Waste Management Bulletin 3 (2025) 100261

Contents lists available at ScienceDirect

Waste Management Bulletin

journal homepage: www.elsevier.com/locate/wmb

Unveiling food waste: A case study of a restaurant specializing in Japanese cuisine in Brazil

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ARTICLE INFO

Keywords:
Case study
Food waste
Restaurant

ABSTRACT

Food waste is a global problem with significant economic, human and environmental impacts. The sources of food waste are many: households, grocery stores, restaurants, food service companies, farms and manufacturers. In restaurants, food waste occurs at all stages, from sellers to consumers, making it a serious social, environmental and economic issue. This study investigates food waste resulting from overstocking in a restaurant specializing in Japanese cuisine in Itabira, Minas Gerais, Brazil using the case study methodology. The findings indicate that the most probable cause of food waste in the restaurant is inaccurate demand and sales forecasting, leading to an outdated production plan. To address the outdated production plan, the following actions are recommended: run informative campaigns, analyze portion and dish sizes, conduct periodic reviews of food quality, change the menu frequently, select an appropriated demand and sales forecasting technique, implement pre-ordering, engage in charity/donation, apply coercion, define standard procedures and train employees. This case study offers a unique perspective by focusing on the specific geographical context of Itabira, Minas Gerais, Brazil, providing insights into waste management in restaurants. The theoretical implications demonstrate how the research advances existing frameworks by integrating a regionally relevant and distinctive context. On the practical side, the findings provide actionable insights to help develop targeted policies and strategies that address the specific challenges and needs faced by managers of restaurants.

Introduction

The United Nations included food security among the sustainable development goals (SDGs) set by the agenda of 2030. It is estimated that between 691 and 783 million people are undernourished globally, while significant amounts of food are wasted. Approximately 1.3 billion tons of food are lost or wasted annually, representing 30 % of world food production and $750 billion in economic losses (World Health Organization, 2023).

In Brazil, 125.2 million people lack full or continuous access to staple food, meaning that half of the population experiences some degree of food insecurity. Among them, 33.1 million are classified as experiencing severe food insecurity, representing 14 million Brazilians who face hunger over a period of approximately one year (de Campos et al., 2025).

Food loss and waste result in economic losses and environmental impacts due to the use of natural resources and the emission of greenhouse gases. Food is lost or wasted at different stages of the supply chain. Typically, food loss occurs in the early stages, while food waste happens in the final stages (Ouro-Salim and Guarnieri, 2025).

Various studies have investigated food loss and waste in different contexts (Boschini et al., 2018; Boschini et al., 2020; Magalhães et al., 2021; Sato and Nakano, 2013; Sato and Nakano, 2016). Although restaurants are significant sources of food loss and waste, the number of investigations in this context is limited (de Campos et al., 2025; Alam et al., 2025; Auwalin et al., 2022; Feodorov et al., 2022; Sato et al., 2020;

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https://doi.org/10.1016/j.wmb.2025.100261

Available online 30 October 2025

Silva et al., 2024).

Food waste in restaurants can be divided into waste during cooking, food not served, leftover food by consumers and unsold food. Waste of ingredients during cooking may occur due to mistakes in quantity or when the number of consumers is fewer than expected. If the ingredients can be used for other dishes or menus on another day, these items will not be wasted (Sato et al., 2020).

The portion size, quality and price of meals; palatability of foods; time limitations; satiety before the end of the meal; and inefficient storage are less mentioned causes of food waste in restaurants (de Campos et al., 2025; Ouro-Salim and Guarnieri, 2025). Regardless of the cause, food waste may represent a significant loss of ingredients, negatively reflecting on the sustainability and profitability of the business. Thus, identifying the causes and developing effective strategies to minimize them are essential to improve operational processes and maximize profits.

This study investigates food waste resulting from overstocking in a restaurant specializing in Japanese cuisine in Itabira, Minas Gerais, Brazil. The objective is to identify the most probable causes of this type of waste and propose an action plan to eliminate them.

This is relevant because most studies on food waste in Brazil focus on broader contexts, such as supply chains, supermarkets, general restaurant settings, or large urban centers. In contrast, this study investigates a specific Japanese restaurant, enabling a deeper understanding of the unique cultural, operational, and logistical characteristics of this type of restaurant. Furthermore, the research is conducted in a medium-sized city, offering a regional perspective that enriches the diversity of data on the topic. It also examines food waste caused by overstocking, a less-addressed issue that involves purchasing planning, demand forecasting, and inventory management (de Campos et al., 2025; Ouro-Salim and Guarnieri, 2025; Magalhães et al., 2021).

This study aims to address two main questions: Why does food waste resulting from overstocking occur in a restaurant specializing in Japanese cuisine? What measures can be taken to reduce this?

Food waste in restaurants

Food waste is a global issue with profound economic, social, and environmental repercussions. There are two categories of wasted food: food loss and food waste. Food loss refers to the decline in quantity or mass of food intended for consumption. This usually occurs due to issues in supply chains, limited access to technology, lack of skills, natural disasters, among others. Food waste refers to edible food that is discarded. This often happens because of spoilage, excess supply, or consumers' eating habits (World Health Organization, 2023).

