Voices from the kitchen: A thematic analysis of food waste management practices among Selangor's restaurant professionals

Farah Ayuni Mohd Hatta[1*], Asilah Aisyah Mohamad Yusoff[1], Norshariani Abd Rahman[1], Mashitoh Yaacob[2], Nor Fazilah Abdul Hamid[3]

[1]Institut Islam Hadhari, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia.
[2]School of Liberal Studies (CITRA-UKM), Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia.
[3]Institute of Technology Management and Entrepreneurship, Universiti Teknikal Malaysia Melaka, 76100, Melaka, Malaysia.

Corresponding author: Farah Ayuni Mohd Hatta (Email: farahayuni@ukm.edu.my)

Abstract

The restaurant industry is a major contributor to global food waste, making effective waste management essential for sustainability. This study investigates the practices employed by restaurant managers and workers across five districts in Selangor, Malaysia, to mitigate food waste and enhance resource efficiency. Employing a qualitative approach through thematic analysis, the study identifies four key practices: waste reduction methods, recycling, technological integration, and social initiatives. The findings highlight that inventory management and real-time food preparation are crucial for minimizing excess food, while innovation in repurposing surplus food further reduces waste. Recycling efforts, such as composting and using food waste as animal feed, contribute significantly to sustainable waste cycles. Additionally, technological solutions, including inventory tracking and decomposition systems, facilitate effective waste monitoring and reduction. Social initiatives, such as community food donation programs, promote broader environmental stewardship. This study offers actionable insights for restaurant operators, policymakers, and stakeholders by highlighting the need for structured inventory practices, portion control policies, and investment in smart waste-reduction technologies to reduce operational inefficiencies and promote environmental sustainability. Despite these efforts, challenges persist, notably in addressing consumer behavior, staff shortages, and food over-preparation, which require continued attention and strategic intervention. Food waste management requires the integration of practical, technological, and community-based strategies tailored to the specific challenges of the local food service context.

Keywords: Food Waste Management, Restaurant, Selangor, Sustainability, Thematic Analysis.

1. Introduction

Food waste management has become a critical issue for the restaurant industry, which plays a significant role in global food waste production. In Malaysia, particularly in the Selangor districts of Kuala Selangor, Kuala Langat, Hulu Langat, Sepang, and Petaling, the restaurant sector is adopting various strategies to mitigate this problem. The rising demand for sustainable practices has pushed many restaurant managers and workers to implement methods that address food waste at multiple stages of the food supply chain. The integration of technology, such as automated inventory systems and real-time demand forecasting, has emerged as a key solution for reducing food waste. These systems allow restaurants to track stock levels and minimize over-ordering, significantly cutting down waste from spoilage and over-preparation [1]. Furthermore, the adoption of recycling practices, including composting and using food waste as livestock feed, has gained traction as part of a broader sustainability effort.

However, challenges persist, such as fluctuating customer demand and labor shortages, which can lead to over-preparation and increased waste. Training programs aimed at improving food handling and waste management have been found effective in reducing waste generation [2]. Despite these efforts, there is a growing need for enhanced community awareness and involvement, as consumers also play a crucial role in reducing food waste through informed decision-making and responsible consumption.

In response, many restaurants are innovating by creating new products from surplus ingredients, refining portion sizes, and employing menu planning strategies that prioritize sustainable sourcing and circular food preparation. This paper investigates the food waste management practices in these five districts of Selangor, focusing on the strategies employed by restaurant managers and workers to tackle the issue. The importance of combining technological advancements with sustainable business practices is to create a more eco-friendly and cost-efficient restaurant industry.

1.1. Solid Waste
1.1.1. Management in Malaysia

Solid waste management in Malaysia has been a growing concern, driven by rapid urbanization and increasing waste generation. The country produces approximately 38,000 tons of solid waste daily, a figure that has been steadily rising. A significant challenge is the reliance on landfills, which accommodate over 90% of waste, many of which are nearing capacity. In addition, this issue has created further problems, as the poor management of residential and industrial waste in unsuitable landfill sites often results in harmful liquids, known as leachate, seeping into nearby water sources and worsening environmental damage [3]. Malaysia has responded by implementing the Solid Waste and Public Cleansing Management Act 2007, aimed at creating a more organized framework for waste management, including recycling and waste-to-energy initiatives [4].

Recent strategies focus on enhancing household waste separation and recycling practices. This includes public awareness campaigns aimed at encouraging more sustainable waste management behaviors among citizens. Additionally, Malaysia is exploring smart technology solutions, such as IoT-based systems, to monitor and optimize waste collection and processing, offering more efficient and sustainable management [5]. These advancements are crucial as Malaysia seeks to transition from traditional waste disposal methods to a circular waste economy.

