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Food waste mitigation practices and their barriers in Santiago, Chile's higher education cafeterias and canteens

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ABSTRACT

Food production significantly impacts the environment through natural resource consumption and greenhouse gas emissions. However, the ongoing increase in global food waste (FW), driven by diverse factors and regional differences, highlights the urgent need for accurate FW assessment and effective mitigation strategies. While many studies address broad sectors, such as tourism, there is a clear need for focused research in areas where FW reduction could yield substantial benefits, particularly in the food service sector, which generates 244 Mt of FW annually. This paper investigates FW mitigation strategies in higher education cafeterias and canteens (HECC) in Santiago (Chile), a region needing more specific studies. Using a qualitative methodology, structured questionnaires and semi-structured interviews with HECC managers were employed to uncover both the benefits and challenges of FW management. A convenience sampling method yielded a sample size of $n = 17$. The findings offer vital insights: FW in HECCs is primarily driven by inadequate infrastructure, high operational costs, limited awareness among managers and consumers, and insufficient institutional backing. The study also highlights tangible benefits, such as cost reduction and operational efficiency, while identifying barriers like regulatory hurdles and spatial limitations. These insights support the development of actionable public policy recommendations to reduce FW in the food service sector, improve infrastructure, refine management practices, and foster greater institutional awareness and support.

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SUBJECTS
Environment and the Developing World; Sustainable Development; Consumer Psychology; Environmental Studies; Environmental Management; Environment and Business; Environment and Resources; Environment and Society

1. Introduction

Food Loss and Waste (FLW) refers to the reduction in mass or quality of food intended for human consumption throughout the entire Food Supply Chain (FSC), from initial production to final domestic consumption (Scherhaufer et al., 2018). However, a universal definition of FLW has yet to be established. The varying definitions, approaches, and methodologies create multiple terms, complicating the issue's understanding, measurement, and resolution (Boiteau & Pingali, 2023). According to Ramaprasad and Kashyap (2024), the definition of FLW can differ based on several factors, including scope (whether the food is intended for human consumption or not), timing (pre-harvest, harvest-ready, post-harvest), criteria (use, edibility, nutritional value), perspective (environmental, social, food security), and type (qualitative, quantitative). This article distinguishes between food loss (FL) and waste (FW). FL refers to the reduction in mass of edible food during production and processing stages within the FSC (Huang et al., 2020; Vilariño et al., 2017), while FW refers to food that remains suitable for human consumption but is uneaten and discarded during distribution, retail, and consumption stages of the FSC (García-Herrero et al., 2021).

Globally, the food service sector contributes significantly to FW (Huang et al., 2020). After household and food processing, it ranks as the third largest contributor to FW (FAO, 2019). For instance, the FAO

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(2019) reports that the food service sector accounts for 19% of all preventable FW within the global Food Supply Chain (FSC). UNEP (2021) also estimates that the global food service industry generates 244 Mt of FW annually. In the European Union (EU-28), food services are responsible for ~11 million tonnes of food waste yearly, representing 12% of the region's total waste (Tostivint et al., 2016). Similarly, in the United States, the food service sector generates an alarming 24 million tonnes of FW annually, constituting 40% of the country's total FW (ReFED, 2016).

Furthermore, FLW, across all stages of the FSC plays a crucial role in sustainable development, as global food production accounts for 37% of all anthropogenic greenhouse gas emissions (Garnett, 2011). The consequences of FLW are significant, contributing ~3% of total carbon dioxide equivalent emissions and resulting in nearly USD 1 trillion in economic losses annually (FAO, 2014; IPCC, 2019). Beyond its economic impact, FLW has serious environmental consequences, depleting valuable natural resources during production and negatively affecting biodiversity (Del Borghi et al., 2020). This issue is particularly pronounced in FW, as losses occur at the end of the FSC after natural resources and energy have already been expended throughout the supply chain. Addressing FLW is also critical for enhancing food security, as it directly influences food availability, utilization, access, and the overall stability of food systems (HLPE, 2014; Lemaire & Limbourg, 2019).

Although the issue of FW has garnered growing political attention, as seen in the development of the United Nations Sustainable Development Goals, significant blind spots remain (Filimonau & Sulyok, 2021). These gaps are particularly evident in understanding the underlying drivers of FW, its prevalence in food services, the practical strategies for its prevention and mitigation, and the barriers to efficient management (Vizzoto et al., 2021).

These knowledge gaps present significant challenges to developing evidence-based policies to minimize FW in the food service sector, as Papargyropoulou et al. (2016) noted. Additionally, these gaps extend to a need for more national knowledge on the issue. There is a critical shortage of precise and reliable statistical data on FW, especially in developing countries (Xue et al., 2017). Remarkably, studies on FW in the food service sector have been conducted in only 28 out of the 233 countries where food is consumed outside the home, covering a mere 12% coverage, according to Dhir et al. (2020) and UNEP (2021). Notably, only nine countries are classified as developing: China, Egypt, India, Malaysia, Pakistan, South Korea, Thailand, Iraq, and the United Arab Emirates (Dhir et al., 2020; Filimonau et al., 2023).

The latest UNEP Food Waste Index Report estimates that the global food service industry generates ~290 million tonnes of FW, accounting for 28% of the total 1.05 billion tonnes of food wasted globally in 2022 (UNEP, 2024). This wasted food represents a significant loss of valuable resources used in production, such as water and land. Even more alarming is the environmental impact, as FW is estimated to contribute 8–10% of global greenhouse gas emissions, exacerbating climate change. It is important to recognize the variations in waste generation within food service. Factors, such as energy consumption in kitchens, transportation inefficiencies, and rigid menu structures can all influence the amount of food wasted (Bux et al., 2023).

Addressing food waste in the food service industry is essential to mitigating its substantial environmental impact. Notably, no studies have been conducted in Chile specifically focusing on FW in the food service sector, particularly in higher education cafeterias and canteens (HECC), creating an opportunity for this research. This topic is significant for several reasons. First, reducing FW could improve resource efficiency and lessen environmental impacts, particularly in key economic sectors, such as livestock and agriculture. Second, on a broader scale, inefficiencies in the FSC can drive up consumer prices. It is essential to address these issues to maintain food security and ensure the effective use of resources, primarily when the government allocates funds to food scholarships for the educational system. Third, Chile can contribute to global efforts to combat climate change by studying and mitigating FW. Adopting sustainable practices in the food service sector could help lower the carbon footprint of the food supply chain. Fourth, understanding vulnerabilities within the food service sector, including points of potential waste and mitigation strategies, can strengthen the system's overall resilience. By identifying and addressing weak links in the FSC, Chile can better prepare for and respond to external shocks, such as extreme weather events, economic crises, or public health emergencies, ensuring a more stable and reliable food supply. This is particularly relevant given the extreme drought the country has experienced over the last two decades.

This article seeks to fill this gap by contributing to the literature on FW mitigation by HECC managers in Chile, presenting the first study of its kind. The research classifies these approaches within the framework of

the 10Rs of the circular economy. The novelty of this article lies in offering a comprehensive overview of food waste management in HECC in Chile, a subject previously unexamined. This is particularly significant given that only eleven countries in Latin America and the Caribbean have conducted FW assessments within households, food services, and retail sectors. However, these studies have been categorized with a medium confidence level (FAO, 2014), and none have been conducted in Chile. This research employs a qualitative approach, utilizing non-probabilistic convenience sampling to select 17 HECC for the survey. The research design includes a structured questionnaire and qualitative semi-structured interviews with HECC managers.