The sources of food waste are many: households, grocery stores, restaurants, food service companies, farms and manufacturers. Food waste in restaurants occurs at all stages, from sellers to consumers. This is why food waste represents a serious social, environmental and economic problem in restaurants and its control is critical to financial success (Silva et al., 2024).

Efforts to reduce food waste in restaurants have been made worldwide and studies have been conducted to address this problem. The studies can be divided into four main groups.

The first group focuses on identifying the probable causes of food waste, measurement, and proposing mitigation strategies. (Sato et al., 2020) investigated a method of reducing food waste at restaurants, particularly the effect of food sharing. The results indicate that the main reasons for food waste in restaurants are leftovers and overstocking. Additionally, recycled food from restaurants is turned into fertilizer and feed.

(Syaukat et al., 2021) investigated the food-wasting process in Indonesian restaurants, estimating the amount and economic value of waste. They found that unsold food waste predominantly consisted of rice, often due to cooking large portions or dried rice that became inedible. Annually, rice waste amounted to approximately 30,000 kg and 357 million rupees.

(Feodorov et al., 2022) studied an enclosed onsite composting system for food waste, operated under real-life conditions. The system, installed in a restaurant with specific needs, processed a mix of food waste and sawdust pellets. Their findings indicated that the quality and properties of the compost were influenced by the operating conditions.

(Silva et al., 2024) investigated the mismatch between portion sizes served and nutritional recommendations, revealing that all meal components were inadequately portioned. Based on data from over 10,000 meals, the study found that 20.8 % of food was wasted, with salads and vegetables accounting for the highest share of plate waste. Findings highlight the need for portion standardization and better menu planning to reduce food waste and improve the nutritional quality of meals served to university students.

The second group highlights how advanced technologies can reduce food waste and improve sustainability. For example, (Alam et al., 2025) explored how advanced sensing technologies, such as internet of things (IoT), artificial intelligence (AI) and intelligent packaging, are transforming the food processing industry to meet growing demands for healthier, more sustainable, and ethically produced food. It highlights innovations like 3D food printing, high-pressure processing, and precision agriculture, which enhance efficiency, reduce waste, and improve food safety. The study concludes that integrating these technologies might boost operational transparency and traceability, as well as align food production with evolving consumer preferences and global sustainability goals.

The third group explores how individuals' traits and awareness affect food waste behavior. For example, (de Campos et al., 2025) investigated how sociodemographic variables, such as gender, age, and field of study, influence students' environmental awareness and behaviors related to food waste in university dining facilities across Brazil. Based on survey data from 5710 students, the study found that female and older students tend to have greater environmental knowledge and awareness, while male students perceive their universities' sustainability efforts more positively. These insights help identify key behavioral drivers and inform targeted strategies for improving organic waste management in higher education institutions.

The fourth group provides foundational understanding of food waste. As in (Ouro-Salim and Guarnieri, 2025), that examined how non-governmental organizations (NGOs) and restaurants in Brasília (Brazil) and Lomé (Africa) contribute to food waste reduction through circular economy principles. Using institutional theory and qualitative methods, the study reveals that NGOs show stronger alignment with circular practices while restaurants demonstrate limited adoption. It highlights the influence of institutional pressures on NGOs, the challenges of implementing circular strategies in developing contexts, and the need for collaboration, awareness, and support to foster sustainable food systems.

Table 1 summarizes the main contributions of each group.

These studies underscore the global significance of food waste and highlight the need for effective strategies to reduce it in restaurants. Understanding the specific causes of food waste in restaurants is crucial for developing effective solutions.

Despite the greater challenges faced by developing countries in managing food waste, due to limited selective collection and hindering historical data planning, developed countries also face significant issues with food waste (de Campos et al., 2025; Ouro-Salim and Guarnieri, 2025).

In addition, studies from the first group identified four primary types of food waste that occur most frequently in restaurant settings: leftovers, overstocking, unsold food, and organic waste. Leftovers refer to uneaten food from served meals, typically resulting from oversized portions, inadequate menu planning, or a mismatch between portion sizes and nutritional needs (Sato et al., 2020; Silva et al., 2024). Overstocking denotes food that is prepared or purchased but not served or sold, often due to inaccurate demand forecasting or poor inventory management

Table 1
Summary of contributions to food waste in restaurants.

Group	Focus area	Main contributions	References
Operational food waste	Causes, measurement, and mitigation strategies	Identifies portioning, leftovers, and unsold food as key drivers of waste, and proposes mitigation approaches such as food sharing and onsite composting.	(Feodorov et al., 2022); (Sato et al., 2020); (Silva et al., 2024); (Syaukat et al., 2021)
Technological innovations in food systems	Advanced technologies in food processing	Demonstrates the potential of IoT, AI, and smart packaging to reduce food waste.	(Alam et al., 2025)
Behavioral and sociodemographic influences	Environmental awareness	Highlights the impact of gender and age on food waste awareness, supporting the development of targeted educational interventions.	(de Campos et al., 2025)
Institutional and circular economy perspectives	NGOs and restaurants in circular economy	Shows stronger alignment of NGOs with circular economy principles and identifies implementation barriers faced by restaurants in developing regions.	(Ouro-Salim and Guarnieri, 2025)

Source: the authors (2025).

