OAMK OULUN AMMATTIKORKEAKOULU

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EFFECTIVE FOOD WASTE MANAGEMENT STRATEGIES IN RESTAURANTS:
PRACTICES, CHALLENGES, AND OPPORTUNITIES

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ABSTRACT

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This thesis investigates the factors contributing to food waste in three selected restaurants owned by Company X and explores effective strategies for minimizing waste. The study uses a mixed-methods approach, utilizing both quantitative and qualitative research methods to analyse data from November 2022 to January 2023 from the restaurants' management systems, Jamix and BIBook, and to conduct interviews with restaurant managers and representatives of the development department to gain a comprehensive understanding of daily routines, processes, and challenges. A comprehensive literature review was also conducted to lay the theoretical foundation for the research.

The research problem addresses three aspects: the company's data management system, food waste drivers, and waste minimization strategies. The first question, investigated through quantitative data analysis, revealed variations and patterns in food data, particularly moderate-to-high correlations between prepared food and waste amounts. The second question used qualitative data from interviews and literature to identify food waste factors, such as customer estimation difficulties, limited staff resources, inaccurate data entry, typing errors, personal preferences in preparation, cooking waste, and uneven consumption. The third question explored waste reduction strategies through interview data and literature, reporting actions like consolidating buffet stations, using smaller dishes, reusing leftovers, monitoring waste data, selling discounted leftovers, maintaining optimal stock levels, enhancing inventory management, cooking in smaller batches, and collaborating with the R&D team.

The study highlights the importance of regular training and workshops for restaurant staff and adopting new technologies to streamline daily operations. Improved communication among stakeholders and increased awareness of food waste management are crucial for reducing waste. Implementing these strategies and promoting stakeholder collaboration can significantly reduce food waste, fostering a more sustainable future.

In conclusion, this study offers valuable insights into factors contributing to food waste in Company X's restaurants and presents a comprehensive set of waste reduction strategies. Quantitative data analysis and qualitative interviews ensure a thorough understanding of the problem, while the literature review contextualizes findings within the broader academic and industry landscape. By adopting the recommended strategies, restaurants can contribute to the global effort to minimize food waste, promoting a more sustainable and responsible food industry.

Keywords: Food waste management, sustainability, leadership and management, restaurants

TIIVISTELMÄ

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Tässä tutkimuksessa analysoitiin tekijöitä, joilla on vaikutusta ruuan hävikkiin kolmessa Yritys X:n omistamassa ravintolassa ajanjaksolla 11/2022–1/2023. Tämän lisäksi tutkittiin tehokkaita strategioita hävikin vähentämiseksi. Tutkimuksessa käytettiin monimetodista lähestymistapaa hyödyntäen sekä määrällisiä että laadullisia menetelmiä datan analysoinnissa. Tutkimusaineisto perustui ravintoloiden Jamix- ja BiBook-tietojärjestelmiin sekä ravintolapäälliköiden ja kehittämisosaston edustajien haastatteluihin, joiden tarkoituksena oli saada kattava ymmärrys päivittäisistä rutiineista, prosesseista ja haasteista. Tutkimusta varten tehtiin kattava kirjallisuuskatsaus teoreettisen pohjan muodostamiseksi.

Tutkimusongelma kohdistui kolmeen näkökulmaan: yrityksen tiedonhallintajärjestelmään, ruuan hävikin syihin ja hävikin minimoimisen strategioihin. Ensimmäinen tutkimuskysymys, johon käytettiin määrällistä analyysiä, paljasti muutoksia ja malleja ruokadatassa. Korrelaatiota havaittiin etenkin valmisruuan ja hävikin määrien välillä. Toiseen tutkimuskysymykseen sovellettiin laadullista dataa haastatteluista ja kirjallisuudesta. Esimerkiksi asiakasmäärien arvioinnin vaikeuksista, rajallisista henkilöstöresursseista, virheellisistä tiedon kirjauksista, kirjoitusvirheistä, henkilökohtaisista valmistusmenetelmien mieltymyksistä, valmistusvaiheiden hävikistä ja epätasaisesta ruuan kulutuksesta kerättiin tietoa. Kolmas tutkimuskysymys kohdistui hävikin vähentämisen keinoihin ja siihen vastattiin haastatteludatan ja kirjallisuuden avulla. Tuloksina raportoitiin toimintoja kuten tarjoilupöytien sijaintien vakiinnuttaminen, pienempien lautasten käyttäminen, ylijääneiden ainesten käytön lisääminen, hävikkien määrien ja laadun seuraaminen, ylijääneiden ruokien myyminen, ainesvarastojen tason optimoiminen, inventoinnin hallinnan laajentaminen, aiempaa pienempien erien kypsentäminen, ja yhteistyön lisääminen tuotekehitystiimin kanssa.

Tämä tutkimus korostaa ravintolahenkilökunnan säännöllisen koulutuksen ja työpajojen merkitystä sekä uusien teknologien omaksumista päivittäisten rutiinien modernisoimiseksi ja sujuvoittamiseksi. Sidosryhmien välisen kommunikaation parantaminen ja lisääntynyt tietoisuus ruuan hävikin hallinnasta ovat oleellisia taitoja hävikin vähentämisessä. Näiden keinojen käyttöönotto ja sidosryhmien välisen yhteistyön korostaminen voivat vähentää merkittävästi ruuan hävikkiä ja siten edistää kestävää tulevaisuutta.

Tämä tutkimus tarjoaa arvokkaita näkymiä tekijöihin, joiden avulla Company X:n ravintoloissa ruuan hävikkiä voidaan tunnistaa, ja samalla se esittää useita käyttökelpoisia keinoja ruuan hävikin vähentämiseksi. Määrällinen datan analyysi ja laadulliset haastattelut mahdollistivat ongelman perusteellisen ymmärryksen, ja kirjallisuuskatsaus mahdollisti tutkimustulosten sitomisen akateemiseen ja käytännön tietämykseen. Ottamalla käyttöön suositeltuja strategioita ravintolat voivat vaikuttaa globaaliin tavoitteeseen minimoida ruokahävikkiä, kun ne omalla toiminnallaan kannattavat ja suosivat aiempaa kestävämpää ja vastuullisempaa ruokateollisuutta.

Avainsanat: Ruokahävikki, kestävyys, johtaminen ja hallinnointi, ravintolat

CONTENTS

1   INTRODUCTION

Food waste and food loss have become a global problem in multiple dimensions. Food loss and waste begin at the agricultural production stage and continue through the supply chain until it reaches the landfills. Every year, an estimated one-third of all food produced for human consumption is lost or wasted globally, amounting to approximately 1.3 trillion kilograms (FAO 2011, cited 13.11.2022). Food loss and waste have significant environmental, social, and economic consequences, such as increased greenhouse gas emissions, water consumption, and food insecurity. While a large amount of food is wasted every second around the world, there are nearly 36,2 million people who cannot afford to provide themselves with a nutritious meal every other day (Eurostat 2022, cited 13.11.2022).

In Europe, it is estimated that around 57 billion kilograms of food waste (127kg/person) occur annually, with an estimated market value of 130 billion euros (Eurostat 2022, cited 02.12.2022). The household sector accounts for the majority of this waste, followed by the food service and retail sectors. In response, the European Union has implemented a number of initiatives to reduce food waste, including co-ordinated food waste prevention interventions including both public and private stakeholders, proposing legally binding targets for member states to reduce food waste, and publishing a set of key recommendations. EU countries, including Finland, have committed to the UN Sustainable Development Goal of halving food waste by 2030. This ambitious target requires a collective effort from all stakeholders, including governments, businesses, and individuals, to adopt sustainable food waste management practices.

1.1   Aim of the Thesis

Reducing food waste in restaurants can result in numerous financial and environmental benefits. As worldwide trends place a greater emphasis on ecologically sustainable and cost-effective business strategies, food waste management is an essential duty for any food service firm. In order to meet sustainability and cost-cutting goals, the restaurant industry has realized the importance of proactive efforts to reduce food waste. This thesis will perform a comprehensive analysis of food waste management from multiple perspectives. The primary purpose of this study is to identify the primary causes of food waste in restaurants and the most effective ways to reduce food waste.

1.2   Research Questions

The research questions are critical for understanding the problem of food waste in the context of the study and identifying potential solutions and strategies to manage it. The following research questions are addressed in this study.

1. How are the changes in food waste and related factors reflected in the company's restaurant data management system?
2. What are the factors driving food waste in restaurants?
3. What are the strategies to minimize food waste in restaurants?

1.3   Commissioner Company

This study is carried out within a large Finnish restaurant chain, which is referred to as "X" throughout the study. The company operates a number of restaurants that are open to the public as well as enclosed staff restaurants throughout Finland. Even though all the restaurants are managed by the same company, there are significant differences in their daily operations. As a first step toward reducing food waste, X's management began tracking how much food the restaurant prepares for buffet lunch, how much food the restaurant sells, and how much food remains in the restaurant after the lunch service. The company refers to the remaining prepared food as "food waste (ruokahävikki)". Various types of actions aimed at measuring and managing food waste are currently underway. The restaurant management records all food waste data in a data management system, and they have a target percentage to achieve within a time period.

2   FOOD WASTE MANAGEMENT

In the context of sustainable food systems, the terms "food loss" and "food waste" are often used interchangeably, despite their distinct meanings. To clarify this issue, it is crucial to understand the fundamental differences between these two concepts. Effective management of food loss and food waste requires distinct approaches. In order to reduce food loss, interventions should target the supply chain and focus on reducing inefficiencies and improving infrastructure. In contrast, addressing food waste requires addressing consumer behaviour and promoting responsible food consumption. Understanding the distinction between food loss and food waste is crucial to the development of effective strategies to address the critical issue of food waste in our society. Through targeted interventions and awareness campaigns, it is possible to reduce both food loss and food waste, thereby promoting sustainable food systems and minimizing the environmental impact of food production and consumption.

2.1   Food Loss Vs Food Waste

Food loss is the reduction in quantity or quality of food during the production, post-harvest, processing, and distribution phases of the food supply chain (FAO 2011, cited 13.11.2022). Typically, food losses are unintentional and result from a variety of factors, including inadequate infrastructure, lack of proper handling, transportation methods, and insufficient storage facilities. The objective of food loss management is to reduce food losses during production, post-harvest, processing, and distribution. This may involve enhancing storage facilities, instituting improved handling procedures, and decreasing spoilage during transportation.

