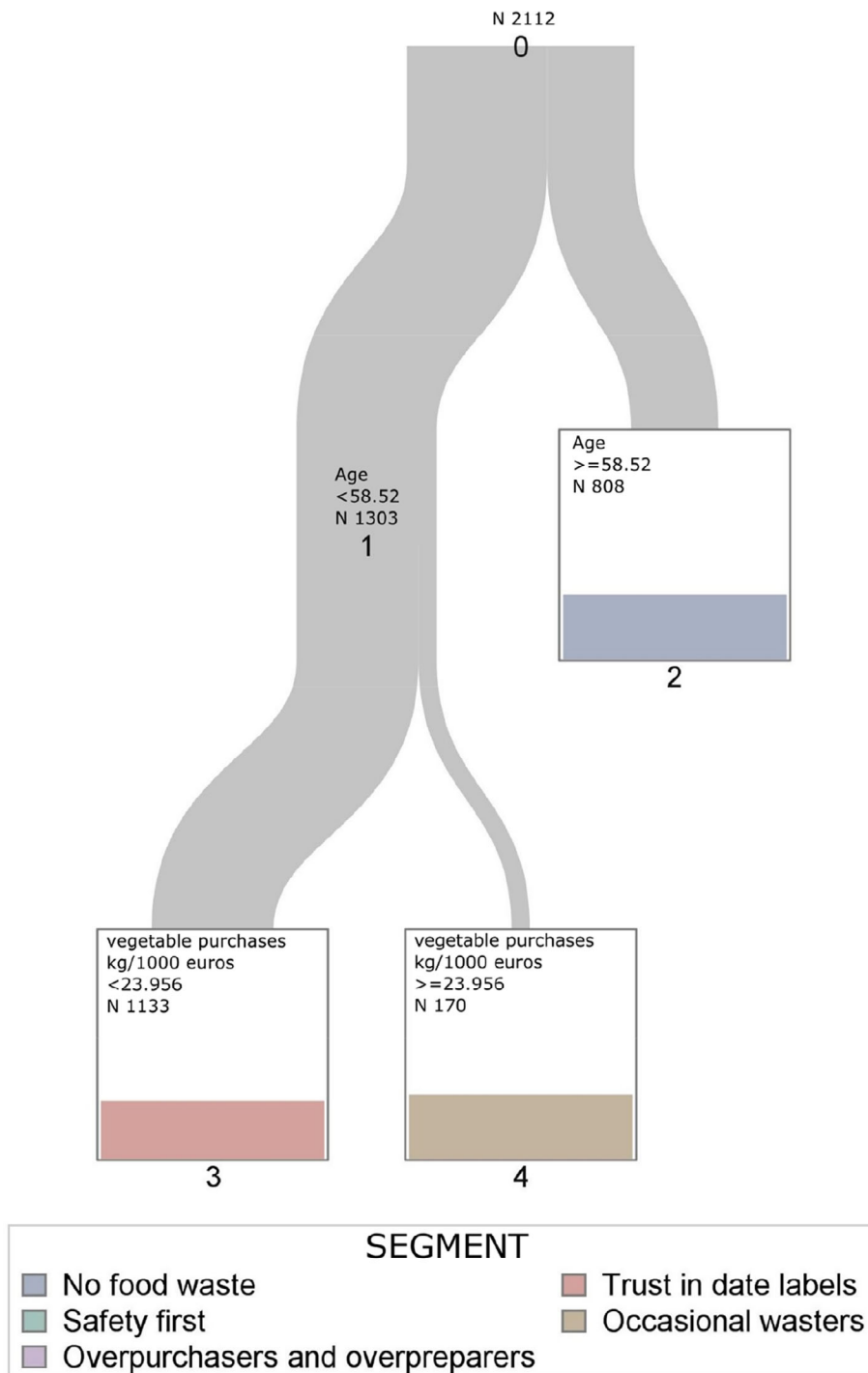


membership of customers in the identified food waste segments. Figure 6 displays the classification tree algorithm designed to identify food waste segments based solely on the participants' purchasing behaviour and background demographics. Overall, the tree succeeded best in detecting customer membership in two segments: the 'Family first' segment, which represented 77% of members correctly classified in the cross-validation, and the 'No food waste' segment, which comprised 52% of members assigned to the right segment. Other segments were not identified at such high rates, but instead resulted <17% (close to or worse than a classification rate that could be achieved by a simple roll of the dice). Participants' age was the best predictor of the segments, as it appeared three times in the classification tree--for example, it twice identified terminal node '4', with participants' age 27.2–48.0 years predicting the 'Family first' segment. Two rather different classification rules were identified by the algorithm to predict the 'No food waste' segment. The first (terminal node '6') involved being at least 48 years old with a high amount of