(Sato et al., 2020). Unsold food includes cooked items that become inedible before consumption, commonly caused by excessively large cooking batches (Syaukat et al., 2021). Organic waste comprises biodegradable food residues suitable for composting, originating from kitchen scraps or unserved food (Feodorov et al., 2022).

This study aims to contribute to the discussion of food waste in restaurants, particularly to the operational food waste, by conducting a case study in a restaurant specializing in Japanese cuisine in Itabira, Minas Gerais, Brazil. The goal is to identify the primary causes of food waste resulting from overstocking at the restaurant and propose an action plan to eliminate them.

The main contribution of this study is the recommendation of actionable strategies that may assist this type of restaurant in reducing food waste.

Materials and methods

The methodology adopted is the case study, which helps in exploration of a phenomenon within some context through various data sources, and it undertakes the exploration through variety of lenses to reveal multiple facets of the phenomenon (Rashid et al., 2019). This study follows four phases: foundation, prefield, field and reporting.

The foundation phase is a crucial initial step in conducting a case study, as it establishes the research's philosophical framework. A clear understanding of research philosophy, that encompasses ontology, epistemology, and paradigm choices, is essential for shaping the methodological approach. This phase involves identifying the appropriate inquiry techniques, typically quantitative or qualitative, and determining the research logic, whether inductive or deductive (Rashid et al., 2019).

The prefield phase focuses on designing the operational aspects of the research. The initial step is to evaluate whether the case study method is the most appropriate approach for addressing the research objectives. Given that case study research involves an in-depth investigation, often supported by empirical material collected over time, it is essential to develop a case study protocol to guide the collection of evidence, analysis of empirical data, and reporting of results (Rashid et al., 2019).

In the field phase, the researcher's active engagement in generating and interpreting empirical data is critical. The case study method employs diverse data collection tools, e.g. semi-structured interviews, meeting observations, and document analysis, to address research questions with comprehensive depth. Equally important is the reporting phase, where the structure and narrative style of the case study shape its overall impact (Rashid et al., 2019).

Foundation phase

Philosophical consideration

A qualitative case study typically embraces a relativist ontology and a subjectivist epistemology, particularly within business and management research, where the interpretive paradigm is commonly employed. This paradigm assumes that reality is socially constructed and that meaning emerges through the interaction between researcher and subject. In this study, the authors adopted a relativist stance, viewing reality as shaped by context and perception. The subjective epistemological approach was applied through active engagement with the field, interpreting participants' perspectives, observing meetings and processes, and analyzing empirical material in an iterative manner. The primary objective was to investigate food waste resulting from overstocking in a real-life restaurant setting, identify its root causes, and propose actionable solutions. Data collection involved contextual visits, interviews with stakeholders, documentation of meetings and projects, and interpretation of findings within their social and operational context (Rashid et al., 2019).

Inquiry techniques consideration

There are two common inquiry approaches in research: quantitative and qualitative. Interpretive research aligns closely with qualitative methods, focusing on addressing credibility, confirmability, transferability, and dependability (Rashid et al., 2019).

In this study, qualitative case study methodology was chosen due to the need for in-depth exploration of food waste in a restaurant setting, a complex social and operational issue. Previous research has shown that case studies are effective in investigating food loss and waste in restaurants, yielding meaningful insights (Feodorov et al., 2022; Sato et al., 2020; Syaukat et al., 2021).

This method is well-suited for exploring the subjective meanings individuals or groups assign to social phenomena (Rashid et al., 2019).

Research logic consideration

Induction and deduction are two common research logics used in social sciences research. Relativist research starts with subjective accounts of lived experiences on which theory is built inductively. Hence, this study adopts an inductive approach, as it begins by observing and interpreting real-world phenomena within a restaurant context to uncover patterns and root causes of food waste. Rather than testing pre-existing theories, the authors engaged with stakeholders, documented operational practices, and analyzed empirical material to construct meaning and generate insights. The findings emerged gradually through immersion in the setting, making this a clear example of theory-building rooted in subjective experience and contextual interpretation (Rashid et al., 2019).

Prefield phase

One of the first steps in the case study protocol involves designing the research questions, which guide the investigation. Accordingly, this study seeks to answer two central questions: Why does food waste

resulting from overstocking occur in the Japanese restaurant? What measures can be taken to reduce it?

Conducted as a single, in-depth case study, the research follows an interpretive stance combined with inductive logic to explore the underlying causes of food waste (Rashid et al., 2019). The company studied is a small restaurant with 10 employees and an annual revenue of approximately R$ 2.4 million. Its mission is to provide an authentic and memorable culinary experience, with a focus on ingredient quality and distinctive flavor. The restaurant's vision is to establish itself as a reference in Japanese cuisine, guided by core values of freshness, meticulous preparation, and cultural authenticity.