Food waste, on the other hand, refers to the retail and consumer-level discarding of food that is still fit for human consumption. This includes foods that have passed their expiration date, are slightly damaged, or are misshapen (FAO 2013, cited 18.11.2022). Food waste management focuses on reducing the amount of food discarded at the retail and consumer levels. This may involve strategies like food donations, composting, and portion control. Both food loss and food waste have substantial environmental, social, and economic consequences.

2.2 Food Waste in Finland

An estimated 641,26 million kilograms of food are lost or wasted annually in Finland, which is equivalent to 116kg per person. The household sector accounts for the majority of this waste with 295,50 million kilograms, followed by the industrial sector with 162,28 million kilograms. Food service, retail, and agriculture sectors have produced 77,91 million kilograms, 57,56 million kilograms, and 48,01 million kilograms of food waste, respectively in 2020 (European Commission, cited 13.01.2023). Figure 1 provides a visual representation of the distribution of food waste across the food chain in Finland during year 2020. According to Figure 1, the largest proportion of food waste in Finland occurs in households, accounting for approximately 46% of total food waste. The second-largest source of food waste is the industry sector, which accounts for approximately 25% of total food waste. The food service sector is the third largest with 12%. The remaining food waste is generated in the retail sector (9%), and agriculture (7%).
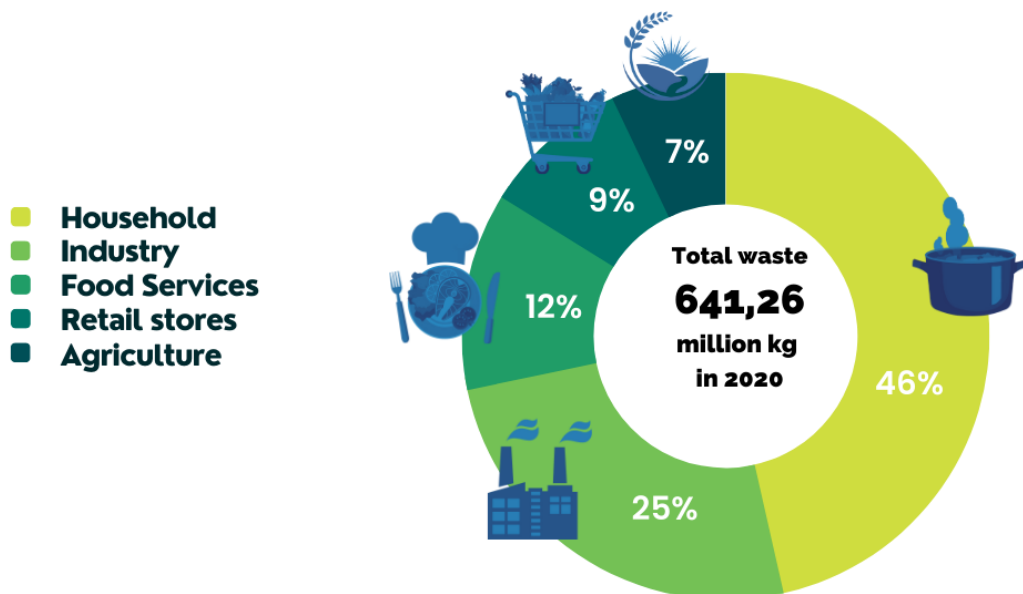

Figure 1. The distribution of food waste throughout the food chain. (Kuluttajaliitto 2021; European Commission, 2023)

In response, Finland has implemented a number of initiatives to reduce food waste, including the establishment of a national food waste reduction target and the creation of a food waste prevention

program. Also, in the beginning of 2021, the Finnish food waste roadmap was published, aiming to reduce the food waste under six themes; (1) effective policy instruments, (2) education and knowledge for a more sustainable society, (3) increasing sustainability by transforming practices, (4) technology for smartness, new products and business models, (5) research and development and monitoring of losses, and (6) together more. (Luonnonvarakeskus 2023, cited 02.02.2023)

2.3   Food Waste in Finnish Restaurant Industry

Food waste is a significant problem in the Finnish food service sector as the food service industry is accountable for a substantial quantity of food waste. Depending on the type of restaurant, between 7% and 28% of cooked food is wasted, and it is estimated that between 75 and 85 million kilograms of food are wasted annually across the entire Finnish food service industry (Katajajuuri, Silvennoinen, Hartikainen, Heikkilä & Reinikainen 2014). This level of food waste has serious implications and highlights the urgent need for action to address food waste in the food service sector. As a result, there has been a growing trend towards reducing restaurant food waste in Finland. It is essential to implement strategies to reduce food loss and waste throughout the entire food supply chain, including in restaurants in Finland.

Food waste in restaurants can be broken down into three categories: kitchen waste, serving waste, and customer waste (also known as plate waste), and as shown in Figure 2, in the context of food waste, these terms typically refer to several different types of waste (Katajajuuri et al., 2014; Silvennoinen, Heikkinen, Katajajuuri, & Reinikainen, 2015). The category of kitchen waste includes food trimmings and peelings, as well as spoiled or improperly prepared food that is discarded during the cooking process. Serving waste, on the other hand, refers to food that is left over after customers have been served or that was prepared but did not reach the customer for some reason. This category can include food that is overproduced, food that is not served due to customer cancellations or no-shows, and food that spoils before it can be served. Finally, customers' uneaten food left on their plates is commonly known as customer waste.
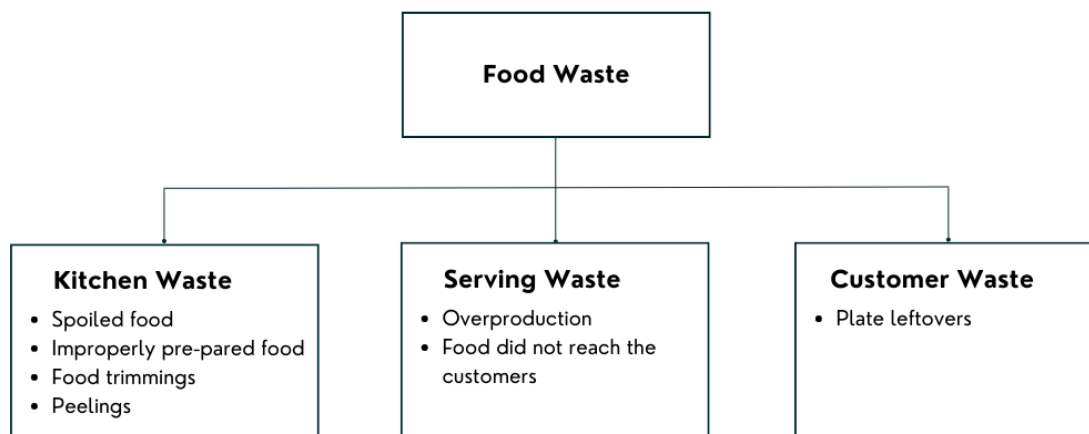
Figure 2. Food waste categories (Silvennoinen et al. 2015)

The amount and composition of waste produced in the Finnish restaurant sector is significantly influenced by the type of restaurant, with buffet restaurants generating more food waste compared to à la carte restaurants, primarily due to their self-service nature, resulting in service waste and overproduction (Silvennoinen et al. 2015). As shown in Table 1, Silvennoinen, Nisonen, and Pietiläinen (2020) compared several studies and concluded that food waste resulting from overproduction and buffets is typically much greater than that resulting from kitchen waste and customer waste. Also, in the same study, it was highlighted that in restaurants that do not offer buffets, customer waste becomes the primary source of food waste.

Table 1. Comparison of proportions of different types of food waste in multiple studies (Silvennoinen et al. 2020)

Study	Food Waste %	Kitchen Waste %	Serving Waste %	Customer Waste %
Betz et al. 2015	7,69	0,9	2,9	1,9
Betz et al. 2015	7,69	0,9	2,9	1,9
Silvennoinen et al. 2015	16,9 - 28	1,5 - 6,4	3,7 - 17,2	4,4 - 9,5
Eriksson et al. 2017	23	0,7	14,7	7,6
Silvennoinen et al. 2017	17,5	2,2	11,4	3,9

2.4   Factors Driving Food Waste in Restaurants

In restaurants, food waste is primarily contributed to by improper planning, including ingredient procurement and dish preparation, which can be attributed to insufficient understanding of required ingredients, inadequate inventory tracking, and failure to account for demand fluctuations, resulting in over-purchasing of perishable items and excessive food preparation (Filimonau, Todorova, Mzembe, Sauer, & Yankholmes, 2020). Inaccurate demand forecasting, influenced by factors such as volatile customer preferences, seasonal variations, health situations, and external events like holidays or promotions, is found to lead to overstocking of food items and overproduction of dishes, causing increased food waste and operational inefficiencies (Papargyropoulou, Wright, Lozano, Steinberger, Padfield, & Ujang, 2016; Filimonau, Krivcova, & Pettit, 2019; Strotmann, Baur, Börnert & Gerwin, 2022). It has been observed that restaurant staff attitudes and behaviours have a significant impact on food waste, with the need to minimize waste for operational cost reduction and reputational gains serving as primary drivers for waste mitigation, while environmental conservation receives less emphasis (Sakaguchi, Pak, and Potts, 2018; Filimonau et al. 2020). The use of extensive menus in restaurants to offer diverse choices has been identified as a factor leading to bulk ordering and unconsumed food, with studies revealing larger portions being chosen at buffet-style venues compared to á la carte restaurants and chefs showing reluctance in reducing portions for fear of disappointing guests, ultimately causing increased inventory, complexity, and waste (Juvan, Grün, and Dolnicar, 2017; Filimonau et al. 2020).

2.5   Strategies for Minimizing Food Waste in Restaurants

Accurate demand forecasting, although challenging to adopt and requiring significant upfront investment, has been identified as crucial for preventing over-supply and over-production of meals, ultimately proving to be a highly effective mitigation strategy (Filimonau et al. 2019; Filimonau et al. 2020). It has been observed that the success of demand forecasting interventions largely depends on corporate policies, as companies committed to reducing food waste in storage and preparation are more likely to allocate significant resources for investments in sophisticated forecasting models (Filimonau & De Coteau 2019).