2. Research background and literature review

2.1. Food waste drivers in higher education cafeterias and canteens

Food waste occurs throughout the entire operation of higher education cafeterias and canteens, affecting kitchen storage, food preparation, and food service. In the storage phase, several factors contribute to FW, with spoilage being a common issue (Bilska et al., 2020), often caused by over-purchasing perishables (Filimonau, Fidan, et al., 2019) and inadequate refrigeration (Principato et al., 2015). Additionally, improper storage practices, such as co-storing incompatible fruits and vegetables or contamination from ethylene gas, can accelerate spoilage (Derqui & Fernandez, 2017). Inefficient stock rotation systems further exacerbate waste (Filimonau et al., 2023). Misinterpretations of expiration dates, coupled with an excessive focus on food safety, can result in unnecessary discarding of food (Derqui et al., 2018). Lastly, poor organization, leading to inadequate visibility of stored items, can cause food to be forgotten and subsequently spoiled (Lonska et al., 2022).

During food preparation, FW is often attributed to inadequate staff training in portion control, food safety, and proper handling techniques (Ko & Lu, 2021). Inefficient equipment, such as ovens with inaccurate temperature controls, can result in undercooked or burnt food, contributing to waste (Huang et al., 2017). Overproduction, stemming from difficulties in accurately forecasting demand, further exacerbates the issue, leading to the disposal of surplus food (Filimonau, Matute, et al., 2020). Poor menu planning and improper ingredient management can also result in excess preparation and food waste (Vizzoto et al., 2021). Moreover, the lack of customer feedback complicates accurate production forecasting, further increasing the risk of waste (Lonska et al., 2022).

In the final service stage, customer preferences are critical in influencing FW, with rejected orders and overordering common issues (Bustamente et al., 2018). In addition to customer behaviour, factors, such as disproportionate portions or poorly cooked meals contribute to plate waste (Bharucha, 2018). Effectively addressing FW requires a comprehensive approach considering the interconnected dynamics of the entire food service operation, including storage, preparation, service, and consumer behaviour and preferences.

2.2. Food waste management

Food service managers have adopted various strategies to address issues related to FW. Scholars have classified these strategies into a hierarchy to understand better the stakeholders and resources involved in FW management: prevention, mitigation, and passive disposal (Filimonau & de Coteau, 2019) (Table 1). The primary goal of the preventive approaches is to reduce the likelihood of FW occurrence (Papargyropoulou et al., 2016). According to the literature, several measures are suggested to prevent FW, including (i) widespread communication to engage customers in FW prevention (Juvan et al., 2018); (ii) the implementation of quality control protocols to reduce food deterioration and FW during food preparation (McAdams et al., 2019); (iii) menu planning to avoid excessive food stock (Filimonau, Fidan, et al., 2019); (iv) accurate demand forecasting to prevent food overproduction (Papargyropoulou et al., 2016); and (v) portion size regulation to reduce FW on customers plates (Condrasky et al., 2007). However, despite the implementation of these strategies by food service managers, they are not always effective due to barriers, such as (i) consumers' expectations regarding food quality and quantity, which often result in leftovers, (ii) the seasonality of customer demand, and (iii) the use of portion size as a competition strategy, which leads to overproduction and consequently to FW (Filimonau, Zhang, et al., 2020; Silvennoinen et al., 2015).

Mitigation strategies are employed to reduce FW by redistributing surplus food. These strategies include repurposing excess food ingredients or unsold items into new dishes, adopting digital solutions to sell food at discounted prices, or simply donating food to staff members or other organizations (Filimonau, Matute, et al., 2020; Huang et al., 2020). Another mitigation strategy is offering takeaway boxes where customers

Table 1. Food waste management.

Categories	Strategies	Description	References
Prevention	Portion size control	Regulating portion sizes to minimize uneaten food on customers' plates	Condrasky et al., 2007
	Demand forecasting	Implementing accurate demand forecasting techniques to reduce overproduction	Papargyropoulou et al., 2016
	Widespread communication	Engaging customers in FW prevention through awareness campaigns	Juvan et al., 2018
	Quality control rules	Implementing stricter quality control measures during food preparation to reduce spoilage and waste (e.g. proper storage temperatures)	McAdams et al., 2019
	Menu planning	Developing menus that minimize excess food stock by considering factors like seasonality and demand	Filimonau, Krivcova, et al., 2019
Mitigation	Food redistribution	Repurposing surplus food by creating new dishes or offering discounts	Filimonau, Matute, et al., 2020; Huang et al., 2020
	Takeaway boxes	Providing takeaway options for customers who don't finish their meals	Filimonau, Zhang, et al., 2020
Passive disposal	Animal Feed	Utilizing FW for animal feed production	Papargyropoulou et al., 2016
	Composting	Converting FW into compost	Papargyropoulou et al., 2016

Source: Own elaboration.

do not finish their meals (Filimonau, Zhang, et al., 2020). However, one barrier that food service managers encounter is the cultural stigma in some countries where takeaway boxes are frowned upon, as they may be associated with poverty. Additionally, health and donation regulations can hinder the donation of unsold food. Finally, passive disposal strategies focus on repurposing FW after it occurs, such as using it to feed animals or to produce compost (Papargyropoulou et al., 2016). According to Huang et al. (2020), passive disposal is the most prevalent approach among small independent restaurants, as these establishments often need more financial resources to invest in prevention or mitigation strategies, which tend to be more costly.

2.3. The context of Chile

In 2018, Chile had the highest GDP per capita in Latin America, with a notable annual growth rate of 3.6% in GDP per capita between 1985 and 2018, raising income from 4,698 US dollars in 1985 to 15,130 US dollars in 2018 (World Bank, 2020). The increased ease of credit acquisition over the past decade further strengthened Chile's consumption capacity, as the Central Bank of Chile (2019) reported, with household debt rising from 36 to 49% of GDP between 2010 and 2019. The correlation between economic growth, improved living standards, increased food consumption, and expanded access to education is significant. Notably, the increase in per capita GDP is linked to a rise in household FW, driven by higher disposable income and a reduced proportion of household budget dedicated to food purchases. As a result, economic growth is closely associated with the escalation of FW (Xue et al., 2017), potentially fostering unintentional FW-related behaviors.

In addition, Chile has experienced a remarkable expansion in higher education, with the proportion of the population aged 18–24 enrolled in higher education increasing from 8 to 53% from 1980 to 2015 (Espinoza, 2020). This growth is reflected in the surge in undergraduate students, which rose from mirrored this growth, escalating from 118,978 in 1980 to 1,211,400 in 2022, representing an extraordinary 918% increase (SiES, 2022). This expansion can be attributed to the proliferation of institutions within the Chilean Higher Education System, driven by societal demands for greater access to education and the promotion of private sector involvement within a free-market framework established in the early 1980s (Espinoza & González, 2015). The number of universities, professional institutes, and technical training centres increased from 8 to 157 between 1980 and 2015 (SiES, 2022). The rise in GDP per capita and the expanding student population have contributed to the increase in higher education consumption capacity (HECC) and food consumption within educational institutions.

Various stakeholders are involved in the operations of HECC in Chile, particularly within the food service sector in higher educational institutions. The process functions as follows: (i) Higher education institutions contract HECC services to private administrators. (ii) The HECC administration is a counterpart to the institution, overseeing food service operations. (iii) Suppliers provide the food and ingredients HECC uses to prepare meals. (iv) HECC staff deliver food and services to customers, including chefs, cooks, and waitstaff. (v) Consumers are divided into students, administrative staff, and professors; HECC primarily offers students-accessible menus, while executive menus are tailored to staff and faculty. Additional stakeholders include charitable organizations and

private and municipal waste collectors involved in waste management. Governmental entities also play a critical role: The National Board of School Aid and Scholarships (JUNAEB for its acronym in Spanish) provides food scholarships to vulnerable students, with funding from the Ministry of Education, which regulates HECC operations, including restrictions on the type of food eligible for purchase with these scholarships. For example, alcohol cannot be purchased using a food scholarship (BCN, 1964). The Ministry of Health oversees food safety and nutritional standards (Cámara de Diputados de Chile, 2016), while the National Taxes Bureau offers tax incentives to encourage FW mitigation or food donation by HECC (BCN, 2020; SII, 2009). Figure 1 illustrates the relationship between stakeholders in the hospitality sector and the higher education sector.