purchases for vegetables (the cutting rule approaching the 90% decile of that variable, i.e., 26 kg/€1000). Consequently, terminal node '6' was small in size ($N = 700$). The other one (terminal node '9') was characterized by a higher age (at least 58 years) and less money spent on food overall (<€3960/year). Interestingly, other variables, such as gender or those reflecting purchasing behaviour (e.g., frequency of purchases), did not appear in the classification tree.

We conducted a separate analysis for single-person households, as outlined in the data analysis section, to exemplify a more detailed customer data analysis. Among single-person households (Figure 7), the classification algorithm was used to distinguish membership into five segments (as 'Family first' was not relevant for this group of participants). The 'Trust in date labels' segment was detected at a 72% rate and the 'No food waste' segment at a 54% rate. Recall that these two segments displayed rather different purchase profiles in Phase 1 (the analysis of covariance; see Table 3). The classification tree used the rule with fewer purchases of vegetables and younger than

FIGURE 6 Classification tree for all households.



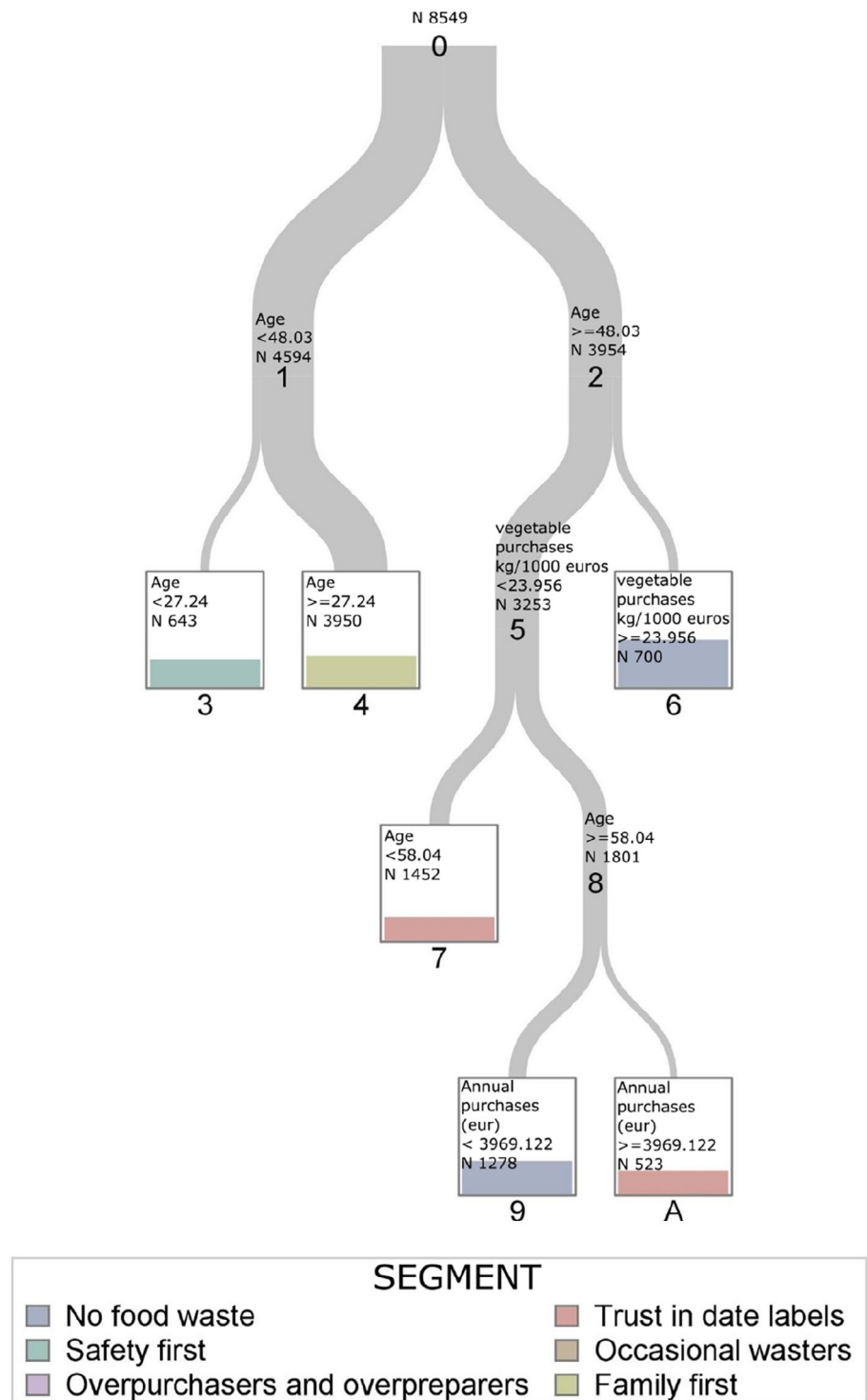
58.5 years to identify customers categorized with 'Trust in date labels'. In contrast, those single-person households with older age (>58.5 years) were assigned to the 'No food waste' segment.