A more proactive role in influencing consumer choices by promoting environmentally friendly purchasing decisions should be taken by restaurants as a food waste mitigation method. An increasing

interest in the effects of food choices on personal health, the environment, and the local economy has been demonstrated by customers, presenting opportunities for 'nudging' interventions aimed at reinforcing this interest (Lehner, Mont, and Heiskanen, 2016). While menus can serve as a medium for delivering these nudges, technology platforms such as interactive websites, mobile apps, and Quick Response (QR) codes appear to be a more effective method in communicating this information to consumers in a visually appealing and comprehensive manner (Filimonau and Krivcova, 2017).

Creative repurposing of food items has been suggested to address managing leftovers as well as excess stocks (Filimonau & Krivcova 2017). For instance, surplus food can be utilized for staff meals or rewards, offered at reduced prices, and redistributed to charities that provide it to those in need (Filimonau & De Coteau, 2019; Mourad 2016). A variety of software applications, such as ResQ Club (Finland), PareUp (USA), FoodLoop (Germany), Optimiam (France), Justoclic (France), MOGO (USA), and Foodzor (Belgium), have been developed to allow restaurants to list products that they are about to discard, enabling consumers to purchase them, usually at a discounted price (Martin-Rios, Demen-Meier, Gössling, Cornuz, 2018; Mattila, Mesiranta, & Heikkinen, 2020). In an effort to reduce and reuse food waste, it has been suggested that restaurants design their offerings in a way that facilitates repurposing leftovers from previous items (Filimonau & Krivcova 2017). By granting greater freedom and flexibility, restaurant managers can develop innovative ways to reuse leftovers or excess items, such as selecting daily menus from a pool of food items or introducing a "dish of the day" concept that incorporates leftover ingredients. Additionally, restaurants can review plate returns and work towards reducing unpopular food items and rethinking plate and tray sizes, particularly in buffet-style establishments (Sakaguchi, Pak, & Potts, 2018).

Food waste mitigation efforts should not rely solely on the latest technologies, but also on in-house training and workshops provided to restaurant managers and staff, ranging from forecasting and procurement to operations managers and chefs (Filimonau & de Coteau, 2019). Studies have indicated that staff, due to insufficient training, knowledge, and resources, may be hesitant to engage in food waste minimization efforts; therefore, providing regular training and updating them with new methods and techniques is highly recommended for reducing food waste in restaurants (Sealey & Smith, 2014). Enhanced communication between stakeholders, including restaurant staff, management, and customers, has been shown to facilitate effective food waste management by raising awareness, improving menu planning and order management, and promoting sustainable attitudes

and demand through analysis of desired menu choices (Sakaguchi et al. 2018). For example, implementing measures that require customers to accept limited dish availability towards the end of the buffet, pay according to their consumption, or offer compensation such as discounts for late arrivals can help minimize food waste, while maintaining good supplier relationships remains crucial (Papargyropoulou, Steinberger, Wright, Lozano, Padfield, & Ujang, 2019).

2.6   Challenges in Food Waste Management

In the restaurant industry, the accurate measurement of food waste has been identified as a continuing challenge, mainly due to the lack of training on measurement techniques (Filimonau & de Coteau, 2019; Papargyropoulou et al. 2016; Pirani and Arafat, 2016). The implementation of a weight-based system for quantifying food waste has been demonstrated to be effective in waste reduction (Sakaguchi, Pak, & Potts, 2018), but it is regarded as labor- and space-intensive in restaurants (Hanks et al., 2014). Moreover, despite the significance of the food waste issue in the food service sector, many managers underestimate its true scale (Filimonau & Sulyok, 2021). Instead, food waste is often regarded as an inevitable consequence of the food business (Vizzoto, Tessitore, Iraldo, & Testa, 2020).

The lack of clear, common definitions and consistency across studies may explain why the food service industry lags behind other industries in food waste management (Grant, Gallardo, & McCluskey, 2019). The absence of a precise definition hinders the implementation of appropriate strategies for mitigating negative effects of food waste in the food service. Individuals' lack of knowledge regarding what constitutes food waste further complicates the problem (Wakefield & Axon, 2020). In addition, although food waste's significance as a global concern is growing, it remains understudied in academia (Filimonau, Todorova, Mzembe, Sauer, & Yankholmes, 2020). Limited insights are provided by the existing research literature into how foodservice professionals, rather than academics, define waste and approach food waste management practices (Heikkilä et al., 2016).

Restaurant staff may be hesitant to provide accurate estimates of food waste generated, potentially underreporting amounts due to social desirability bias and the negative implications associated with reporting higher levels of waste (Filimonau, Krivcova, & Pettit, 2019). Furthermore, poor public knowledge of the magnitude of hospitality food waste and insufficient consumer understanding of

its detrimental environmental and societal implications contribute to irresponsible behavioral patterns, such as a preference for more choices without considering the impact on food waste (Russell, Young, Unsworth, & Robinson, 2017).

In the context of corporate policies, food safety and customer satisfaction are often prioritized over food waste mitigation, resulting in the limitation of the reuse or utilization of surplus food, as observed in buffet items where unconsumed food from one meal period is frequently mandated to be discarded (Papargyropoulou et al., 2016). Furthermore, the ability and willingness of restaurants to address food waste can be hindered by government policies and national legislation, as waste prevention can be discouraged by overly stringent food safety standards that prioritize disposal and prohibit the redistribution of unsold food (Watson & Meah, 2012). As stated by Thyberg & Tonjes (2016), a single corporate policy is insufficient for addressing food waste; rather, the adoption of customized, adaptable, and situational solutions is necessary, allowing managers and staff to modify their strategies in response to various circumstances.

3 RESEARCH METHODOLOGY

Both qualitative and quantitative approaches have been used in this thesis study. The qualitative research mainly utilized interviews and observations, while the quantitative research relied on data from the business intelligence systems. The data obtained from the quantitative research was used to complement the qualitative research and provide a more comprehensive understanding of the food waste management practices at X restaurants. The integration of these approaches provided a comprehensive understanding of the causes, consequences, barriers, and potential solutions for food waste in X restaurants. Furthermore, the study provides a number of recommendations that are aimed at improving the overall food waste management procedures of the chosen restaurants, based on the research outcomes and theoretical knowledge.

3.1 Qualitative Research

The qualitative research was conducted using separate interview guides for restaurant managers and the development department. To responsible for the planning of the responses, all interviews were audio recorded, transcribed using Simon Says[1] software, and subsequently translated into English. Particularly, four interviews were conducted in Finnish while only one was in English.

The interview guide created for the development department staff consisted of 12 questions covering a variety of topics, including obtaining basic information, clarifying the primary reason for initiating the food waste management process in the company, collecting feedback from restaurant staff, identifying the obstacles encountered to date, and gathering any suggestions for improving the current food waste management process in X.

The interview guide for restaurant managers consisted of 18 questions divided into four sections. The first section, titled "Basic Information," consisted of questions Q1 through Q5 that were designed to collect information about each restaurant manager and the location. The second section, titled "Restaurant operation," consisted of questions Q6 to Q9 that aimed to obtain a comprehensive understanding of each restaurant's operations. The third section, titled "Food waste management," consisted of questions Q10 to Q15 intended to collect information from restaurant managers

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[1] https://www.simonsaysai.com

regarding their perspective on food waste management and how they collaborated with other restaurant staff. The final section, "Steps to Improve the Process," consisted of questions Q16 to Q18, which allowed restaurant managers to provide their feedback, suggestions for future operations, and key points for reducing food waste at the X company.

3.2   Quantitative Research

The objective of quantitative research is to measure and quantify the relationships between data points related to restaurant operations and food waste management. Quantitative research is conducted utilizing data from the two primary business intelligence systems used by X to manage their restaurants' daily operations: Jamix[2] and BI Book[3].

Jamix is an enterprise-level kitchen management software used by X to manage kitchen and food service operations such as recipe management, menu planning, orders, inventory management, food production and requisitions, multi-unit restaurant management, and sustainability. Meanwhile, BI Book is a software used by X to collect data on each restaurant's financial management and daily operations. The software generates reports based on financial data, making it easier to compare various types of data and observe overall changes.

Using the above-mentioned software systems, data from November 2022 to January 2023 is collected and analysed to determine the relationships between various food waste management-related elements. IBM SPSS[4]. statistical analysis tool and Microsoft Excel are used for data analysis in the study.

3.3   Data Collection

Three of X restaurants in Oulu were selected for the collection of data. The food waste data from the data management system of these restaurants was analysed to identify patterns in their daily operations. In addition, the daily operations of these restaurants, including food waste management, were observed, and the required data and information was collected.

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[2] https://www.jamix.com
[3] https://get.bibook.com
[4] https://www.ibm.com/products/spss-statistics

Each restaurant has unique characteristics and a customer base. Restaurant A, with a seating capacity of 150, is situated in a business hub, attracting a diverse clientele comprised of both regular customers and new customers from various business events. Restaurant B, with a capacity of 140 seats, has a more balanced customer base, consisting of regulars and occasional newcomers, while Restaurant C, with a capacity of 100 seats, primarily caters to a consistent, loyal customer base from neighbouring workplaces. The staffing structures also vary across the three restaurants, with Restaurant A employing two permanent staff members and one trainee; Restaurant B having three permanent workers with only one full-time employee; and Restaurant C operating with a single full-time staff member who occasionally receives support from trainees. Table 2 shows the number of customers for each restaurant during the study period.

Table 2. Number of customers during the study period

Month	Restaurant	Number of Customers
Jan		
	A	1519
	B	1997
	C	1454
Nov		
	A	1846
	B	2173
	C	1690
Dec		
	A	1068
	B	1574
	C	1242

Company X's research and development department plays a crucial role in leading product and process enhancements within the organization. The department's responsibilities include the creation, testing, and uploading of new recipes to the Jamix system, ingredient cost calculations, the identification of suitable substitutes, and the assurance of dish quality. Additionally, the development team supervises the Jamix system, supports restaurant staff in maintaining food quality and the company's reputation, and directs corporate sustainability projects, staff training programs, and AI initiatives. The development team is responsible for corporate sustainability projects aimed at

reducing the company's environmental footprint, conserving resources, and fostering social responsibility. Such projects involve waste reduction initiatives, energy efficiency improvements, and collaboration with local suppliers to endorse sustainable practices. Furthermore, the team spearheads staff training programs designed to enhance the skills and knowledge of restaurant staff, focusing on sustainable practices, service optimization, and food quality. The research and development department also actively investigates applying new technologies, such as artificial intelligence, to improve operational efficiency and customer experience. Overall, Company X's research and development department is responsible for promoting innovation and sustainability within the organization, nurturing a culture of continuous improvement, and improving the experiences of both employees and customers.