Finally, it is important to highlight that the food service sector in Chile is multifaceted, encompassing a variety of business models and stakeholders, each with its specific characteristics. These include fresh food markets, private restaurants, street food vendors, and food services in hospitals and schools. While providing a comprehensive overview of the food service sector in Chile could enrich the discussion on FW by demonstrating how mitigation strategies, benefits, and barriers are shared across different sectors, it could also dilute the focus of this article. For this reason, the broader examination of the Chilean food service sector has been excluded from the scope of this study.

3. Methodology and data

Given the limited availability of information and prior studies on FW in HECC in Chile, this research adopts a qualitative approach, which is particularly appropriate for several reasons. First, qualitative methods are pragmatic in situations where prior knowledge of the phenomenon under examination is either inaccessible or fragmented and ambiguous (Jaeger & Halliday, 1998). Second, qualitative methods are well-suited to exploring human attitudes and behaviors in complex, diverse, and unpredictable contexts, such as waste management in the hospitality sector (Tzschentke et al., 2008). This approach enables the identification of specific behavioral patterns among key stakeholders, which can then be corroborated and validated through subsequent quantitative studies. Third, qualitative research aligns with the practical realities of HECC, where the demanding schedules of restaurant staff limit their willingness to participate in academic research (Filimonau et al., 2022), alongside the sensitivity associated with FW information.

3.1. Survey sample, questionnaire design, and data collection

Non-probabilistic sampling, specifically convenience sampling, was employed to select HECC for the survey. Several factors support the rationale for using this method: (i) increasing the likelihood of participation, particularly among HECC managers who

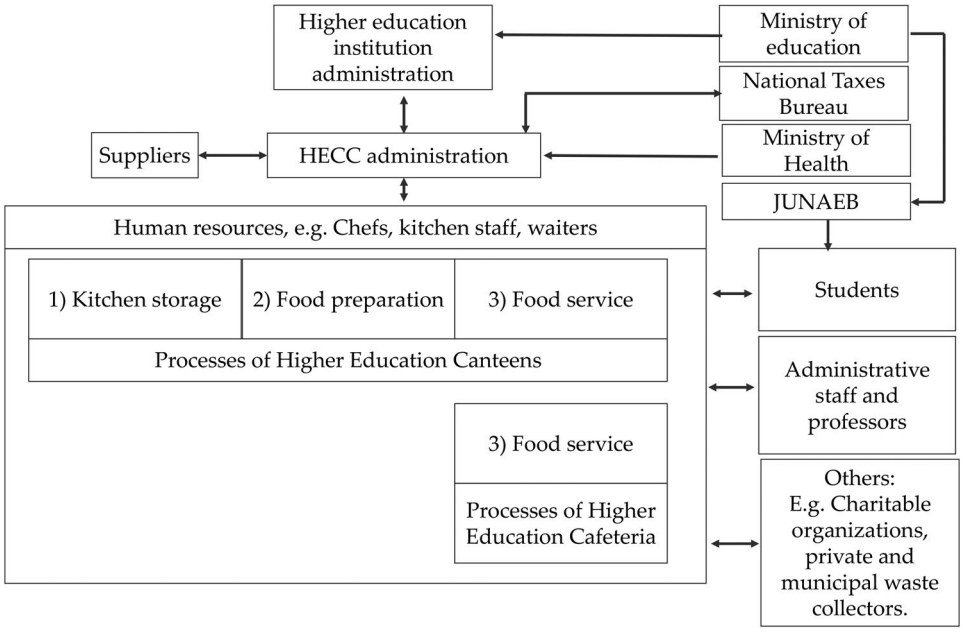

Figure 1. Stakeholders involved in the hospitality higher education sector.
Source: Own elaboration based on the information provided by HECC managers and the Chilean legislation.

possess critical operational knowledge; (ii) addressing the logistical challenges associated with obtaining necessary permissions across multiple higher educational institutions for survey implementation; (iii) considering the cost-effectiveness of convenience sampling compared to simple random sampling; and (iv) using the size of HECC, measured by the daily number of dishes prepared and the number of on-campus students, as selection criteria. However, convenience sampling also presents several disadvantages. First, it lacks generalizability, as the sample may not represent the broader population. This method often introduces bias, as it typically relies on the most accessible individuals, who may not reflect the full diversity of the target group. As a result, findings derived from convenience sampling cannot be confidently extended to the general population, limiting the applicability and external validity of the research. Second, this approach can introduce significant selection bias, as the sample drawn from a specific population subset may overrepresent or underrepresent certain characteristics, leading to skewed data. This can affect the reliability of the study's conclusions and hinder the identification of actual patterns or relationships within the data. Finally, the lack of randomness in the sample selection process reduces the likelihood of capturing the population's inherent variability, compromising the study's robustness. Despite these limitations, this research mitigates these concerns by focusing on HECC managers, recognized food service management, and operations experts.

The primary unit of analysis in this study is the HECC. In Chile, a higher education canteen is an establishment within educational institutions where meals are provided to professors and administrative staff, often at subsidized rates for students. These canteens are typically managed by higher education institutions or external entities contracted for this purpose. The main function of a higher education canteen is to offer nutritious and affordable meals to the academic community, particularly to those who may experience financial difficulties in accessing adequate nutrition—individuals who might face financial challenges in obtaining sufficient nourishment. Menus generally include various options to accommodate different lunch preferences and dietary requirements. Since canteens are equipped with full kitchens, administrators must also manage the food waste generated in these areas. In contrast, higher education cafeterias primarily serve beverages and light snacks, such as coffee, tea, pastries, sandwiches, and other fast-food items. The main objective of a cafeteria is to provide a space for individuals to gather, socialize, and take a break while enjoying food and beverages. Higher education cafeterias are generally designed to offer quick and affordable food options for students and staff but lack a fully equipped kitchen.

The research design integrates a structured questionnaire survey and qualitative semi-structured interviews with HECC managers. These professionals are employed full-time within the industry and possess specialized expertise in food service management. Additionally, they maintain long-term relationships with their clients, as students, faculty members, and administrative staff regularly utilize their services, given the nature of higher education institutions where students, for example, typically enroll for programs lasting between 3 and 6 years. The choice of a qualitative semi-structured interview as a qualitative research method is based on its ability to generate rich, detailed data from participants who are often busy and difficult to access (Silverman, 2013). Furthermore, this interview format offers analytical flexibility, allowing for an in-depth exploration of specific topics and questions (Veal, 2011). Importantly, semi-structured interviews are particularly effective in eliciting participants' genuine and nuanced perspectives on sensitive topics with significant societal and business implications (Ghauri & Gronhaug, 2005).

The principal researcher conducted the survey, with the co-researchers responsible for interviewing HECC managers. The survey instrument was adapted from previous research efforts aimed at estimating FW, its causes, and mitigation strategies in university canteens and restaurants across various countries (Filimonau, Fidan, et al., 2019; Filimonau, Zhang, et al., 2020; Filimonau & Sulyok, 2021; Greggio et al., 2021; Yang et al., 2019). The structured questionnaire consisted of three sections and was primarily based on the work of Yang et al. (2019), which gathers general information regarding the characteristics of HECC and the collection and disposal of FW. This data was utilized to perform a descriptive analysis of the main characteristics of the surveyed HECCs, including the type of food provided, operating hours, number of business days per week, average number of business days per year, and the number of employees. The semi-structured interview questions were adopted from a script developed by Filimonau, Krivcova, et al. (2019) and Filimonau, Zhang, et al. (2020). These qualitative interviews aimed to complement the findings of the questionnaire by specifically exploring mitigation practices, barriers to FW reduction, and the perceived benefits of FW prevention. The

semi-structured interviews were guided by questions such as: What type of food is most wasted in your establishment? Could you tell me what you currently do to reduce food waste in your restaurant? Could you tell me what you think the key benefits of reducing food waste in your restaurant are (if any)? Could you tell me what you think are the barriers to managing your food waste more effectively? The full survey instrument is available in the supplementary information.