5 | DISCUSSION

The purpose of our study was to identify and analyse household food waste segments and discuss their actual purchasing behaviour patterns. In addition, through our example, we illustrated and exemplified

the potential use of customer loyalty card data in addressing global food-related sustainability challenges such as food waste. Through hierarchical cluster analysis, we first identified six customer segments based on customer survey data: 'No food waste'; 'Trust in date labels'; 'Safety first'; 'Occasional wasters'; 'Overpurchasers and overpreparers'; and 'Family first'. These segments differed in their self-reported reasons for food waste and their sociodemographic and purchase profiles. Furthermore, by utilizing tree-based algorithms and demographic and purchase data, we demonstrated which variables best forecast different food waste behaviours. The tree-based

FIGURE 7 Classification tree for single-person households.



algorithms identified age, annual purchases (in €), and the amount of vegetables purchased (in kg per €1000) as the most powerful variables distinguishing customers' memberships in certain food waste segments. Furthermore, we scrutinized single-person households as an example to showcase how household type can be used as the basis for creating tree-based models. This study was conducted in the context of Finland and focused on country-specific product groups. Thus, caution should be taken regarding the generalizability of the findings to explain food waste behaviours in other contexts. However, as an

illustrative example, our study has relevant implications for theory and practice, which we discuss below.

5.1 | Theoretical contributions

This study contributes to the literature on food waste studies and to sustainable retailing. First, food waste research has recently begun to segment consumers based on their food waste behaviour

(Aschemann-Witzel et al., 2018, 2021). The present study extends this literature by linking food waste segments to customers' purchase data. A recent study by Aschemann-Witzel et al. (2021) found that consumer food waste profiles are related to lifestyles and differ in terms of consumers' price consciousness and food involvement, such as cooking skills and interest in food. Our study brings further insight into the link between purchasing behaviour and the heterogeneous reasons for wasting food. Our data suggest that patterns of buying certain products, such as rye bread (which does not dry out as quickly as wheat or multi-grain bread), may be linked to less food waste produced at home. Furthermore, purchasing a greater amount of fresh vegetables predicts no food waste, which may be linked to better cooking skills, as they require more preparation at home compared to ready-made meals (Aschemann-Witzel et al., 2016; Evans, 2011). Thus, this study extends previous food waste literature by illustrating the potential of retailer's customer data in explicating household food waste behaviours (Aschemann-Witzel et al., 2016; Aschemann-Witzel, de Hooge, et al., 2017; Calvo-Porrà et al., 2017).