Interviews were conducted with key personnel from the three restaurants and the development department of Company X to gain insights into food waste management practices and identify areas for improvement. The restaurant managers of each restaurant were interviewed to obtain their perspectives on the changes to their daily routines and the challenges they faced. These participants included Restaurant A's manager (A1) with four years of experience, Restaurant B's manager (B1) with five years of experience, and Restaurant C's manager (C1) with a notable 19 years of experience in the company. Additionally, members of X's product development team were interviewed to gain insight into the company's past and present situations. The development department was represented by the development manager (D1), who has eight years of experience in Company X and serves as the head of corporate sustainability, and a Jamix expert (D2) with three years of experience. Table 3 summaries the information about the interviewees. The diverse backgrounds and expertise of the interviewees provide valuable perspectives on the intricacies of food waste management within the company.

Table 3. Information of the interviewees

Person	Unit	Role	Experience in Company X
A1	Restaurant A	Restaurant manager	4 Years
B1	Restaurant B	Restaurant manager	5 Years
C1	Restaurant C	Restaurant manager	19 years

D1	Development department	Development manager	8 Years
D2	Development department	Jamix expert	3 Years

To ensure a focused and efficient analysis, the research was limited to service waste. By doing so, it was possible to narrow the scope of the study and obtain accurate and relevant data. The findings of this research will be shared with the development team to find better development measures to reduce food waste. These measures will not only benefit X company but also society and the environment.

4 RESULTS

In the data analysis, significant information and patterns regarding the management of food waste in three restaurants were identified. The data obtained from X company's data management system permitted the extraction of information such as the quantities of food prepared, consumed, food waste in kilograms, and food waste in euros for all three restaurants during the months of November, December 2022, and January 2023.

The interviews conducted revealed that differences in personal perspectives, experiences, and leadership have a significant impact on the final results of each restaurant.

4.1 Food waste categorization process in X restaurants

In the X company, a unique system is used for collecting food waste data at the end of each day. The remains of all warm main dishes, hot and cold sauces for the warm dishes, garnishes for warm main dishes, warm side dishes, and soup lunch dishes are measured and recorded as food waste by the restaurant staff. However, leftovers of salad items, bread table, dessert, drinks, and coffee & tea are excluded from the food waste data. This exclusion is due to the significantly lower cost of these items in comparison to the main courses and sides. Furthermore, measuring multiple categories of food waste would initially be difficult and time-consuming for the restaurant employees, which further justifies the focus on main and side dishes for data collection.

The served amount is recorded in the data management system using the number of customers as the number of served portions for each dish. This approach is taken because all three restaurants serve buffet lunches, allowing customers to choose any food from the buffet and any amount from each dish as they like. To estimate the number of portions that should be prepared, the staff utilizes pre-defined portion sizes for each dish, based on previous data and experience. The cashier machine charges a single price for the lunch buffet, further simplifying the process.

Figure 3. Screenshots of Jamix data system

In the Figure 3, it shows the details of the Salmon fishcake (Lohimurekepihvi) dish and the Vegetable puree soup (Kasvissosekeitto) which were served on 4th of January 2023 at the restaurant A. For each item it includes prepared (Valmistettu), Consumed (Menekki), Wasted (Hävikki) information including number of portions (Annosmäärä), weight (Paino) and portion size (Annoskoko).

4.2   Summary of food data

Over the course of three months, the food waste data for the three restaurants revealed a variety of trends, with differences in prepared and consumed food amounts across the restaurants. Table 4 shows the summary of food data for three restaurants from November 2022 to January 2023. The table outlines the prepared food amounts in kilograms, consumed food amounts in kilograms, food waste in kilograms, and food waste costs in euros for each restaurant during this period. By examining these data, it is possible to gain valuable insights into the food waste trends and identify possible areas for improvement in food waste management practices across the three restaurants.

Table 4. Summary of collected food data

Month	Restaurant Name	Prepared Food (kg)	Consumed Food (kg)	Food Waste (kg)	Food Waste (€)
Nov-22	A	1101.8	937.9	163.9	541.26 €
	B	1234.37	1039.07	195.3	701.58 €
	C	922.23	846.41	75.82	279.76 €
Dec-22					
	A	559.1	463.44	95.66	271.98 €
	B	1002.4	869.25	133.15	496.53 €
	C	684.1	602.843	66.257	291.08 €
Jan-23					
	A	953.7	813.3	140.4	449.50 €
	B	1071.57	906.17	133.4	522.55 €
	C	832.955	720.245	112.71	432.80 €
Grand Total		8362.225	7198.628	1116.597	3,987.03 €

In November 2022, Restaurant B exhibited the most significant volume of prepared food, amounting to 1234.37 kg, followed by Restaurant A with 1101.8 kg and Restaurant C with a more modest 922.23 kg. Interestingly, despite the larger quantity of prepared food, Restaurant B customers consumed merely a marginally greater amount (1039.07 kg) than those at Restaurant A (937.9 kg), while Restaurant C registered the lowest consumption rate (846.41 kg). Consequently, Restaurant B generated the highest food waste, both in terms of weight (195.3 kg) and associated cost (701.58 €), followed by Restaurant A with 163.9 kg of waste (541.26 €) and Restaurant C with the least at 75.82 kg (279.76 €).

In December 2022, all three restaurants lowered their prepared food quantities, which contributed to a decline in food waste compared to the previous month. This reduction in food preparation is most likely attributable to lower restaurant opening days due to the Christmas holidays. Restaurant

A prepared 559.1 kg, Restaurant B prepared 1002.4 kg, and Restaurant C prepared 684.1 kg. The consumed food amounts were 463.44 kg for Restaurant A, 869.25 kg for Restaurant B, and 602.843 kg for Restaurant C. As a result, Restaurant B persisted in having the highest food waste both by weight and cost at 133.15 kg and 496.53 €, respectively. In contrast, Restaurant A generated the second-highest food waste by weight at 95.66 kg, compared to 66.257 kg for Restaurant C. However, Restaurant C incurred a higher food waste cost than Restaurant A, with figures amounting to 291.08 € and 271.98 €, respectively.

In January 2023, the food waste levels witnessed an increase compared to December, albeit remaining below those recorded in November. The prepared food quantities were 953.7 kg for Restaurant A, 1071.57 kg for Restaurant B, and 832.955 kg for Restaurant C, while the consumed food quantities were 813.3 kg, 906.17 kg, and 720.245 kg, respectively. In terms of cost, Restaurant B continued to report the highest food waste at 522.55 €, followed by Restaurant A with 449.50 €, and Restaurant C with 432.80 €. However, in terms of food waste by weight, Restaurant A surpassed both Restaurant B and Restaurant C, registering 140.4 kg compared to 133.4 kg and 112.71 kg, respectively.

Figure 4 shows the comparison of total food waste in each restaurant in terms of weigh and value during the three-month period. Among the three restaurants, Restaurant B generated the highest amount of total food waste in both weight and value followed by Restaurant A, and finally, Restaurant C with the lowest food waste.
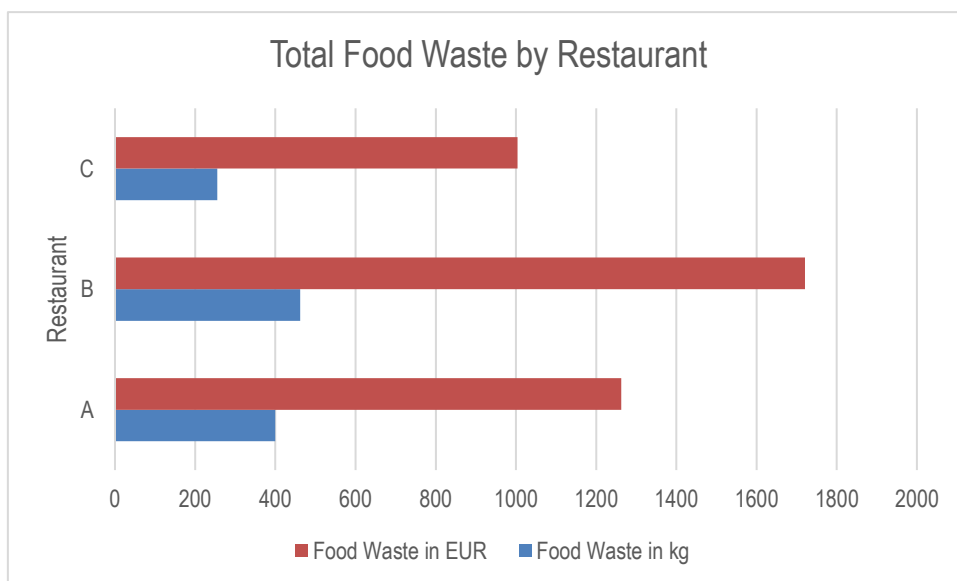

Figure 4. Comparison of total food waste

Over the entire three-month period, spanning November 2022 to January 2023, the restaurants cumulatively prepared 8362.225 kg of food, of which 7198.628 kg were consumed, resulting in a total food waste of 1116.597 kg. The combined food waste cost for all three establishments amounted to 3,987.03 €.

4.3   Relationships between food data

In the following sections, relationships between various food data are explored, with a focus on the links between prepared food, consumed food, and food waste. By recognizing these connections and understanding their significance, valuable insights can be gained into how food preparation and consumption methods can be used to reduce food waste. The analysis will discuss the correlations between these aspects of food data and the differences in their strengths, while a statistical measure is also utilized to quantify the associations between them.