The administration of both the structured questionnaires and qualitative semi-structured interviews took place between April to October 2023, with each session lasting an average of 60–90 min. The surveys were conducted in Spanish, with subsequent translations into English. Participants did not receive any incentives for their involvement. A pre-test survey was initially carried out in one HECC to assess FW management practices, and the insights gained from this pilot survey were used to refine the final survey instrument. Ethical approval for the study was obtained from the Universidad Central de Chile's Ethics Committee, 148/2022, and written informed consent was secured from the participants. The saturation effect determined the sample size ($n = 17$), which marks the point in data collection where no new information, themes, or insights emerge (Guest et al., 2006). This sample size aligns with the typical saturation range of 10–30 interviews, as suggested by Marshall et al. (2013). Notably, similar studies on FW estimates causes, and mitigation strategies, such as those by Filimonau and Sulyok (2021) ($n = 18$) and Filimonau et al. (2023) ($n = 18$) have employed a comparable number of interviews.

The data collected from the structured questionnaire survey were analyzed using Microsoft Excel to calculate descriptive statistics about the characteristics of the participants. The qualitative data obtained from the audio recordings of the semi-structured interviews were transcribed verbatim using Otter.ai (Otter.ai, 2022) and subsequently underwent cleansing and verification to ensure accuracy. Due to the sensitivity of the topic concerning FW, some HECC managers declined to be recorded. In such cases, the interview continued, and participants were asked to complete the semi-structured interview's guiding questions in writing.

Open coding was employed to analyze the raw data without predetermining categories. After the transcription of the audio recording, the data were broken down into distinct parts for close examination. During the open coding process, concepts related to FW were identified and labelled using words or short phrases. This approach involved coding every data segment without restricting it to predefined categories to create an initial set of codes that reflected the content and meaning of the data concerning FW, including the categorization of mitigation strategies, benefits, and barriers to FW reduction. This stage laid the groundwork for the subsequent application of inductive coding. Inductive coding, like open coding, is a data-driven approach that does not rely on predefined codes or categories (Fereday and Muir-Cochrane, 2006). However, inductive coding explicitly allows codes and themes to emerge organically from the data as the researcher becomes immersed in it, identifying recurring patterns. The purpose of applying inductive coding was to identify categories for each mitigation strategy and benefits and barriers to reducing FW based on patterns and themes that naturally surfaced through data iteration. This process involved continuous comparison and iteration, with codes evolving as more data were analyzed, leading to a comprehensive understanding of the data. According to Mollaei et al. (2023), the combination of open and inductive coding allows patterns and concepts related to FW to emerge naturally from the data without relying on preconceived notions or existing categories.

Open and inductive coding stand in contrast to deductive coding, also known as a priori coding, which involves applying a predetermined set of codes to the data based on existing theories, frameworks, hypotheses, or literature. In deductive coding, researchers begin with a clear understanding of what they seek and use this framework to guide the coding process (Fereday & Muir-Cochrane, 2006). Deductive coding is systematic and theory-driven, which can help ensure consistency and maintain focus during the analysis. However, it may restrict the discovery of unexpected themes or insights not accounted for by the initial framework or the predetermined codes. In this research, deductive coding was employed solely to compare the categories derived from the open and inductive coding with existing literature on FW. This approach enabled preliminary comparisons between the emergent categories and labels in other studies, such as Filimonau and Sulyok (2021) and Filimonau et al. (2023).

For example, during the initial open coding review of the transcribed data, responses to the question 'Could you tell me about what you currently do to reduce food waste in your restaurant?' were identified and labeled using short phrases, such as '*Do not by in excess*', '*we maintain more or less the necessary stock*', '*control purchase*', '*the store manager knows that*

they sell more or less X stock of products', among others. These responses were preliminarily categorized under the label 'stock control'. In the second stage, inductive coding was applied to identify patterns and themes that emerged from data iteration, and related responses were grouped and regrouped under the same mitigation strategy, such as stock control. Third, quotes were associated with the corresponding labels related to each mitigation strategy. Fourth, the derived labels were compared with those from the existing literature to attempt to standardize the naming conventions. Lastly, the chosen indicator was the number of HECCs that mentioned a specific mitigation strategy rather than the frequency of mentions of the same strategy. The decision was made to account for variations in data volume between HECC managers who provided longer oral responses and those who submitted shorter written responses.

4. Empirical results and discussion

4.1. Descriptive analysis

In this study, a total of 17 HECCs were interviewed, comprising 11 cafeterias and six canteens. Most of the cafeterias (7) employed fewer than four staff members. In contrast, the staffing levels in the canteens varied more widely, ranging from 4 to 12 employees. It was observed that 91% of the cafeterias offer breakfast, lunch, and dinner, whereas only 50% of the dining rooms provide these three meals. Among the remaining 50% of canteens, two offer lunch exclusively, and one provides both breakfast and lunch. Additionally, most cafeterias (82%) operate for more than 300 days per year, with only two cafeterias providing services for 200 days per year. This discrepancy is due to the fact that these two cafeterias close during the winter and summer holidays, unlike the others that remain open throughout the year. For canteens, 50% offer services year-round, while the other 50% do not. This variation is linked to the closure of some higher education institutions during summer holidays or the reduced number of students attending summer courses. Consequently, many canteens close during this period. However, those that remain open typically adjust by offering breakfast, lunch, and dinner to compensate for decreased sales, adopting a business model similar to that of cafeterias, which sell pre-prepared packaged food rather than freshly prepared meals. HECC business days generally run from Monday to Saturday, with shorter operating hours on Saturdays, and most HECCs operate ~14 h per day. Table 2 provides a summary of this information.

4.2. Mitigation approaches

The interviews identified numerous managerial strategies for reducing FW in HECCs (Figure 2). These mitigation approaches were classified according to the 10 Rs of the circular economy model. In interviews with higher education cafeteria managers, eleven strategies were identified, categorized into three reduction strategies, three redesign strategies, three reform strategies, and two recycling strategies.

Similarly, higher education canteen managers identified ten mitigation strategies: three reduction

Table 2. Interview participant characteristics ($n = 17$).

ID	Type of HECC	Type of food	Opening hours	Number of business days per week	Average number of business days per year	Number of employees
1	Canteen	B-L	7:00–16:00	5	200	5
2	Canteen	B-L-D	8:00–22:00	6	315	8
3	Canteen	B-L-D	8:00–22:00	6	315	12
4	Canteen	B-L-D	8:00–22:00	6	315	Not informed
5	Canteen	L	8:00–15:00	Not informed	200	4
6	Canteen	L	8:00–18:00	Not informed	252	11
1	Cafeteria	B-L-D	8:00–21:30	6	200	4
2	Cafeteria	B-L-D	8:00–21:30	6	200	4
3	Cafeteria	B-L-D	8:30–21:30	6	312	4
4	Cafeteria	B-L-D	8:30–21:30	6	312	3
5	Cafeteria	B-L-D	8:30–19:00	6	312	2
6	Cafeteria	B-L-D	8:30–21:30	6	312	2
7	Cafeteria	B-L	8:00–18:00	Not informed	318	3
8	Cafeteria	B-L-D	8:00–22:00	6	315	Not informed
9	Cafeteria	B-L-D	8:00–22:00	6	315	Not informed
10	Cafeteria	B-L-D	8:00–22:00	6	315	Not informed
11	Cafeteria	B-L-D	7:30–21:45	6	300	7

B: breakfast; L: lunch; D: dinner.
Source: Own elaboration.