This restaurant was chosen due to its relevance within the local food service sector, representing a small-scale operation with significant production volume and streamlined organizational structure. The decision was also influenced by the restaurant's openness to participate in the research and the ease of access to its facilities and personnel.

The authors conducted direct observations of the restaurant's daily operations over a continuous 30-day period in April 2025, exclusively during evening hours, which align with the restaurant's regular operating schedule. Data collection encompassed both weekdays and weekends to ensure a comprehensive understanding of the restaurant's daily dynamics. The evening period was deliberately chosen, as it represents the peak of customer activity and operational flow, thereby providing richer and more representative data for the study. The restaurant operates seven days a week, offering delivery services daily and in-person dining from Tuesday to Sunday. This study focuses on food waste generated from Tuesday to Sunday, when both service modalities are available.

Data collection was primarily conducted through semi-structured interviews, complemented by participant observation, document review, and meeting notes. The dataset comprises information on production dates, product types, quantities prepared, and the number of overstocked items. Semi-structured interviews were conducted with all 10 employees of the restaurant, including the manager. Participants were adults aged 22 to 48, occupying roles such as kitchen staff, service attendants, cleaning personnel, and management. This range of professional profiles enabled a comprehensive understanding of the restaurant's operational routines and food waste generation.

During the interviews, employees were asked about the number of products prepared at the beginning of each shift and any additional items produced by the end of the shift. The manager was responsible for counting overstock items throughout the month and provided this data for analysis. Each interview lasted approximately 30–45 min, totaling around 6 h of recorded conversations. These interviews aimed to capture operational routines and decision-making processes related to food preparation and waste.

All empirical material was organized and stored using electronic spreadsheets. Findings were interpreted by the researchers and subsequently validated through participant feedback, ensuring contextual accuracy and co-constructed understanding (Rashid et al., 2019).

To ensure data reliability, triangulation techniques were applied by cross-referencing information obtained through semi-structured interviews, direct observation, and internal documents. For example, employee reports on food preparation and waste were compared with observational records and production logs. Interviews were audio-recorded and transcribed, while observations followed a structured protocol with daily field notes. This methodological integration allowed for a more robust and validated understanding of operational practices and food waste dynamics.

Results

Through observations, stakeholder interviews, and detailed documentation, the study identified key drivers of food waste. The process reflects a theory-building approach, where understanding emerged progressively through engagement with the field, rather than testing pre-established hypotheses (Rashid et al., 2019).

Based on the unit selling prices of the products, the total cost of food waste for the month was calculated.

Despite weekly production planning, the manager reported that some days result in a high volume of overstocked items that must be discarded, leading to significant losses in ingredients, time and labor. The use of high-quality ingredients further exacerbates the financial losses.

Currently, the production plan is based on sales history, the manager's experience, marketing campaigns and special dates.

At the start of each shift, employees prepare meals according to the weekly plan. However, customers may order items not included in the plan or in quantities exceeding forecasts, requiring the preparation of additional products.

Data analysis and evaluation

Cause analysis

The employees conducted a brainstorming session to identify the most probable causes of food waste, which were illustrated in a cause-and-effect diagram. A synthesis of the result is shown in Table 3.

The employees found that the highest demand occurs during the first and second weeks of the month due to payday. Additionally, Sunday has the highest demand for products from 1 to 7 and 9, while product 8 experiences peak demand on Tuesdays due to a marketing campaign.

Products 6, 7 and 9, along with their ingredients, cannot be repurposed for other menu items or used on another day, leading to their disposal if unsold. Low quality products also contribute to waste. Thus, the restaurant prioritizes high-quality ingredients, which are more expensive. This aligns with findings that low-quality ingredients spoil faster and are more likely to be discarded, increasing the financial impact of waste (Feodorov et al., 2022; Syaukat et al., 2021).

The lack of skills in product preparation and the absence of standard procedures may result in products that, while consumable, do not meet visual standards, leading to their discard to ensure customer satisfaction. This is consistent with studies showing that inadequate training and lack of standardization contribute to food waste in restaurants (de Campos et al., 2025; Sato et al., 2020).

The restaurant uses equipment designed to roll and wrap sushi with seaweed to streamline production. While this equipment improves speed, standardization and hygiene, incorrect configuration can result in poor-quality products that may need to be discarded if they cannot be corrected manually. Similar cases were reported where equipment misconfiguration led to product loss due to quality issues (Alam et al., 2025).

The discussion revealed that the production plan was outdated, likely due to insufficient historical data or inaccurate demand and sales forecasting. Predicting consumer demand and expectations is challenging and inadequate planning can lead to excess inventory and increased food waste (de Campos et al., 2025; Ouro-Salim and Guarnieri, 2025). This reflects broader trends identified in the literature where poor forecasting and lack of historical data are major contributors to overproduction and waste (Sato et al., 2020; Silva et al., 2024).

Employees rely on their experience for production, which has led to overproduction, improper cuts, crushing and incorrect cooking. This points to potential management issues, including a lack of supervision and communication gaps between shifts. These factors are commonly cited as operational inefficiencies that increase food waste in restaurant environments (de Campos et al., 2025; Ouro-Salim and Guarnieri, 2025).