4.3.1   Correlations in food preparation, consumption, and waste

After analysing the daily amounts of prepared food, consumed food, and food waste, it is possible to identify correlations between prepared food and food waste, as well as consumed food and food waste. Figure 5, Figure 6, and Figure 7 show the comparisons of changes in prepared food amount, consumed food amount, and food waste amount over the period of three months for Restaurant A, Restaurant B, and Restaurant C, respectively. While the amounts in the charts generally fall within a certain range, there are some unusual situations like Christmas lunch buffet as in Figure 6 and, missing data as in Figure 5. Correlation between food data in Restaurant A.
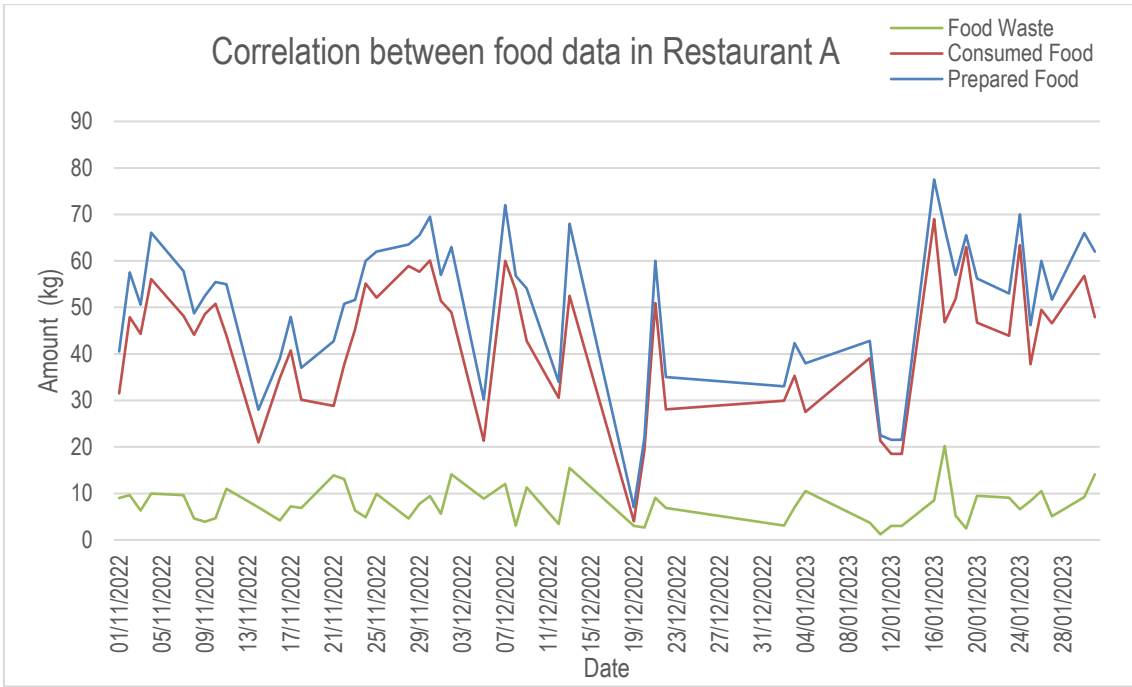
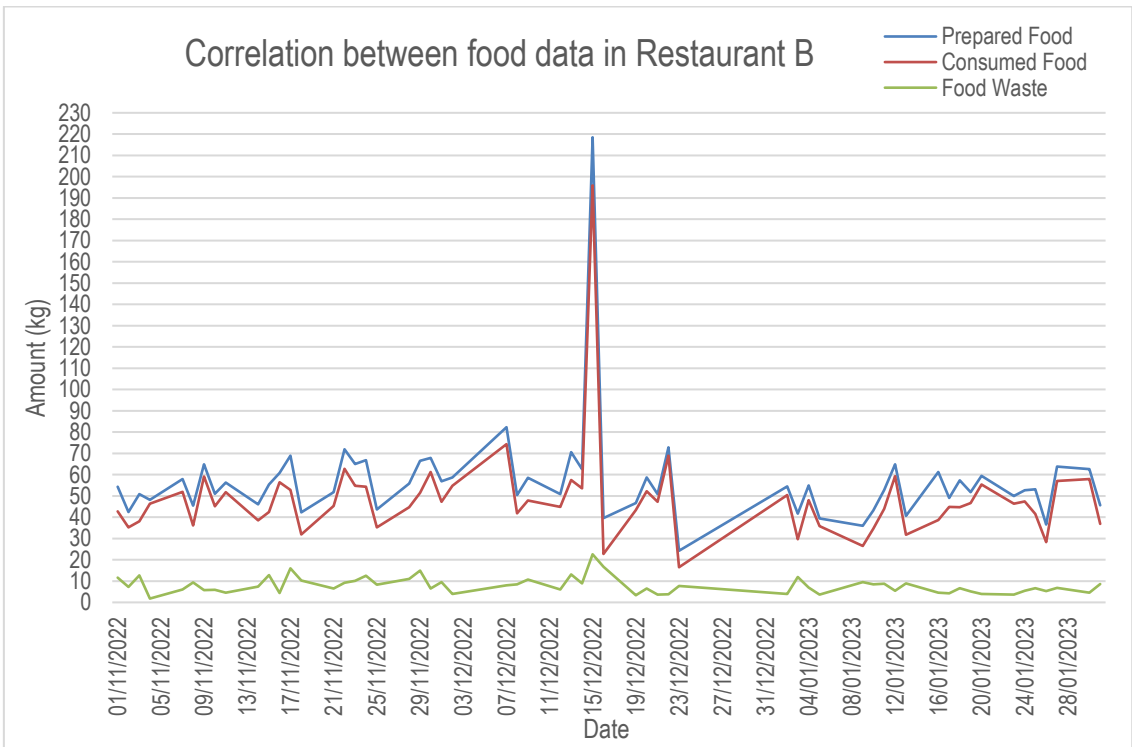*Figure 5. Correlation between food data in Restaurant A*

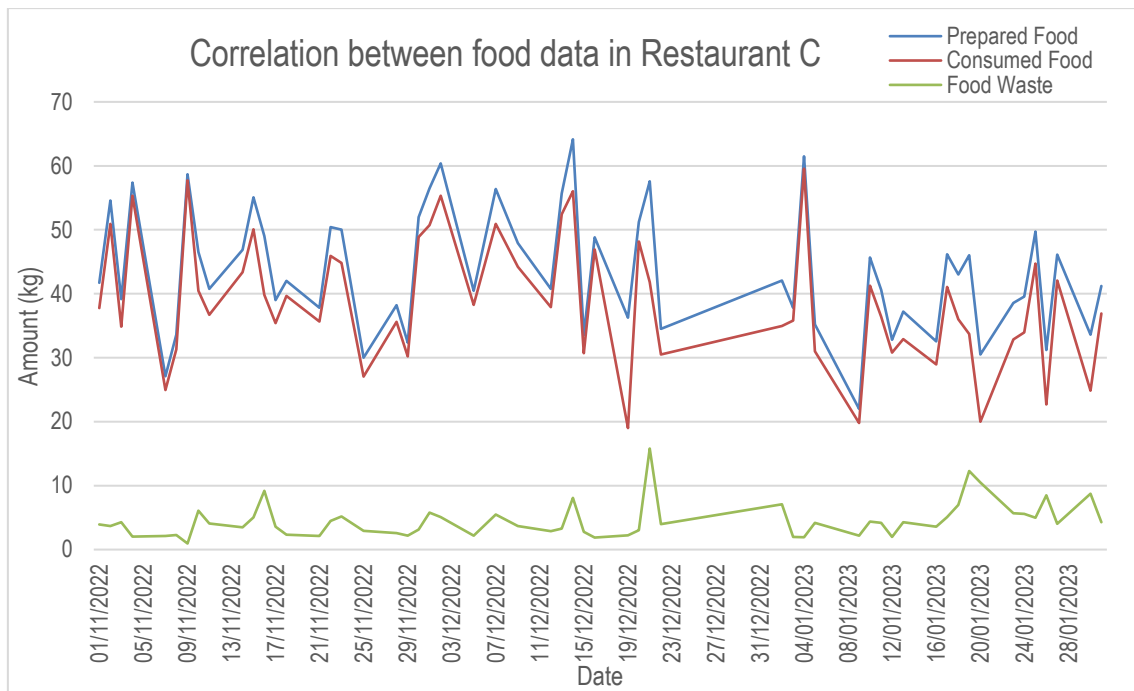*Figure 6. Correlation between food data in Restaurant B*

Figure 7.Correlation between food data in Restaurant C

After analysing food data from all three restaurants, it appears that there is a positive correlation between Prepared Food and Food Waste, as well as between Consumed Food and Food Waste. As the amount of Prepared Food increases, the amount of Food Waste also tends to increase. Similarly, as the amount of Consumed Food increases, the amount of Food Waste also tends to rise. This indicates that the more food is prepared and consumed at the restaurant, the higher the amount of waste generated. However, it is important to note that the correlation between Consumed Food and Food Waste seems to be weaker than the correlation between Prepared Food and Food Waste.

4.3.2 Pearson correlation coefficient

The Pearson Correlation Coefficient (r) is a statistical measure that quantifies the degree of association between two variables. It is commonly used to analyze the relationship between variables that are expected to be linearly related. The coefficient ranges from -1 to +1, with 0 indicating no correlation, -1 indicating a perfect negative correlation, and +1 indicating a perfect positive correlation. (Kent State University 2023. Cited 02.04.2023)

The Pearson Correlation Coefficient is calculated using SPSS to identify the correlation between prepared food and food waste as well as consumed food and food waste. Based on the calculation

shown in Figure 8, there is a significant positive correlation between the variables prepared food and food waste with a Pearson Correlation Coefficient of 0.365** (p<0.01). This suggests that as the amount of prepared food increases, the amount of food waste also tends to increase. The correlation coefficient is moderate, indicating a moderate strength of association between the variables.

Correlations

		Prepared Food (kg)	Food Waste (kg)
Prepared Food (kg)	Pearson Correlation	1	,365**
	Sig. (2-tailed)		<,001
	N	864	864
Food Waste (kg)	Pearson Correlation	,365**	1
	Sig. (2-tailed)	<,001	
	N	864	864

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 8. Pearson Correlation Coefficient for prepared food and food waste

As shown in Figure 9, there is a significant positive correlation between the variables consumed food and food waste with a Pearson Correlation Coefficient of 0.164** (p<0.01). This suggests that as the amount of food consumed increases, the amount of food waste also tends to increase. The correlation coefficient is low, indicating a weak to moderate strength of association between the variables.

Correlations

		Consumed Food (kg)	Food Waste (kg)
Consumed Food (kg)	Pearson Correlation	1	,164**
	Sig. (2-tailed)		<,001
	N	864	864
Food Waste (kg)	Pearson Correlation	,164**	1
	Sig. (2-tailed)	<,001	
	N	864	864

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 9. Pearson Correlation Coefficient for consumed food and food waste

4.4   Causes of Food Waste in the Restaurants

This section aims to explore the causes of food waste in the restaurants, as perceived by the interviewed restaurant managers. Factors such as customer number fluctuations, staff limitations, batch cooking, dish combinations, uneven consumption, emergency situations, and cooking waste are discussed in detail to provide insight into the challenges faced by the restaurants in managing food waste.