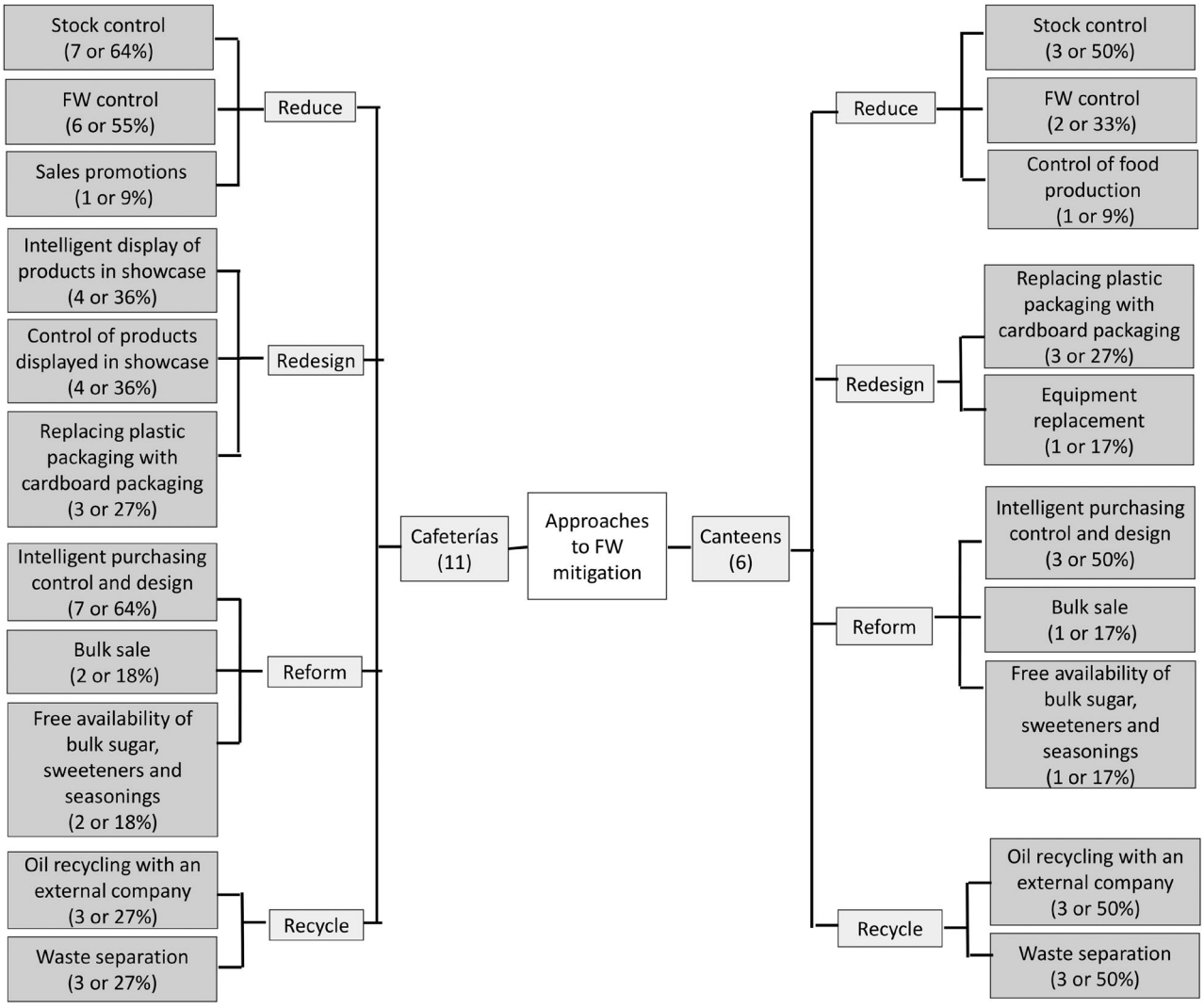

Figure 2. Approaches to FW mitigation stated by managers of cafeterias and canteens.
Source: Own elaboration.

strategies, two redesign strategies, three reform strategies, and two recycling strategies. The most common mitigation strategy across HECCs was intelligence purchasing control. Design and stock control are also HECC's most common mitigation strategies, with seven cafeterias out of 11 (64%) and three out of six canteens (50%) citing them as effective strategies. This finding is consistent with the literature, where demand forecasting and intelligence purchasing control have been widely studied in restaurant settings to balance supply and demand. For example, Filimonau, Fidan, et al. (2019) reported that in Plovdiv, 77% of restaurants utilized demand forecasting techniques to estimate customer numbers and adjust food orders accordingly to minimize FW. Forecasting, intelligence purchasing control, and design are considered mitigation strategies because they represent proactive and preventive approaches, which should be prioritized (Filimonau & de Coteau, 2019; Papargyropoulou et al., 2016). However, some studies, such as Filimonau, Krivcova, et al. (2019), offer a contrasting perspective, noting that restaurant managers in the UK tend to rely on reactive and disposal strategies rather than preventive measures to reduce FW due to challenges in accurately predicting food demand. As a result, restaurants often order more food than necessary, as they must account for uncertainty in customer demand, leading to excess stock (Gruber et al., 2016). According to the cafeteria manager 3:

> *"Do not buy in excess; every time we buy wrongly, we have FW; what does that mean? Some products, like bread or a daily fresh crumb sandwich, have a slightly longer shelf life in a transformed environment. I don't remember the word, but it comes with a helium gas that makes the bread last seven days, and this is*

vacuum sealed in a bag. But in general terms, this is given by two things. First is the purchase of food. If we are going to have food that does not come in these modified atmosphere conditions, we have to buy a predetermined quantity so that it is not lost. For example, for prepared dishes, fruit salad, or yogurt, we know that the useful life is three days, and we know that if we buy 50, they will not be sold; we have to buy 20 so that we maintain more or less the necessary stock to satisfy the needs of the students, but that there are not many products left over either. So, what we do is buy better".

Interviewees also noted that they implemented FW control measures, a set of practices and procedures designed to reduce FW, as a key mitigation strategy, though managers did not fully specify the details of these practices. Six cafeterias (55%) and two canteens (33%) indicated the use of these strategies. The intelligent and controlled display of products in showcases was highlighted as a significant mitigation action, but this practice was only relevant for higher education cafeteria managers, with four cafeterias (36%) adopting this approach, while no canteens reported its use. This difference arises because cafeterias often sell dough-based products that are prepared in advance and displayed in showcases, whereas canteens primarily serve freshly prepared food. Therefore, in cafeterias, the intelligent, controlled display of pre-prepared products helps prevent their hardening. According to the manager of Cafeteria 4:

"The display or sale of products, the store manager knows that they sell more or less X stock of products in the store, and if they get more than that, things will go badly. There is a question of how they are displayed so that a complete display showcase can be seen, but it does not have excess products. It is super easy to put 50 muffins, obviously yes, but no; the idea is that we put everything in order so that they [Muffins] *come out. We refilled* [the showcase] *as they come out, and without us putting 50* [Muffins], *having half as waste."*

Another mitigation approach, less commonly applied than the previous strategies, is the use of bulk sales and the free availability of bulk sugar, sweeteners, and seasonings. Only two cafeterias and one canteen reported implementing these strategies. According to the managers, this practice allows consumers to take only the quantity they intend to use, thereby preventing the purchase of excess food and reducing FW. Additionally, the free availability of bulk sugar, sweeteners, and seasonings helps eliminate the use of individual sachets, thereby reducing plastic waste from food packaging. However, managers acknowledged that this practice has a minimal impact on FW reduction due to the small volume of these items. According to the manager of canteen 1:

"Things are handled in bulk [FW], *for the same reason, to minimize the issue of packaging waste and packaging overruns. There is free sugar, sweetener, and water, and only the seasonings are kept in a sachet, but only when they are ordered for take away are the individual sachets handled. Generally, the individual sachet is not used in the canteen. For the same reason, you fall short if you give one sachet, but if you give two, the client will most likely throw one away."*

To a lesser extent, the sales promotion for food nearing its expiration date or when the packaging is damaged was identified as another mitigation strategy by interviewees, though this practice was only reported by one cafeteria. However, some managers explicitly expressed their refusal to adopt this strategy, as they believe it could create a perverse incentive for staff to misuse sales promotions to increase sales, even for food that is not in such conditions. For example, the manager of Cafeteria 6 pointed out:

"Last year, we launched a zero-waste campaign, which was that all products that were close to expiring or had some packaging error, which does not mean that they were open, were sold with a 50% discount, but this generated a bad incentive, a perverse incentive, and we took it out, and now we buy more organized."