Even when the production plan is followed, overproduction before service leads to work overload and idle time, while underproduction results in a stressful environment with high-pressure demands during service hours. Stressful work conditions and demand fluctuations are known to affect food handling and increase waste (de Campos et al.,

Table 2
Number of units planned, and the additional products prepared each week.

Product	Description	Week 1 Plan (unit)	Additional products (unit)	Waste (unit)	Waste cost (R$)	Week 2 Plan (unit)	Additional products (unit)	Waste (unit)	Waste cost (R$)	Week 3 Plan (unit)	Additional products (unit)	Waste (unit)	Waste cost (R$)	Week 4 Plan (unit)	Additional products (unit)	Waste (unit)	Waste cost (R$)	Week 5 Plan (unit)	Additional products (unit)	Waste (unit)	Waste cost (R$)	Total planned (unit)	Total of additional products	Total wasted (unit)	Total waste cost (R$)
1	Grilled salmon skin nigiri	276	34	0	0.00	356	50	0	0.00	223	40	0	0.00	262	4	3	14.85	76	9	0	0.00	1193	137	3	14.85
2	Salmon nigiri	262	35	0	0.00	332	45	0	0.00	232	40	0	0.00	292	7	26	162.50	29	2	1	6.25	1147	129	27	168.75
3	Philadelphia uramaki	165	39	7	26.08	205	45	5		190	17	0	0.00	194	14	4	14.90	22	2	1	3.73	776	117	17	63.34
4	Grilled salmon skin hosomaki	98	26	0	0.00	126	32	0	0.00	103	10	0	0.00	102	18	4	9.90	32	2	2	4.95	461	88	6	14.85
5	Seared salmon uramaki	70	22	8	29.80	89	22	7	26.08	90	3	2	7.45	82	8	4	14.90	9	0	0	0.00	340	55	21	78.23
6	Grilled salmon skin uramaki	60	21	0	0.00	77	23	0	0.00	81	9	4	12.90	68	2	3	9.68	120	10	0	0.00	406	65	7	22.58
7	California uramaki	34	5	0	0.00	65	8	0	0.00	70	2	9	26.78	61	8	4	11.90	120	11	0	0.00	350	34	13	38.68
8	Hot temaki	70	40	0	0.00	70	38	2	3.95	14	0	1	39.90	96	4	0	0.00	46	2	0	0.00	296	84	3	43.85
9	Crab stick hosomaki	17	4	0	0.00	21	8	0	0.00	27	0	0	0.00	30	3	1	1.98	100	14	0	0.00	195	29	1	1.98
Total		1052	226	15	55.88	1341	271	14	48.65	1030	121	16	87.03	1187	68	49	240.60	554	52	4	14.93	5164	738	98	447.09

Source: the authors (2025).

2025).

The lack of performance indicators exacerbates these issues, as it is difficult to assess product quality in terms of size, format, weight, appearance and texture, or to track waste per employee for better training and waste reduction. The absence of performance indicators and monitoring tools has been identified as a barrier to waste reduction and operational improvement (de Campos et al., 2025).

Data from Table 2 show that product 2 has the highest waste in both quantity and cost for the month. This is unexpected because product 2 and its ingredients can be used on other menu items or on different days. The high amount of waste may be attributed to the number of additional products prepared. This supports findings thar overproduction, even of reusable items, can still result in waste due to poor planning and excess inventory (Sato et al., 2020).

Table 2 also indicates that 129 additional units of product 2 were prepared throughout the month, representing about 11 % of the production plan. Reducing this number to 102 units (approximately 9 % of the plan) could have eliminated the waste.

Similarly, additional products for product 3 accounted for around 15 % of the production plan and for product 5, approximately 16 %. If these percentages had been closer to 13 % and 10 %, respectively, waste could have been minimized. These observations reinforce the importance of accurate forecasting and controlled production margins to reduce waste (Ouro-Salim and Guarnieri, 2025; Sato et al., 2020).

Product 8, despite having the lowest waste in terms of units, has the fourth highest waste cost due to its high selling price per unit. In contrast, product 9, with the second-lowest waste in units, has the lowest waste cost because of its lower selling price. This reflects the economic dimension of food waste, where high-value items amplify financial losses even with minimal physical waste (Syaukat et al., 2021).

Week 4 recorded the highest volume of food waste, with 49 units discarded at a total cost of R$ 240.60, representing more than half of the total waste cost for the month (53.8 %). This may indicate atypical events or specific operational failures during that period, such as inaccurate demand forecasting or low product turnover, which are recognized as key contributors to food waste in restaurant settings (de Campos et al., 2025; Sato et al., 2020).

Overall, about 2 % of the total products were wasted. Literature suggests that a waste threshold of up to 3 % is acceptable and values up to 10 % might be acceptable if a safety margin is included during menu planning (Silva et al., 2024). Therefore, the food waste of the restaurant, while present, falls within acceptable national standards.