Second, aligned with the second aim of our purpose, our study contributes to the sustainable retailing literature (Gravelly & Fraser, 2018; Vadakkepatt et al., 2021; Young et al., 2018) by illuminating, with the example of food waste, how customer data can be used to serve sustainability purposes. For example, identifying customer segments from a sustainability perspective, such as the food waste segments presented here, can help retailers initiate novel and tailored customer relationship management activities with the aim of helping customers become more sustainable, for example, by helping reduce customers' food waste. Utilizing loyalty card data for sustainability purposes provides an extension to measures that retailers have previously implemented, and shifts attention from using consumer data for the benefit of firms or customers towards using it for societal benefit.

5.2 | Methodological contributions

The potential of retailers' customer loyalty card data remains an underutilized area for scientific research. To the authors' knowledge, this study is the first to illuminate the potential of large-scale loyalty card data to target consumer food waste. Compared with traditional methods of collecting and analysing research data, customer loyalty schemes offer many advantages for research. Traditional methods of examining consumer behaviour, such as food purchases and consumption, have largely relied on consumers' self-reported data, which are time-consuming and costly to collect and analyse. However, customer purchase data are generated automatically with the help of existing data infrastructure (company loyalty card schemes, IT systems, and cash registers) and lack self-reporting's risk of impreciseness or biases. Moreover, the data are longitudinal, enabling a detailed examination of how food purchasing behaviour evolves over time and providing access to smaller subgroups of consumers that would otherwise remain unexamined (Nevalainen et al., 2018). The magnitude of these types of data allows for the use of advanced analytics arising from

different fields of data sciences, including unsupervised and supervised clustering, dimension reduction, and flexible regression methodologies. This study also illustrates the potential of tree-based algorithms, which allow for learning from large-scale data without specifying an a priori structure or assumptions.

However, methodological challenges also remain in using this type of data specifically for food waste research. First and foremost, customer loyalty data need to be complemented with additional household-level, self-reported data on food waste, such as the questionnaire on the reasons for food waste used in this study. While self-reported data are at risk of being subjective or biased, in collaboration with food retailers—and with the customer's consent—the data can be linked with the customer's purchase data. Data on the amount of household food waste can be captured using different methods, including questionnaires, diaries, and waste-bag and waste-composition analyses. Combining these types of more detailed data on household food waste amounts with purchase data provides a future research opportunity.

Altogether, companies' customer loyalty data offer a novel and promising methodological tool for studying sustainable consumer behaviour beyond the food waste context. Customer data that are complemented with appropriate information can provide unique empirical access to study many contemporary challenges, such as obesity, malnutrition, or unsustainable diets. Furthermore, using customer data for research purposes can uncover new opportunities—for example, studying health (e.g., Aiello et al., 2019; Nevalainen et al., 2018), alcohol consumption (Lintonen et al., 2020), sustainable food purchasing (Erkkola et al., 2022; Meinilä et al., 2022), and nicotine replacements (Timberlake et al., 2019)—and thus, direct attention towards using customer data to benefit individuals and society at large (Hermann, 2022; Saarijärvi et al., 2019). While there seems to be increasing interest in examining tensions revolving around collecting, analysing, and leveraging customer data in retailing (see Krafft et al., 2021; Martin & Palmatier, 2020; Wieringa et al., 2021), harnessing data's potential to benefit society through scientific research can increase customers' willingness to continue to share their data. Through new collaborative initiatives among researchers, retailers, public authorities, and consumers themselves, customer data can be harnessed to address major global challenges, such as food waste. This study illustrates in detail how such collaboration can take place, hopefully paving the way for similar initiatives in the future.

5.3 | Managerial and consumer implications

This study has many implications relevant to managers and consumers themselves. First, while food retailers have a unique position in the supply chain, they can encourage and facilitate the shift towards reducing food waste both upstream and downstream. In this endeavour, segments based on well-grounded empirical insight help retailers support customers in their efforts to reduce household food waste. Thus, by giving their customer data to a retailer that can use it for the consumers' benefit, consumers can gain valuable insight and feedback

to help them reduce their food waste. With this data, retailers can tailor their marketing communications related to food waste based on the segments. For example, to address customers in the 'Trust in date labels' and 'Safety first' segments, retailers could provide information and tips on how consumers can self-evaluate food edibility. For example, retailers may educate customers on how fruits and vegetables look during different stages of their ripening processes, or how to distinguish between different date labels, for example, 'best before' or 'use by' dates. In contrast, customers in the 'Family first' segment could be aided by communicating about how children can be more attached to food by participating in family cooking practices or how parents can include food waste reduction practices in their household management skills without compromising their good provider identity. For consumers themselves, knowing that they belong to a certain segment may help them become more conscious of their own food waste-related behaviour, the challenges involved in their household, and how to overcome them.