One manager highlighted that equipment maintenance and replacement are additional strategies for mitigating FW, as they help prevent equipment malfunctions that can lead to FW and enhance the efficiency of food preparation processes. According to the manager of Cafeteria 2:

"To minimize the issue of fried foods, we invested in technology to incorporate convector ovens because, on the one hand, they offer healthier food, and on the other hand, costs are controlled. Because they are more functional, it is easier to determine the quantities. If you have to re-make more food, you should not have a person who is aware of the device [convector oven]; you program it and leave it working; for example, in a fryer, you should have a dedicated person who is surveillance of frying, because if you don't have it, either your potatoes will burn or the oil will burn. Still, in both cases, it is a significant loss."

While waste separation, oil recycling, and the replacement of plastic bags with cardboard bags are not directly aimed at reducing FW, several managers (three cafeteria and three canteen managers) still highlighted these practices as contributing to reducing the environmental impact associated with FW. Figure 2 provides a summary of all the mitigation strategies mentioned by HECC managers,

classifying them according to the Rs of circular economy and indicating the number of HECCs that implemented each strategy, as well as the percentage of total HECCs.

4.3. Benefits of reducing food waste

Interviewees identified numerous benefits of reducing FW in HECCs, with the majority being economic and social, as opposed to the two environmental benefits mentioned (Figure 3). Most HECC managers highlighted the economic advantages of FW reduction, including cost reduction, increased profitability, and enhanced operational efficiency. To a lesser extent, other economic benefits cited by interviewees included reduced input purchase volumes and higher final sales. This finding is consistent with the literature, which emphasizes financial savings as a primary motivator for FW prevention in restaurants (Charlebois et al., 2015). According to the manager of Cafeteria 2:

> *"Reducing food waste is directly related to efficiency, efficiency in all aspects, both in the production process, in the purchasing process, and also in the process of sales."*

An interesting finding from the study is the manager's recognition of the social benefits associated with reducing FW. The primary social benefit mentioned by both cafeteria and canteen managers was the ethical responsibility to avoid food waste. According to Manager 12, '*…wasting food has a social aspect as it is unethical to waste food*'. Another social benefit highlighted by managers was the reduction in student food prices, as mitigating FW allowed cafeterias and canteens to lower food prices, making them more affordable for students. According to Manager 7:

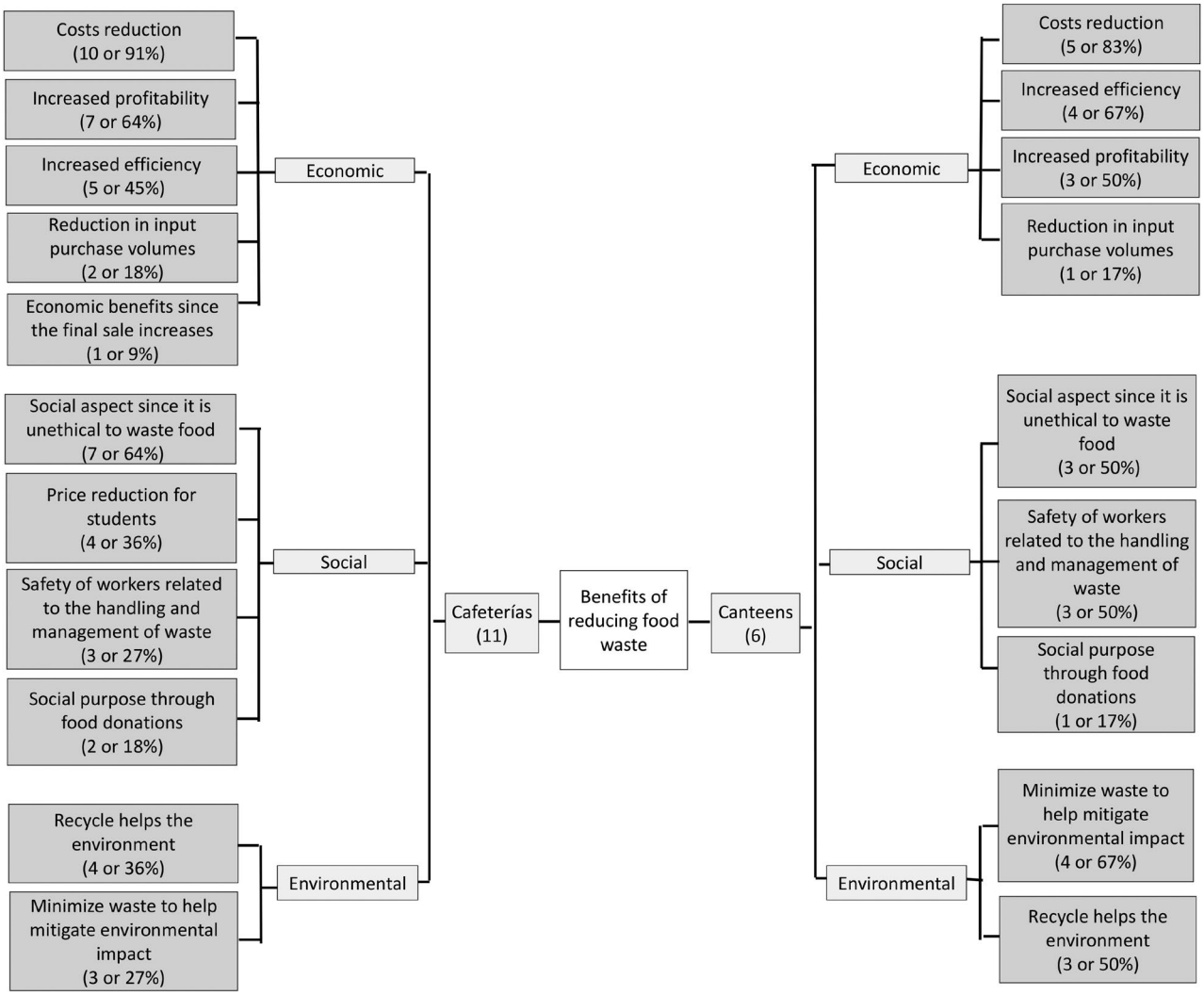

Figure 3. Managers of cafeterias and canteens have stated the benefits of reducing FW.
Source: Own elaboration.

> *"If you throw away much food, your margin becomes increasingly limited; if you have a narrower margin, you must raise prices, then there is a direct benefit between the service you provide to the students and the profit you must keep per product. If you give a bad service and throw away much food, you must increase the price; if you give a good service and you adjust it* [food waste]*, you can maintain correct prices, so to speak."*

Managers also identified helping those in need and supporting their staff through food donations as a social benefit of reducing FW. However, they highlighted the challenges associated with food donations, primarily due to the potential health and safety risks, as well as national regulations. This concern is supported by the literature; for instance, Sakaguchi et al. (2018) noted that restaurants are often discouraged from donating food due to the potential health risks posed by spoiled food. Similarly, Filimonau, Fidan, et al. (2019) found that in Bulgaria, only half of the restaurants actively engage in food donation initiatives, despite recognizing it to reduce waste. Another issue that complicates food donation is the lack of charities and non-governmental organizations willing to take the risk of collecting potentially spoiled food (Filimonau, Krivcova, et al., 2019). Interviewees also highlighted a social benefit not directly related to FW reduction but associated with the practice of separation. Managers argued that even if FW cannot be entirely avoided, HECC should separate waste to enhance the safety of workers involved in handling and managing waste.