4.4.1   Fluctuations in Customer Numbers

The interviewed restaurant managers identified the difficulty in predicting the number of customers as one of the main reasons for food waste. Daily fluctuations in customer numbers make it challenging to accurately estimate the required food quantities, even when consulting previous customer data. External factors, such as the location of the restaurant, work-from-home situations, or health-related concerns in the vicinity, can significantly impact customer numbers and contribute to food waste, as explained by one restaurant manager *"We are located in a place where employees have a two-day Work from Home (WFH) strategy, which they can take whenever they want. We are affected by cold weather and various other factors. For instance, last week, there was a COVID-19 outbreak in the building, and we experienced a large drop in the number of people eating at our restaurant, decreasing from sixty to twenty."*

4.4.2   Limited Staff

Limited staff resources were identified as another cause of food waste. The challenge of managing food waste with a limited workforce makes it difficult to cook in smaller batches, consistently monitor food consumption, or adjust production accordingly. This issue was also highlighted by a development team member, suggesting that it is a concern recognized at various levels of the organization.

4.4.3   Batch Cooking

Batch cooking, in which large quantities of base recipes are prepared and stored in advance to increase efficiency, is often employed in restaurants. When it is time to refill the buffet, required ingredients can easily be added to a portion of the pre-cooked base, and the dish can be finished.

Examples of such dishes include Bolognese sauce and Salmon soup. However, certain dishes, such as casseroles, require longer cooking times and must be cooked whole at once. Large quantities of these dishes are prepared in the morning to ensure they will not run out during the buffet. Nonetheless, this can lead to increased waste if customer demand does not match the prepared quantities, emphasizing the potential drawbacks of batch cooking for certain food types in terms of food waste management.

4.4.4 Dish Combinations

Dish combinations were mentioned as another factor contributing to food waste. When two dishes are intended to be served together, they are expected to be consumed in similar proportions. However, uneven consumption may occur if one dish is more popular than the other, resulting in a significant amount of leftovers from the less popular dish and increased food waste. One interviewee explained, *"The food pairing should be well-balanced, ensuring that customers are equally likely to choose this dish as they would choose the other dish. Otherwise, there might be situations where one dish gets finished too quickly while the other remains largely untouched, resulting in a significant amount of leftover food."*

4.4.5 Uneven Consumption

Uneven consumption of dishes, whether due to individual customer preferences or unsuccessful dish combinations, can lead to a surplus of certain menu items and consequently increased food waste. Identifying and addressing these disparities can help to minimize waste and improve overall efficiency.

4.4.6 Emergency Situations

Emergency situations, such as unexpected staff changes in the kitchen, can also impact the amount of food waste. Even when following a recipe, individual cooking methods and ingredient preferences can result in taste variations, which may affect customer satisfaction and contribute to waste.

4.4.7   Cooking Waste

Lastly, cooking waste, or "paistohävikki," was cited as a factor that could lead to excessive use of main ingredients. The discrepancy between the weight of ingredients before and after cooking may result in an overuse of ingredients, further contributing to food waste. Addressing this issue could help to optimize ingredient usage and minimize waste throughout the cooking process. One restaurant manager emphasized, *"If you take 15 kilograms of meat according to the instructions and it looks like you have lost only 300g or 400g. But in reality, you might have lost 3Kg. It makes an immediate impact. A good example was frozen fish. I ordered 20 kilograms according to the instructions. But when it was cooked, I only had 12kg of finished product. So, I had to place a new order to our supplier."*

4.5   Food Waste Management Process

This section presents an analysis of the food waste management practices in three different restaurants, based on qualitative interviews with their respective managers. The insights gathered from these interviews have been divided into six subsections: Production Planning, Menu Selection, Quantity Estimation, Daily Procedures, Process Variation, and Data Management. These subsections provide a comprehensive overview of the various processes and practices followed by the restaurant managers to minimize food waste and manage their resources efficiently, while adapting to changing customer preferences and demands.

4.5.1   Production Planning

Production planning was conducted by all three restaurant managers one week in advance, utilizing the Jamix system to access menu lists and make informed decisions about dishes to prepare during the upcoming week. Old inventory and remaining ingredients were checked before ordering new supplies, minimizing waste by utilizing existing inventory, reducing the risk of overstocking and spoilage, and contributing to efficient resource management.

4.5.2 Menu Selection

Menus were provided to the restaurants by the R&D team via the Jamix system, with a unique structure dividing them into three periods throughout the year. Each period contained different menu sets designed for a 4-week duration, with every week comprising menus for five days, resulting in a 4-week rotating menu cycle. Restaurant managers were permitted to make changes to the menus by selecting from the pool of menu items available for the given period, but some managers used earlier printed menus instead of the most recent ones from the Jamix system.

4.5.3 Quantity Estimation

To estimate daily production quantities, managers considered the previous week's customer data, menu list data, and data from days when the specific dish was served previously. This approach helped to reduce waste by focusing on dishes that were more likely to be consumed by the customers, allowing managers to adjust their daily production plans to better match customer needs and preferences.

4.5.4 Daily Procedures

When new menu lists were introduced, managers collaborated with the R&D team to discuss potential dish combinations and customer preferences, making adjustments based on their instincts and previous experiences. This continuous process of evaluating and refining daily procedures enabled the restaurants to maintain a high level of efficiency and customer satisfaction while minimizing food waste throughout their operations.

4.5.5 Process Variation

During the first week of a new menu list, managers relied on intuition and experience to estimate dish quantities. In subsequent weeks, data from the first serving of each dish was used to refine estimations, allowing for better identification of popular dishes, successful combinations, and areas that required adjustments. This ongoing process of evaluating and adjusting production quantities and portion sizes contributed to an optimized and more efficient food waste management process. As noted by a restaurant manager, *"The first rotation of the menu with the new menu is always a*

guessing game. We don't know the quantities of the items to bring in until we see what works and what doesn't. Then we take what works and incorporate it into the next rotation. This is how we cycle through, removing dishes that don't work and keeping those that do. That's why the quantities fluctuate."

4.5.6   Data Management

After buffet service, leftover food in both the buffet area and the kitchen is weighed, and the measurements are entered into the Jamix data system for analysis and decision-making. Although daily data entry is recommended by company guidelines, it is also allowed for the restaurant staff to enter the data on a weekly basis due to the associated workload. Gaps in the data of some restaurants can be attributed to restaurant managers being occupied with their day-to-day responsibilities, which highlights the importance of consistent and timely data entry for the effectiveness of food waste management initiatives. Figure 10 illustrates the food data management process carried out in practice at one of the restaurants.
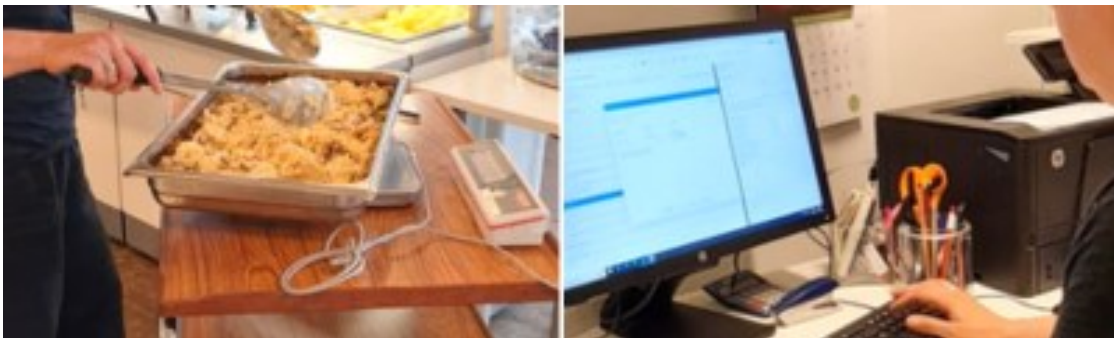
Figure 10. Measuring food waste and entering data to Jamix system

4.6   Challenges in Food Waste Management

An identified set of challenges faced during the implementation of food waste management practices are presented. The challenges related to time constraints, additional workload, variation in peak hours, struggle with adaptation to new guidelines, difficulty in integrating new tasks into daily routine, and inconsistency in implementing new guidelines were identified by the restaurant managers. On the other hand, the challenges concerning workforce shortage, difficulty in recognizing

benefits, and issues with inaccurate food waste measurements were highlighted by the development team. This analysis aims to provide an understanding of the various challenges encountered while implementing food waste management practices.

4.6.1 Time Constraints

All three managers expressed similar concerns regarding time constraints, with the main challenge being the lack of time to perform the new tasks, given their limited 7.5-hour workday. This made it difficult for some of them to follow the initial steps of the new guidelines at the beginning.

4.6.2 Additional Workload

The managers reported that their first reaction to the new guidelines was the concern about an increased workload. They wondered how they could manage to complete all the tasks, given their already busy schedules.

4.6.3 Variation in Peak Hours

Another challenge identified by the managers was the variation in peak hours among different restaurants. In some establishments, the busiest time occurred from 11:00 to 12:00, while in others, a significant influx of customers arrived during the last half hour of the lunch buffet. One manager explained, "This is typically the kind of place were, in the last half hour of the lunch buffet, there will be so many customers. Then, if you're alone, you can't make all the food ready and available or have no time to make more." This variability in peak hours posed an additional challenge to the implementation of food waste management practices, as it required further adjustments in food production and staffing.

4.6.4 Struggle with Adaptation to New Guidelines

The managers found it challenging to adapt to the new practices at the beginning. However, clear guidelines and training sessions provided by the development department made it easier for them to learn and adapt to the new practices.

4.6.5 Difficulty in Integrating New Tasks into Daily Routine

One manager stated that the main challenge was not the difficulty of the tasks, but rather learning something new and integrating it into their daily routine. They had to adjust their schedules and reorganize their work processes to ensure that the new tasks became part of their job description.

4.6.6 Inconsistency in Implementing New Guidelines

Although measuring food waste and entering data into the Jamix system eventually became an integral part of the managers' daily routine, maintaining consistency in implementing the new guidelines across all restaurants proved to be a challenge. Ensuring that all managers consistently followed the guidelines and adapted their practices accordingly was a significant challenge to overcome.

4.6.7 Workforce Shortage

The implementation of food waste management practices is hindered by the main obstacle of workforce shortage, which results in difficulty for restaurant managers and staff to allocate time to food loss management. The process is further complicated when employees are absent due to illness, especially in restaurants where additional workforce is hard to find. The lack of time poses a significant challenge to be overcome.