In conclusion, the most probable cause of food waste at the restaurant appears to be inaccurate demand and sales forecasting, leading to an outdated production plan. This conclusion is supported by multiple studies that identify poor forecasting and lack of historical data as central causes of food waste in food service operations (de Campos et al., 2025; Ouro-Salim and Guarnieri, 2025; Sato et al., 2020).

Proposal for action plans

Based on the analysis of the causes, an action plan is proposed to eliminate food waste and minimize errors in demand and sales forecasting. The actions listed were derived from the literature on food waste reduction strategies in restaurants and validated through interviews with the restaurant manager and staff, who confirmed the feasibility and relevance of each measure in their operational context.

Literature recommends several interventions to address food waste, including campaigns, adjusting portion and dish sizes, improving quality, changing menus, providing nutritional information, planning, pre-ordering, charity/donation, coercion, preparation/cooking and storage (de Campos et al., 2025; Ouro-Salim and Guarnieri, 2025).

At the restaurant, a marketing campaign on Mondays repurposes unsold Sunday products in new menu items, thereby reducing waste. Additionally, a specific campaign for product 9 occurs on Tuesdays. As shown in Table 2, only one unit of product 9 was wasted during the

Table 3
Synthesis of the cause-and-effect diagram.

Category	Cause	Description	Reference
Measurement	Lack of monitoring during products preparation	The absence of monitoring during food preparation leads to errors in quantity, overproduction, and inefficient use of ingredients.	(de Campos et al., 2025)
	Insufficient historical data	Without historical data, it becomes difficult to predict demand accurately, resulting in excessive preparation and waste.	(Ouro-Salim and Guarnieri, 2025)
	Lack of performance indicators	The absence of performance indicators prevents the identification of inefficiencies and hinders corrective actions to reduce waste.	(de Campos et al., 2025)
Machine	Incorrect configuration of the equipment	Equipment not properly calibrated can lead to overcooking, spoilage, or improper storage conditions that accelerate food deterioration.	(Alam et al., 2025)
Manpower	Lack of skills to prepare the products	Inadequate training results in mistakes during preparation, such as incorrect portioning or cooking errors, and increasing food waste.	(Sato et al., 2020)
	Lack of supervision	Without supervision, employees may not follow procedures correctly, leading to inconsistencies and waste.	(de Campos et al., 2025)
	Communication gaps between shift	Poor communication between shifts can cause duplication of tasks or misalignment in production, resulting in surplus and waste.	(Ouro-Salim and Guarnieri, 2025)
Material	Cost of ingredients	High-cost ingredients increase the financial impact of waste, especially when spoilage or overproduction occurs.	(Syaukat et al., 2021)
	Low quality of ingredients/products	Inferior quality items spoil faster or are rejected during preparation, contributing to waste.	(Feodorov et al., 2022)
Environment	High demand during service hours	Intense service periods may lead to rushed preparation and errors, increasing the likelihood of waste.	(Ouro-Salim and Guarnieri, 2025)
	Stressful environment	Stress among staff can reduce attention to detail and adherence to procedures, resulting in mistakes and food loss.	(de Campos et al., 2025)
Method	Absence of standard procedures	The lack of standardized processes leads to inconsistent practices and overproduction, contributing to waste.	(Silva et al., 2024)
	Inaccurate demand and sales forecasting	Poor forecasting causes mismatches between production and actual demand, resulting in unsold or spoiled food.	(Sato et al., 2020)

Source: the authors (2025).

month analyzed, indicating that this intervention is effective.

However, the restaurant does not conduct informative campaigns about the negative impacts of food waste. Such campaigns could emphasize the importance of reducing, recycling and reusing food and advise consumers to take only what they can eat (de Campos et al., 2025; Ouro-Salim and Guarnieri, 2025; Silva et al., 2024; Painter et al., 2016). Previous studies suggest that food waste awareness campaigns significantly reduce waste by informing consumers about its adverse effects on food safety and the environment (Mirosa et al., 2016).

Another recommended intervention is decreasing portion sizes, as large portions are linked to unconscious increases in food consumption and waste (Painter et al., 2016; Jagau and Vyrastekova, 2017; Lorenz et al., 2017; Marais et al., 2017). Reducing dish sizes has also been explored in the food industry because smaller dishes limit the space for food, thereby encouraging smaller portions and reducing waste. Conversely, larger dishes can lead to larger portions and more waste (de Campos et al., 2025; Ouro-Salim and Guarnieri, 2025; Mirosa et al., 2016). Therefore, analyzing both portion and dish sizes is recommended.

Investing in meal quality is another effective intervention to minimize avoidable waste (Painter et al., 2016; Mirosa et al., 2016; Lorenz et al., 2017). Periodic reviews of food quality could help the restaurant identify whether customers demand higher-quality products or if supplier choices need reconsideration.

Flexible menus contribute to quality improvement and providing nutritional information allows consumers to make informed choices based on value-based information, potentially choosing healthier options (de Campos et al., 2025; Ouro-Salim and Guarnieri, 2025; Painter et al., 2016; Marais et al., 2017; Lorenz and Langen, 2018).