Managers are also increasingly recognizing the environmental benefits of reducing FW. Managers note that minimizing FW helps reduce the ecological impact, and when FW cannot be avoided, recycling through composting is viewed as an effective environmental strategy. The growing environmental awareness among managers regarding the societal and ecological impacts of FW may be attributed to the increasing media attention on this issue, particularly considering the ongoing public debate on climate change.

4.4. Barriers to reducing food waste

The HECC manager identified multiple barriers to mitigating FW, which can be categorized into internal and external obstacles. Internal barriers are directly related to HECC operations and fall under the responsibility of managers or staff, while external barriers involve other stakeholders, such as consumers, suppliers, and government entities. Interviewees indicated that the primary internal barrier is the economic cost associated with the waste management process. Although waste management addresses FW after it has occurred rather than mitigating it at the source, managers emphasized that the main obstacle to properly handling FW is the high cost of transporting it from the HECC to collection and recycling facilities. Managers reported that most recycling companies charge significant fees for removing FW. The second internal barrier, also related to waste management rather than FW mitigation, is the limited spaces available in university cafeterias and canteens, which complicates proper FW handling, particularly when it comes to waste separation. According to the manager of Cafeteria 5:

> *"At the end of the day, we have minimal spaces, and separating different types of waste is a little more complicated."*

The primary external barrier identified by HECC managers was legislation. They emphasized the limited governmental public policies and laws supporting FW mitigation efforts. According to Canali et al. (2016), government assistance is essential for reducing obstacles and encouraging industry participation in the hospitality sector's FW reduction initiatives. Consequently, more robust and ambitious pro-environmental initiatives in the restaurant industry require government (dis)incentives (Clemens & Douglas, 2006). In Chile, the issue of FW has gained increasing relevance over the past seven years, particularly since the country joined a regional alliance aimed at FW prevention and reduction, alongside 13 other countries in Latin America and the Caribbean (FAO, 2016). In 2017, the Chilean committee for FW reduction was established, involving stakeholders, such as national government organizations, civil society organizations, universities, and the FAO. In 2020, various national government organizations introduced The National Organic Waste Strategy of Chile for 2040, which seeks to optimize the collection and management of organic waste and prevent its deposition in landfills, thereby reducing uncontrolled greenhouse gas emissions.

Nevertheless, these initiatives have not yet reached all sectors involved in FW management given their recent implementation. As a result, higher education cafeterias and canteen managers have yet to recognize these initiatives as effective public policies that could assist them in mitigating FW in their establishments. For instance, one legislative barrier highlighted by a manager was the difficulty of donating food due to existing health regulations. According to the manager of Cafeteria 3:

> *"The absence of recycling policies, in every sense, both in the garbage and in leftover products, for example, if an issue such as food banks existed, I would not have problems."* After that, the manager aggregated that they donate food to their staff despite this.

Another external barrier identified by managers, closely related to legislative challenges, is the lack of comprehensive recycling policies. When prevention and re-distribution are no longer practical or feasible for FW mitigation, FW separation, and recycling become crucial components of FW management in restaurants (Filimonau & de Coteau, 2019). However, organic waste recycling is only feasible if reliable FW collection services are available (Papargyropoulou et al., 2016), which is not always the case, particularly in developing countries where high logistics costs pose significant challenges (ReFED, 2016).

Local authorities often oversee these collection services (Tai et al., 2011), but they are not always effective and efficient. Interviewees highlighted this issue in HECCs in Santiago, where they observed that local collection services frequently dispose of organic food waste alongside other waste fractions. As a result, many managers perceive on-site food separation and recycling efforts as futile. In this context, the improved design and implementation of waste management collection services by the national government appear essential to effectively addressing FW issues.

Social and cultural values were also identified as barriers by HECC managers. They noted that irresponsible consumer behavior presents a significant external obstacle to mitigating FW in educational establishments. This issue has also been similarly discussed in the literature, which highlighted the impact of consumer behavior on FW generation in restaurants (Ge et al., 2018), coffee shops (Filimonau, Krivcova, et al., 2019), and hotels (Radwan et al., 2010). Managers further argued that this irresponsible behavior extends to a lack of awareness regarding waste separation and recycling. Lastly, interviewees identify sales variation and the challenges of accurately forecasting demand as additional barriers, as previously discussed. These barriers are summarised in Figure 4.

5. Policy implications

This research provides valuable insights and practical recommendations to assist managers in developing effective food waste management strategies. It underscores the importance of adopting localized and context-specific approaches, as well as fostering collaborative efforts to achieve sustainability goals. Simultaneously, it is essential to identify both

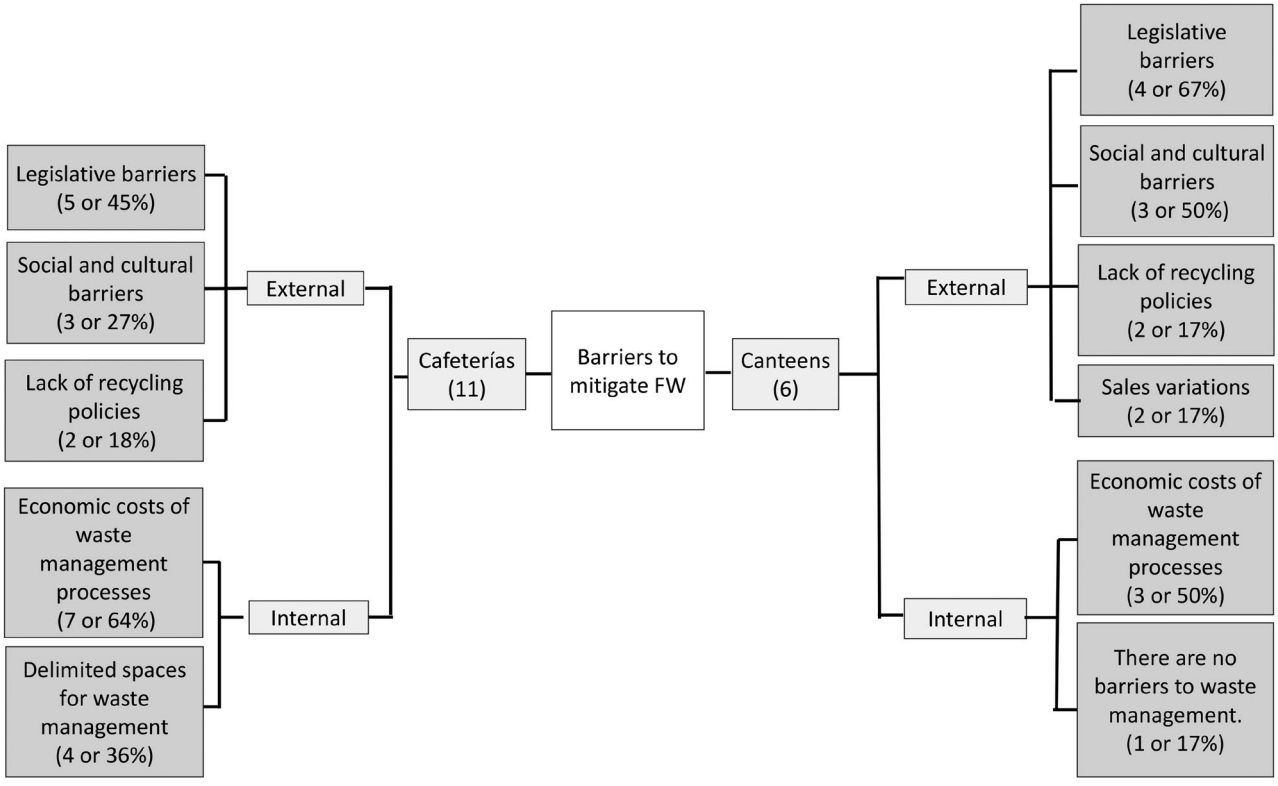

Figure 4. Managers of cafeterias and canteens state barriers to FW mitigation.
Source: Own elaboration.

internal and external barriers to FW reduction in HECC. The literature distinguishes internal barriers as those directly related to HECC operations and the responsibility of managers and staff, while external barriers involve stakeholders, such as consumers, suppliers, and government entities (Filimonau, Krivcova, et al., 2019; Lonska et al., 2022).