Second, the segments can also be utilized by retailers to develop and market new products and services for different segments. Innovations in product packaging, such as Mimica Touch (UK), allow for dynamic date labelling based on tactile cues that help extend food products' shelf life in retailing and help customers in the 'Trust in date labels' and 'Safety first' segments evaluate edibility. Those in the 'Occasional wasters' segment might benefit from tools to facilitate planning, such as mobile applications that suggest recipes based on purchases or that help in managing customers' pantry and refrigerator. Recently, new product innovations that utilize potential food waste in retailing have emerged. For example, many European grocery chains have started to monetize suboptimal food, such as 'ugly' fruit and vegetables and expiration date-based pricing practices. Our results offer early insight into which types of customers are most likely to adopt these new types of products. For example, customers in the 'Safety first' segment may not be interested in food that is near its expiration date, but those in the 'Occasional wasters' or 'Overpurchasers and overpreparers' segments may be likelier to buy it.

Finally, this study exemplifies the vast societal potential that food retailers in particular hold in terms of their loyalty card data. Executives and managers should consider their customer loyalty programs as a means of tackling the many global challenges and consider such data collaboration initiatives as key elements of their overall corporate responsibility.

5.4 | Limitations and directions for future research

This study has some limitations that provide opportunities for future research. First, we relied on self-reported food waste behaviours, assessed through a single-item measure. Social desirability bias is a genuine concern when people are answering questions about their own behaviour, and it may have influenced the respondents of this study as well. For example, people tend to underestimate the amount of household food waste they have (Giordano et al., 2018). The survey data could be complemented with data about actual food waste levels

in households by asking study participants to weigh it with scales or use waste-bag analysis. However, this would require considerable effort from those participating in the study compared with answering a survey, which would potentially result in a low participation rate. In the future, technological innovations would allow for combining different data sets more automatically. For instance, Internet of Things solutions, such as smart appliances in the kitchen, could yield data on actual consumption of food items in a household, and food waste collection systems based on Radio Frequency Identification could report food waste amounts. This data could then be combined with purchase data to investigate the relationships between purchasing, preparation, consuming, and wasting food.

Another significant limitation of our study is that, for purposes of illustration, we chose only specific product groups to be included in the data analysis. These were chosen on the basis of the cultural context of the study and information about which specific foods are most likely to be wasted in the country. In future studies, other cultural contexts and other product groups should be included. For instance, even though animal-based products were not among the most wasted product categories, they generally have a bigger impact on the environment, and thus, wasting these products is more detrimental. It would be beneficial to study food waste behaviours related to animal-based proteins in more detail. Furthermore, as food purchase, consumption, and waste habits vary greatly across countries and cultural contexts, more research in other cultures is needed to examine the relationship between purchase and food waste behaviour. Finally, we further encourage researchers and retailers to initiate collaborative efforts to both study and harness the potential of customer loyalty program data for the common good. As our study illuminates, while food consumption is linked with many global challenges today, detailed data on consumers' food purchases offer rich venues for generating a better understanding of and informed decision-making on how to tackle them together. We hope that our study encourages other researchers to follow and unlock the full potential of food retailers' loyalty card data.

AUTHOR CONTRIBUTIONS

All authors have approved their contributions as well as the final article. Conceptualization: Elina Närvänen, Nina Mesiranta, and Hannu Saarijärvi. Methodology: all authors. Formal analysis: Jaakko Nevalainen. Writing: all authors.

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CONFLICT OF INTEREST STATEMENT

S Group consists of 19 independent regional cooperatives, six local cooperatives and SOK with its subsidiaries, which engage in the travel and hospitality business. One of the authors is a board member at one independent regional co-operative of S Group. Other authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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