4.6.8 Difficulty in Recognizing Benefits

In the beginning, the benefits of the new food waste management practices were not seen by some staff members, leading them to question the necessity of these practices. The belief that the extent of food loss was already known was held by them. However, once waste measurement was initiated, a realization of the true scale of waste occurred, which led to a change in attitude towards the new practices. The importance of recognizing benefits became evident in encouraging staff to adopt the new guidelines.

4.6.9   Inaccurate Food Waste Measurements

During the early stages of implementing the new practices, inaccuracies in measuring food waste were encountered, such as recording zero waste when food supplies had run out. In reality, waste is always present in the packaging, and even small amounts of waste accumulate over time. By providing additional training to staff, this challenge was addressed, ensuring that the importance of accurate measurements was understood and that correct recording methods were followed.

During the interview, it was discussed that if kitchen leftovers are reused in another dish or on another day, the food waste for that dish should be zero. However, the current data system records these leftovers multiple times, leading to misleading data. The interviewee expressed a desire for a solution or a method to record these leftovers as reused products, thereby accurately reflecting their waste reduction efforts. "*In this waste reduction effort, it's really a lot because we freeze everything we can. So we make our own sweet potato-corn patties, and whatever is left over, we put it in the freezer and use it the next day as a vegetable dish. So, in reality, the waste is practically zero, because the leftovers are put to good use, but here it appears as red.*"
"*For example, leftover Bolognese sauce is really good to freeze and make ground meat pizza. So the waste is zero, and we've been thinking, is there some kind of solution, where we could mark that, in fact, we've saved that 27.88, and the leftovers are put to good use there. Then the waste is zero.*"

4.7   Minimizing Food Waste in the Restaurants

The existing actions taken by the interviewed restaurant managers to minimize food waste and their suggestions for future actions that could further reduce waste, are useful input for planning food waste management strategies. Table 5 provides a comprehensive overview of the current food waste reduction measures and future suggestions, organized by focus areas: Operations Management, Leftover Handling, Cooking Strategy, and Monitoring and Feedback. This categorization allows for a clear understanding of the different aspects of food waste management in restaurants and highlights potential areas for improvement.

Table 5. Existing measures and proposed strategies for food waste reduction

Area of focus	Existing measures for food waste reduction	Proposed strategies for further food waste reduction
Operations Management	Adjusting operations during busy hours. Opening two stations during rush hour and consolidating to one station afterward to use smaller serving dishes.	Improve inventory management to prevent food shortages and minimize the need for last-minute purchases, which can help reduce food waste and maintain optimal stock levels.
Leftover Handling	Implementing a "hävikkimyynti" system to manage leftovers from the buffet table.	Finding creative ways to repurpose leftovers, such as incorporating leftover carrots into soups or pickling excess cucumbers to serve as a salad item.
Cooking Strategy	Reusing leftover food from the kitchen, such as turning Bolognese sauce into minced meat pizza, provided the food has been properly stored and chilled.	Implementing a strategy to cook in smaller batches, which would help control the quantity of food produced for the buffet. Adjusting portion sizes to reduce waste while still meeting customer expectations.
Monitoring and Feedback	Regularly monitoring waste figures and using this information to improve operations. One manager mentioned that seeing the weekly reports on the money saved by minimizing food waste was highly motivating and indicated the progress they had made in reducing waste in their restaurant.	Organizing meetings with the R&D team at the end of the first round of serving a menu list or at the end of a season, providing an opportunity for restaurant staff to share their feedback on the menu list and discuss challenges they encountered.

5   DISCUSSION

This study emphasizes the importance of monitoring food waste and related factors in the restaurant industry, particularly in buffet-style establishments such as those operated by Company X. By examining this information, restaurants can pinpoint areas for improvement, develop more effective waste management strategies, and better understand fluctuations in food waste levels from month to month, ultimately striking a balance between customer satisfaction and sustainability. It is emphasized that reducing food waste not only results in more sustainable business practices but also yields financial savings for the establishments, reinforcing the importance of addressing this issue within the restaurant industry.

This study employed both quantitative and qualitative research methods to study the food waste management from November 2022 to January 2023 in three buffet-style restaurants operated by Company X. The research was limited only to serving waste in the restaurants, as Company X aimed to minimize food leftovers from lunch buffets.

5.1   Factors Contributing to Food Waste

In the data analysis, a positive correlation between prepared food and food waste was revealed, as well as between consumed food and food waste. This indicates that increases in prepared and consumed food quantities lead to higher food waste levels. However, the correlation between the amount of consumed food and the amount of food waste was found to be weaker, while the correlation between the amount of prepared food and the amount of food waste was moderate to strong. This suggests that the focus should be on the relationship between the amount of prepared food and the amount of food waste.

Inaccurate demand forecasting was found to have a significant impact on generating food waste. One of the main factors affecting demand forecasting was identified as the variability in the daily number of customers. Although restaurant managers had access to previous data to estimate customer numbers and possessed the knowledge and experience to predict them, the process remained uncertain for managers and staff. Factors such as the location of the restaurant, seasonal variations, and external events were recognized by study participants and research literature as

reasons causing fluctuations in customer numbers. Not only did COVID-19 outbreaks contribute to fluctuations in customer numbers in restaurants, as observed by Strotmann et al. (2022), but also one of its by-products, flexible "work from home" policies, made it difficult for restaurant staff to predict the number of customers for a given day. The above observations aligned with previous studies by Papargyropoulou et al. (2016) and Filimonau et al. (2019), which mentioned that inaccurate demand forecasting could lead to overproduction of dishes, resulting in increased food waste and operational inefficiencies in restaurants.

The impact of restaurant staff on food waste levels was widely recognized by both the interviewees and the literature (Sakaguchi et al., 2018). Specially, the lack of staff could cause an increase in food waste as continuous food consumption monitoring and appropriate adjustments to production become challenging to implement. Although managers are aware that one of the best solutions to minimize food waste involves preparing food based on need, staff shortages sometimes necessitate that certain dish be cooked in large quantities in the morning. It was observed that, despite receiving all necessary cooking instructions from the R&D team, personal preferences of staff regarding salt, spices, or cooking methods might be reflected in the dish, leading to leftovers at the end of the buffet service. One of the main causes of this issue is identified as emergency situations arising in the restaurant, such as the permanent chef falling ill and a substitute chef taking over the kitchen.

Batch cooking, while an integral part of restaurant operations, may contribute to increased food waste for certain food types that must be prepared all at once rather than in stages. Cooking waste, also referred to as "paistohavikki," was identified as another factor that could lead to the excessive use of primary ingredients. Discrepancies between the pre- and post-cooking weights of ingredients might have resulted in overuse of ingredients and, consequently, an increase in food waste.

Moreover, it is crucial for restaurant managers and chefs to select optimal combinations of food dishes from the menu lists provided by the R&D team at Company X. Uneven consumption may arise due to inappropriate dish combinations. A thorough understanding of the required quantity of each dish to be prepared is also essential. Prior to selecting dishes from the menu lists received from the company's R&D team, the restaurant staff should consult previous data to make informed decisions. Improper planning of the day's menu can lead to situations that greatly increase the food waste levels (Juvan et al., 2017; Filimonau et al., 2020).

5.2   Strategies for Minimizing Food Waste

Strategies to minimize food waste are crucial for the restaurant industry to reduce its environmental impact, improve operational efficiency, and contribute to a more sustainable future. By understanding various strategies and best practices, restaurants can tailor their waste reduction plans to their specific needs and circumstances.

The importance of accurate demand forecasting was highlighted in the research literature (Filimonau et al., 2019; Filimonau et al., 2020), as well as corporate policies for investment in forecasting models (Filimonau & De Coteau, 2019). In this study, restaurant managers mentioned adjusting operations during busy hours and consolidating stations afterward. Concurrently, it was shown that Company X is keen to use advanced technologies, such as AI and data analysis, to improve the efficiency of restaurant operations. Inventory management improvements were also suggested to prevent food shortages and minimize last-minute purchases, which again align well with the emphasis on demand forecasting in the literature (Filimonau et al., 2019; Filimonau et al., 2020). Leftover handling strategies, including creative repurposing of food items (Filimonau & Krivcova, 2017) and surplus food redistribution (Filimonau & De Coteau, 2019; Mourad, 2016), are discussed in the literature. In this study, the implementation of a "hävikkimyynti" system was presented, and finding creative ways to repurpose leftovers was proposed, supporting the suggestions in the literature (Filimonau & Krivcova, 2017). The importance of reusing leftover food, cooking in smaller batches, and adjusting portion sizes was highlighted by the study participants as means to control food quantities and reduce waste, which aligns with the suggestions of Filimonau & Krivcova (2017) and Sakaguchi et al. (2018).

Monitoring and feedback are essential for effective food waste management (Sakaguchi et al., 2018). The literature emphasizes the role of in-house training, communication between stakeholders, and the importance of staff engagement in food waste minimization (Filimonau & de Coteau, 2019; Sealey & Smith, 2014). This study supports these findings, suggesting that regularly monitoring waste figures and organizing meetings with the R&D team to share feedback on menu lists and discuss challenges can be effective strategies for food waste reduction.

5.3 Training and Support for Restaurant Staff

During the interviews, restaurant managers reported that they received clear instructions and training at the beginning of the food waste management process, which helped them overcome initial challenges. Effective training for restaurant staff on predicting customer numbers, calculating portion sizes, and understanding the company's goals can positively impact food waste reduction efforts. This aligns with the food waste minimization strategies suggested by Filimonau and de Coteau (2019) and Sealey and Smith (2014).

Providing ongoing support and resources for restaurant staff is essential for maintaining and enhancing waste reduction efforts. This can include regular training sessions, access to resources and tools for monitoring and managing food waste and fostering a culture of open communication and collaboration among staff members. By investing in staff development and creating a supportive work environment, restaurants can promote a sense of ownership and commitment to food waste reduction efforts among employees.

5.4 Tailoring Guidelines to Individual Restaurants

The three restaurants in this study exhibited significant differences in terms of location, target customers, and other factors. As a result, applying common guidelines for food waste reduction to all restaurants in Company X may not provide a fair opportunity for each establishment to address their unique challenges. Factors such as location, restaurant size, seating capacity, and target customers should be considered when developing food waste reduction guidelines for individual restaurants.