Adequate planning is crucial for reducing food waste. Ingredient purchases and food preparation should align with demand forecasts (Painter et al., 2016; Zotesso et al., 2016). Accurate demand and sales forecasting are vital for restaurant success. Historically, many forecasting techniques rely on intuitive judgments from managers, which can be flawed due to factors like time, weather, economic conditions and random events (Lasek et al., 2016).

Small and medium-sized restaurants often struggle with forecasting due to limited data or funds for analysis (Schmidt et al., 2022). Common forecasting techniques include multiple regression, Poisson regression, exponential smoothing, Holt-Winters models, Box-Jenkins models, neural networks, Bayesian networks and hybrid methods (Lasek et al., 2016; Schmidt et al., 2022). Machine learning techniques are also being explored for sales forecasting (Tanizaki et al., 2019).

Pre-ordering could be another option, allowing consumers to order meals 48 h in advance with the option to cancel up to 24 h before service/delivery (de Campos et al., 2025; Ouro-Salim and Guarnieri, 2025; Painter et al., 2016; Marais et al., 2017). However, this approach carries risks, as consumer preferences may change, potentially increasing food waste (Mirosa et al., 2016). A better alternative for the restaurant might be to allow orders a few hours before service, ensuring meals are ready when customers arrive.

Charity or donation is a viable intervention for managing food waste. Since 2020, Brazilian Law No. 14.016 permits restaurants to donate unsold meals to help reduce hunger and food insecurity. The National Health Surveillance Agency provides guidelines for donation, including proper storage, packaging and labeling of food items. Restaurants can donate to employees, the public, or collaborate with public authorities, food banks and charitable organizations (Schneider, 2013).

Coercion is another intervention that can reduce food waste by using penalties to discourage overstocking items. Restaurants and cafeterias have successfully implemented coercion to increase the likelihood that customers will not leave food behind (Mirosa et al., 2016). The analyzed restaurant might consider introducing penalties or charges for overstocking items.

Finally, developing standard procedures for preparation and cooking is essential to reduce waste. These procedures should include reusing overstocking items (as legally permitted), rapidly cooling food to prevent microbial growth and training employees. The absence of standard procedures was identified among the probable causes of food waste, so establishing and training in these procedures could enhance product

quality and address miscommunication during shifts. After defining standard procedures, it is important to train the employees to eliminate the lack of skills in preparing products.

The recommended action plan for the restaurant is summarized in Table 4.

Theoretical implications

The theoretical implications of this study highlight its contribution to advancing existing frameworks by incorporating a regionally specific and distinctive context. By focusing on the city of Itabira, Minas Gerais, Brazil, and examining a Japanese cuisine restaurant in a medium-sized urban setting, the research offers a unique perspective. This is particularly relevant given that most studies on food waste in Brazil concentrate on broader contexts, such as supply chains, supermarkets, general restaurant categories, or large metropolitan areas. In contrast, this study provides deeper insight into the cultural, operational, and logistical particularities of a niche restaurant type (de Campos et al., 2025; Ouro-Salim and Guarnieri, 2025; Magalhães et al., 2021).

Methodologically, the research adopted relativist ontology and subjectivist epistemology, consistent with the interpretive paradigm. An inductive approach was employed to support theory-building grounded in subjective experience and contextual interpretation. Rather than testing pre-existing theories, the study sought to observe and interpret real-world phenomena within the restaurant environment to identify patterns and root causes of food waste (Rashid et al., 2019).

Ultimately, the study contributes to the academic discourse on operational food waste in restaurants by offering context-sensitive insights that challenge generalized assumptions.

Practical implications

From a practical standpoint, the findings offer actionable insights to support the development of targeted policies and operational strategies tailored to the specific challenges faced by restaurant managers. The study's main practical contribution lies in the recommendation of context-sensitive interventions to reduce food waste in small-scale restaurants.

The research identified inaccurate demand and sales forecasting, resulting in an outdated production plan, as the most probable cause of food waste in the restaurant investigated. This finding aligns with existing literature, which highlights poor forecasting and the absence of historical data as key contributors to overproduction and waste in food service operations. Historically, the restaurant relied on intuitive managerial judgment for forecasting.

To address this issue, the study proposes a comprehensive action plan (Table 4), which includes the following measures:

- Informative campaigns to raise awareness about the environmental and economic impacts of food waste, emphasizing reduction, reuse, and recycling.
- Portion and dish size analysis to minimize plate waste, recognizing the link between oversized portions and unconscious overconsumption.
- Periodic food quality reviews to assess customer expectations and supplier performance, aiming to reduce avoidable waste.
- Frequent menu adjustments to enhance flexibility and reduce waste through ingredient variation and nutritional transparency.
- Adoption of advanced forecasting techniques, such as machine learning, neural networks, and hybrid models, in place of intuitive methods.
- Implementation of short-term pre-ordering systems to improve production planning without the risks associated with long lead times.
- Donation of unsold items, in compliance with Brazilian Law No. 14.016/2020, as a strategy to combat food insecurity.
- Coercive measures, such as penalties for overproduction, to discourage wasteful practices.
- Definition of standardized procedures to prevent errors and inefficiencies during food preparation.
- Employee training to ensure proper execution of standardized practices and reduce skill-related waste.