The government plays a crucial role in addressing external barriers and establishing a clear legislative framework for FW mitigation. Chile's National Organic Waste Strategy for 2040 aims to provide such a framework but has not yet reached all sectors involved in FW management due to its recent implementation. As a result, HECC managers have yet to recognize it as an effective public policy. To address this, the government must socialize this policy with all stakeholders involved in FW management through a systematic dissemination campaign. Moreover, the government should prioritize incentivizing FW mitigation strategies according to the 10 Rs of circular economy, encouraging HECC managers to adopt the most impactful strategies. Additionally, interviewees highlighted the inefficiency and ineffectiveness of current waste collection services. The national government could address this issue by improving the design of waste management systems, including the transformation of general landfills into specialized organic waste treatment facilities. Reducing the distances between organic waste processing plants and waste producers would also help lower transport costs, creating further savings.

Despite the acknowledged environmental benefit of reducing FW, HECC managers placed relatively less emphasis on this aspect. To address this, the government could enhance the importance of FW reduction through environmental education programs targeting various stakeholders in the food service sector, with a particular focus on HECC managers and consumers. These programs could also help mitigate the social and cultural values barrier identified by HECC managers, particularly by irresponsible consumer behavior in educational establishments.

6. Conclusion

Higher education cafeterias and canteens are part of the broader food service sector, and FW is generated throughout their operations, such as kitchen storage, food preparation, and food service. In smaller establishments, the primary causes of FW include the over-purchasing of perishable products, inadequate infrastructure, and inefficient management practices.

The overarching objective is to reduce FW, which requires multifaceted interventions that account for the interconnected dynamics of the entire food service operation process. These measures range from FW prevention, the most desirable approach, to passive disposal or mitigation. While these three actions are complementary, it is not always feasible to implement them simultaneously, often due to resource constraints.

In this article, the authors focus on mitigation measures in cafeterias and canteens in Santiago (Chile). The rationale for this focus stems from the significant expansion of higher education in Chile over the last thirty years and the increase in Chilean GDP per capita, which has contributed to higher food consumption in these institutions. The methodological approach was qualitative, utilizing a structured questionnaire survey and qualitative semi-structured interviews with canteen/cafeteria managers. The aim was to gather information on the characteristics of HECC, the collection and use of FW, the causes of FW, mitigation approaches, and the barriers and benefits associated with reducing FW.

A novel approach of this paper is the classification of mitigation according to the 10Rs of the circular economy, identifying reduction, redesign, reform, and recycling strategies for both cafeterias and canteens. Some of the findings align with previous studies, particularly in the case of intelligence purchasing control, design, and stock control, which are the most common mitigation strategies in university cafeterias and canteens (64%). While this is a highly desirable mitigation measure, it is only always the most frequently employed by similar establishments. As a policy recommendation, prioritizing stock control through accurate forecasting of stock levels in these establishments should be encouraged wherever feasible.

It is also important to highlight that some managers noted equipment maintenance and replacement as additional methods for mitigating FW, as these actions prevent equipment malfunctions that can lead to FW. In addition to these measures, other less prominent mitigation measures were mentioned, including the bulk sale and free availability of sugar, sweeteners, and condiments, which also help reduce plastic packing waste. Another strategy mentioned was the promotion of food items with damaged packaging or those nearing expiration.

The responses also reveal a lack of understanding regarding the true nature of FW mitigation measures. For example, some managers mistakenly believe that oil recycling, waste separation, or the use of

cardboard bags contribute directly to FW reduction. This represents an important area for improvement, as addressing this misconception could enhance the effectiveness of FW mitigation efforts.

Regarding the benefits of FW reduction and in alignment with the three dimensions of sustainability, it is noteworthy that most of the identified benefits were economic, such as financial savings, consistent with the conclusions of similar studies. From a social perspective, the view that food waste is unethical is commendable. The managers interviewed highlighted other social benefits of FW mitigation, such as making food prices more accessible and facilitating food donations. Finally, there is growing awareness within these establishments about the link between FW and environmental degradation and the environmental benefit of reducing FW.

Nevertheless, the study identified several barriers to FW mitigation, particularly legislative obstacles and the lack of institutional support. Additionally, waste management, while not directly related to FW mitigation, is crucial for addressing the issue. From an economic perspective, proper waste management can be costly. Furthermore, limited space in higher education cafeterias and canteens poses another challenge.

The study concludes that waste management processes need to be reinforced. Higher education institutions must demonstrate a strong commitment to meeting sustainable development goals by engaging all stakeholders and collaborating closely with local authorities. Campaigns focused on preventing food waste and promoting sustainability and mitigation efforts are essential for driving change and improving institutional management.

This study's exploratory nature, convenience sampling, and the limited number of interviews restrict the applicability and generalizability of the findings. Additionally, variations in HECC size, consumer numbers, management practices, food service contexts, calculation methods, sample sizes, and FW composition limit the ability to compare the results with another research. Despite the significant costs, future research should employ quantitative measurement techniques on larger samples to obtain more accurate results. Furthermore, subsequent, studies should expand their scope to include other sectors of the food service industry, such as fresh food markets, private restaurants, and street food vendors, to gain a more comprehensive understanding of the FW issues in Chile. Lastly, future research efforts should develop standardized output metrics to enhance the comparability and clarity of findings within Chile and internationally.

Ethical approval

Ethical approval for the study was obtained from the Universidad Central de Chile's Ethics Committee, 148/2022, and written informed consent was secured from the participants.

Author contributions

D.D. conceived and designed the research. D.D., G.D., and G.B. performed the experiments, analyzed the data, and prepared figures and tables. D.D., G.D., G.B., and A.V. drafted the manuscript. D.D., G.D., G.B., and A.V. revised the manuscript and discussed the results. D.D., G.B., and A.V. supervised the project and provided the resources. All authors read and approved the final version of the manuscript.

Disclosure statement

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Data availability statement

The data that support the findings of this study are available upon reasonable request from the corresponding author, D.D.-S. The data is not publicly available because the participants consider ethical, legal and commercial concerns involved in the issue of food waste for higher education canteens and cafeterias, as well as for operations managers at the higher education institutions where they are located. In any case, if the data is shared upon reasonable request, it may be shared in aggregate analyses, without identification of the participants, because they did not give written consent for their data to be shared publicly.

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Anexo 1

No.

Questionnaire on food waste in higher education cafeterias and canteens

1. General information:

Name of interviewer:
Date: Day Month Year
Investigation Location: Region City Commune
Name of higher education institution where is located the HECC:
Campus of the higher education institution:
Name of HECC:
Name of interviewee:
Position: □ Manager/Owner □ Staff
Telephone number of interviewees:
Email address of interviewee:

2. Characteristics of the HECC

Number of students on campus:
Number of employees:
Type of meal: □ Breakfast □ Lunch □ Dinner
Business area: m^2; Number of seats;
The average number of consumers per day;
The average number of business hours per day;
The average number of business days per year.

3. Collection and deposit of food waste from the HECC.

Food waste collection	Proportion (%)
Collected by an organic waste recycling company.	
Collected by the municipal garbage removal service.	

Food waste deposit	Proportion (%)
Deposited in private collection sites for recycling.	
Deposited in municipal collection sites.	
Does not know.	

Questions for guiding the semi-structured interview on food waste in higher education cafeterias and canteens

1. What food is wasted the most in your business?
2. Could you tell me about what you currently do to reduce food waste in your restaurant?
3. Could you tell me what you think the key benefits of reducing food waste in your restaurant are (if any)?
4. Could you tell me about what you think are the barriers to managing your food waste more effectively?