Customizing guidelines for each restaurant allows managers and staff to better address the specific challenges they face during the operational process as state by Thyberg and Tonjes (2016). Restaurants can work closely with the R&D team to develop tailored guidelines that take into account their unique circumstances and customer base. This approach can help ensure that food waste reduction strategies are both effective and feasible for each restaurant.

5.5   Collaboration and Knowledge Sharing

Promoting collaboration and knowledge sharing among restaurants within Company X can further enhance food waste reduction efforts. By sharing best practices, innovative ideas, and lessons learned, restaurants can learn from each other's experiences and adopt successful strategies to minimize food waste (Sealey & Smith, 2014). Establishing a platform for communication, such as an internal online forum or regular meetings, can facilitate knowledge sharing and collaboration among restaurant managers and staff (Sakaguchi et al. 2018).

5.6   Challenges in Food Waste Management

Time constraints and additional workload emerged as common challenges identified by restaurant managers in the study as well as in the literature (Filimonau & de Coteau, 2019; Papargyropoulou et al., 2016). The lack of time to perform new tasks and the increased workload associated with implementing food waste management practices hindered the adoption of new guidelines. These findings align with the existing literature on the challenges of accurate food waste measurement due to limited training and resources (Pirani & Arafat, 2016).

Variation in peak hours, struggle with adaptation to new guidelines, and difficulty integrating new tasks into daily routines also surfaced as challenges in the study. In addition, inconsistency in implementing new guidelines and the shortage of workforce present further obstacles in food waste management.

Difficulty in recognizing benefits and issues with inaccurate food waste measurements were highlighted by the development team in the results section. These challenges corroborate the literature's findings that many managers underestimate the true scale of food waste (Filimonau & Sulyok, 2021) and that accurate estimates may be hindered by social desirability bias (Filimonau, Krivcova, & Pettit, 2019).

Moreover, the study highlights the need for a solution or method to record reused products accurately, thereby reflecting waste reduction efforts. This challenge ties in with the literature's call for more research into how foodservice professionals define waste and approach food waste management practices (Heikkilä et al., 2016).

Overall, valuable insights into the factors driving food waste in restaurants, strategies to minimize food waste, and the challenges faced in implementing effective food waste management practices have been provided by this study and the research literature. A comprehensive approach to food waste reduction, encompassing aspects such as demand forecasting, leftover handling, cooking strategies, monitoring and feedback, staff training, and stakeholder engagement, can significantly contribute to more sustainable and responsible restaurant management practices. Food waste reduction guidelines tailored to individual restaurants and collaboration and knowledge sharing fostered can further enhance these efforts.

6   CONCLUSION

Although no precise definitions exist for these terms, food loss, as described by FAO 2011, is an unintentional reduction in the quantity or quality of food during the production, post-harvest, processing, and distribution phases of the food supply chain due to inadequate systems or infrastructural capacities. Food waste, however, refers to the intentional discarding of food fit for human consumption at retail and consumer levels, often caused by human behaviour.

The objective of this study was to determine the factors contributing to serving waste in three selected restaurants owned by company X by analysing data from their Jamix and BIBook systems and identifying effective ways to reduce food waste. Restaurant managers of the selected establishments were interviewed to gain insights into daily routines, processes, and challenges faced in restaurant operations. Additionally, the development manager and an R&D team member were interviewed for further understanding from the development department's perspective.

Three research questions were formulated to address the research problem. The first question, "How are the changes in food waste and related factors reflected in the company's restaurant data management system?" was investigated by analysing prepared, consumed, and leftover food amounts in kilograms for each restaurant from November 2022 to January 2023. Valuable insights into food waste patterns were discovered, and areas for staff improvement were identified to minimize food waste from lunch buffets. The data indicated a correlation between high amounts of prepared food and increased food waste.

The second research question, "What are the factors driving food waste in restaurants?", was addressed by analysing the data from the interviews. Difficulty in estimating customer numbers for lunch buffets and limited staff resources were identified as the main factors. Additional factors related to the above-mentioned main factors were identified, including inaccurate data entry, typing errors, personal preferences during preparation, excessive use of main ingredients due to cooking waste, and uneven consumption within dish combinations, all of which contributed to significant food waste.

The third research question, "What are the strategies to minimize food waste in restaurants?", was explored through interviews with restaurant managers, who mentioned existing actions such as

combining buffet stations, using smaller serving dishes after rush hours, reusing kitchen leftovers, monitoring food waste data, and selling lunch leftovers at discounted prices. The managers also suggested strategies such as maintaining optimal stock levels, improving inventory management, creatively reusing leftovers, cooking in smaller batches, and holding discussions with the R&D team after the first menu cycle or season.

Additional strategies identified from the research literature include accurate demand forecasting to prevent overproduction, encouraging environmentally responsible consumer decisions, utilizing technologies like QR codes and mobile apps for customer communication, designing dishes that facilitate repurposing leftovers, allowing restaurant managers to choose daily menus from a set of recipes, providing staff training and workshops, improving communication among stakeholders, and raising awareness about food waste management. A significant difference can be achieved when staff members possess a clear understanding and knowledge of food waste management.

In conclusion, addressing food waste in the restaurant industry is a complex challenge that requires a multifaceted approach. This study has shed light on the factors contributing to food waste in selected restaurants and provided insights into possible strategies for effective waste reduction. By implementing these strategies, fostering a culture of awareness, and promoting collaboration among stakeholders, the restaurant industry can take significant steps towards minimizing food waste, thus contributing to a more sustainable and responsible future for all.

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Basic Infomation:

1. What is your position within the restaurant?
2. How long have you been working for X?
3. How many seats are there in the restaurant?
4. How many staff members are in the restaurant?
5. What is the average number of customers per day?

Restaurant operation:

6. What is the basic food preparation process in the restaurant? (From planning and making the menu to the end of service and waste disposal)?
7. How do you plan production and the quantity per day?
8. Who is responsible for each of these stages?
9. Do you prepare the same amount of food as was originally planned? If not, why?

Food waste management:

10. What was your initial thought upon hearing about food waste management?
11. Can you describe the procedure you are following every day?
12. Did you find it easy to adapt to the new guidelines?
13. What were the biggest obstacles during the implementation?
14. What are the main reasons for food waste in your restaurant (from your point of view)?
15. What kinds of situations increase the amount of food waste?

Steps to improve the process:

16. What is your opinion on the given guidelines for food waste management? What were the easiest to follow and what were the hardest ones?
17. Do you regularly monitor the actual waste figures and improve your operations on the basis of these figures?
18. What are your suggestions to minimize the food waste in the restaurant?

Haastatteluopas ravintoloiden haastatteluja varten

Perustiedot:

1. Mikä on roolisi ravintolassa?
2. Kuinka kauan olet työskennellyt X:illa?
3. Kuinka paljon istumapaikkoja ravintolassa on?
4. Kuinka paljon työntekijöitä ravintolassa on?
5. Kuinka paljon asiakkaita käy keskimäärin päivässä?

Ravintolan toiminta:

6. Minkälaisia vaiheita ravintolan ruoanvalmistusprosessi sisältää (suunnittelu, menekinseuranta jne.)?
7. Kuinka teet tuotannonsuunnittelun ja määrität valmistusmäärät?
8. Kuka vastaa mistäkin edellä mainitusta vaiheesta?
9. Valmistatteko ruokaa saman verran kuin sitä on suunniteltu? Jos ette, miksi?

Ruokahävikki Hallinta:

10. Mitä ajatuksia sinussa heräsi, kun kuulit menekinseurannan alkamisesta?
11. Mitkä ovat menekinseurantaan liittyvät toimenpiteet, joita teet päivittäin?
12. Oliko uusien toimintamallien omaksuminen sinulle vaikeaa?
13. Mitkä olivat suurimmat haasteet menekinseurannan aloittamisessa?
14. Mitkä ovat mielestäsi pääsyyt hävikin syntymiseen ravintolassasi?
15. Minkälaisissa tilanteissa hävikin määrä kasvaa?

Toimenpiteet prosessin parantamiseksi:

16. Mitä mieltä olet menekinseurantaan liittyvistä ohjeista ja toimintamalleista? Minkä noudattaminen oli helpointa, minkä vaikeinta?
17. Seuraatteko säännöllisesti toteutuneita hävikkimääriä ja kehitättekö toimintaanne lukujen perusteella?
18. Minkälaisia ehdotuksia sinulla on ravintolan ruokahävikin vähentämiseksi?

1. What is your role in the X company?
2. How do you involve yourself in food waste management at Company X?
3. How does food waste affect company X?
4. What was your initial thought upon hearing about food waste management?
5. What is the main reason X group started to follow the food waste management process?
6. Could you please describe the process initiated by the X group?
7. What benefits has Company X gained so far from the food waste management process?
8. What significant obstacles did you face during the process? How have you handled them?
9. Is X company participating in "Luken ruokahävikkimittauksessa," which is conducted by the Natural Resources Institute Finland? https://www.mara.fi/toimiala/vastuullisuus/ruokahavikin-vahentaminen.html
10. Do you think the restaurants will achieve the companies' goal during the exact time period?
11. Do you have any suggestions to minimize the food waste in restaurants?
12. Do you have anything else to add to our conversation?

Kysymykset tuotekehitystiimin haastatteluja varten

1. Mikä on roolisi yrityksessä?
2. Millä tavoin olet mukana yrityksesi hävikin käsittelyssä?
3. Miten ruokahävikki vaikuttaa yritykseenne?
4. Mikä oli ensimmäinen ajatuksesi, kun kuulit hävikinhallinnasta?
5. Mikä on tärkein syy siihen, miksi yrityksenne aloitti ruokahävikin hallintaprosessin?
6. Voisitko kuvailla prosessia, jonka yrityksenne aloitti?
7. Mitä etuja yrityksenne on tähän mennessä saanut ruokahävikin hallinnasta?
8. Mitä merkittäviä esteitä kohtasitte prosessin aikana? Miten olette voittaneet ne?
9. Osallistuuko X-yritys Luonnonvarakeskuksen toteuttamaan Luken ruokahävikkimittaukseen?
   https://www.mara.fi/toimiala/vastuullisuus/ruokahavikin-vahentaminen.html

10. Uskotteko, että ravintolat saavuttavat yritystavoitteen annetussa aikataulussa?
11. Onko sinulla ehdotuksia ruokahävikin minimoimiseksi ravintoloissa?
12. Onko sinulla jotain muuta lisättävää keskusteluumme?