Table 4
Recommended action plan for the Japanese restaurant.

What	Why	Where	Who	When	How	How much
Informative campaigns	To inform about the negative impact of food waste	At the restaurant and on social media	Manager/ Employees	Immediate	Creating informative content about the negative impact of food waste	Approximately R $5.000,00
Analysis of portion sizes	To decrease the waste left in meals	Face-to-face service	Manager/ Employees	Immediate	Collecting data about food waste during service hours	Cost of working hours
Analysis of dish sizes	To provide less space for food layout	Face-to-face service	Manager	Immediate	Changing the dishes	Approximately R $5.000,00
Periodic reviews of food quality	To improve food quality and reduce food waste	Face-to-face service and delivery	Manager	Monthly	Conducting a questionnaire survey	Cost of working hours
Changing the menu	To increase menu flexibility and reduce food waste	Restaurant's menu	Manager	Monthly	Varying the composition or ingredients of meals and providing nutritional information	Cost of working hours
Demand and sales forecast	To predict sales accurately, avoiding food waste	Restaurant's management	Manager	Immediate	Studying the most suitable forecast technique	Cost of working hours
Pre-ordering	To better predict sales and avoid food waste	Restaurant ordering system	Consumers	Few hours in advance	Ordering the meals in the system	None
Charity/ donation	To contribute to the reduction of hunger and food insecurity	City	Manager/ Employees	At the end of service hours	Donating products/meals that were not sold	None
Coercion	To increase the likelihood that consumers will not leave overstocking items	Face-to-face service	Manager	Immediate	Establishing penalties or charging for overstocking items	Cost of working hours
Standard procedures	To eliminate waste from overproduction and mistakes during product preparation	Restaurant's kitchen	Manager	Immediate	Defining a step-by-step process to prepare each product on the menu	Cost of working hours
Training	To eliminate the lack of skills in preparing products	Restaurant's kitchen	Manager	After defining standard procedures	Training employees in the standard procedures	Cost of working hours

Source: the authors (2025).

This set of recommendations serves as a practical guide for the restaurant studied and may be adopted by other commercial food establishments seeking to improve sustainability and reduce operational waste.

Conclusions

The objective of this study was to identify the primary causes of food waste in a restaurant specializing in Japanese cuisine and propose an action plan to minimize or eliminate them. A case study methodology was adopted.

The study identified inaccurate demand and sales forecasting as the primary cause of food waste in the restaurant, leading to an outdated production plan. Historically, demand and sales forecasting in the restaurant has relied on judgmental techniques. Identifying and implementing more accurate forecasting methods is crucial for improving restaurant yield. Therefore, it is recommended that the restaurant explore advanced forecasting techniques, such as machine learning, neural networks and hybrid methods.

In addition to improving forecasting techniques, several measures are suggested to reduce food waste, including informative campaigns, analysis of portion and dish sizes, periodic reviews of food quality, menu changes, pre-ordering, charity/donation, coercion, defining standard procedures and employee training. These actions are intended to guide the studied restaurant and other commercial establishments in their efforts to reduce food waste.

This study has limitations that should be considered. The research was conducted in a single Japanese restaurant in a medium-sized city in Brazil, which may limit the generalizability of the findings to other types of restaurants or geographic regions. Data collection was restricted to one month, which may not capture seasonal variations or long-term operational patterns that influence food waste. The validation of actions proposed relied on interviews with the restaurant's staff and manager. While this approach ensured contextual relevance, it may be subject to response bias or limited by the participants' perceptions. Some data (e.g. the number of additional products prepared) was manually recorded, which introduces the possibility of measurement inaccuracies. Although the study proposes practical strategies to reduce food waste, their effectiveness has not yet been tested through implementation or longitudinal follow-up.

Future research should consider applying these strategies in diverse restaurant settings and evaluating their impact over time or investigating the impact of the actions recommended on the amount of food waste to provide more conclusive results.

CRediT authorship contribution statement

Isabela Maganha: Writing – review & editing, Validation, Supervision, Methodology, Formal analysis. **Ana Flávia Andrade Martins:** Writing – original draft, Data curation, Conceptualization. **Cíntia Cristiane Moreira:** Writing – original draft, Data curation, Conceptualization. **Leonardo Flaviano Silva Moura de Sá:** Writing – original draft, Data curation, Conceptualization. **Lucas Filipe de Almeida Brito:** Writing – original draft, Data curation, Conceptualization. **Sara Alves de Araújo:** Writing – original draft, Data curation, Conceptualization. **Thaís Ribeiro Santiago:** Writing – original draft, Data curation, Conceptualization. **Antonio Mousinho de Oliveira Fernandes:** Writing – review & editing, Validation, Supervision, Methodology, Formal analysis. **Tábata Nakagomi Fernandes Pereira:** Writing – review & editing, Supervision, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement

This research did not receive any specific grant from funding agencies in the public, commercial, or non-profit sectors.

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