These ongoing efforts, along with the promotion of waste-to-energy technologies and better recycling policies, reflect Malaysia's commitment to mitigating the environmental impact of solid waste and moving towards a more sustainable future [6].

1.2. Food Waste Management Technology

In Malaysia, technology has become a key tool in tackling food waste, especially in the hospitality sector. One approach is the use of biodigester systems, which convert organic food waste into biogas and bio-fertilizers. This helps reduce the amount of waste sent to landfills while generating renewable energy. Biodigesters have proven effective in transforming food waste into energy in various sectors, and their adoption in Malaysia is increasing as part of the country's broader waste-to-energy initiatives [7].

Moreover, smart waste management systems that utilize Internet of Things (IoT) technology allow restaurants and hotels to monitor food waste in real time. These systems help track the amount of waste generated, enabling timely interventions to

reduce wastage and improve resource management. IoT technology is particularly useful in monitoring food storage conditions, helping to reduce spoilage by keeping track of food inventory [8].

Incorporating automated inventory management systems has also allowed restaurants to optimize food purchases based on customer demand, significantly reducing food waste caused by overordering. These systems analyze sales trends and help managers forecast food requirements more accurately, ensuring that food is ordered and used efficiently [9, 10]. These innovations are helping Malaysia transition toward more sustainable food waste management practices by reducing the environmental impact of waste and promoting energy recovery.

1.3. Recycling

Recycling in Malaysia has progressed through various national policies, such as the Plastic Sustainability Roadmap 2021–2030, which aims for a 25% recycling rate for post-consumer plastic by 2025. Despite these efforts, recycling rates remain low, with only about 0.097% of domestic plastic waste recycled formally as of 2018. This highlights the need for greater public awareness and participation in recycling activities [11].

The country's recycling system is heavily reliant on landfills, where approximately 85% of waste is disposed of. Although Malaysia has mandated waste separation at the source, public engagement remains minimal. Community-driven activities, such as "gotong-royong" (community cleanup), help support recycling efforts, but formal recycling systems still struggle with low participation [12].

Moreover, illegal dumping and the mismanagement of waste have worsened environmental challenges, particularly in terms of plastic waste entering the oceans. Strengthening public awareness campaigns, improving enforcement, and leveraging advanced technologies in waste management are essential for Malaysia to meet its recycling and sustainability goals [7].

1.4. Composting

Efforts are being made to scale up composting practices, including the development of community-level composting plants, which are expected to complement waste-to-energy initiatives by diverting organic waste from landfills and producing compost for agricultural use [13]. These projects are part of Malaysia's broader goal of reducing landfill reliance and mitigating the environmental impact of waste.

Figure 1.
Infographic of environmentally friendly food waste management.

By incorporating technologies like smart composting bins and enhancing public awareness, Malaysia is moving towards more sustainable waste management practices through composting. Based on Figure 1, it emphasizes the significance of environmentally friendly food waste management techniques in Malaysian eateries, such as the application of IoT-based inventory systems, cutting-edge recycling techniques, and community composting programs. It highlights the incorporation of technological innovations that are revolutionizing waste management by improving resource efficiency and lowering landfill contributions, such as automated systems and biodigesters.

2. Methodology

This qualitative research employs semi-structured interviews to explore food waste management practices among restaurant managers and workers in five districts of Selangor, Malaysia. This approach allows for an in-depth understanding of the strategies that have been used, challenges, and perspectives related to food waste in the fast-paced restaurant industry.

2.1. Study Design

This qualitative study aimed to explore the perspectives and experiences of workers and managers in the restaurant industry. Data were collected through in-depth interviews conducted with participants from five different restaurants located in Selangor, Malaysia. The choice of in-depth interviews as the primary method allowed for a comprehensive exploration of participants' insights, lived experiences, and contextual challenges within their work environments. Participants were purposefully selected to ensure a diverse representation of roles and responsibilities within the restaurants, providing a holistic view of the workplace dynamics.

2.2. Sampling

The study employed purposive sampling to ensure representation from different geographical areas within Selangor. One restaurant was selected from each of the five districts in the state, resulting in a total of five restaurants included in the study. This approach was designed to capture diverse perspectives and account for potential variations in practices, challenges, and experiences across different districts. From each restaurant, one manager and one worker were interviewed, creating a balanced sample of participants representing both management and staff perspectives. This dual representation ensured that the study captured a comprehensive understanding of the operational and experiential aspects of the restaurant industry.

The final sample size consisted of 10 participants, providing a manageable yet sufficiently diverse dataset for in-depth qualitative analysis. The inclusion of both managers and workers allowed the study to explore dynamics such as decision-making processes, workplace challenges, and interpersonal relationships from multiple viewpoints, enriching the overall findings.

2.3. Data Collection

All participants were interviewed in person at a location and time of their preference. Each participant was interviewed individually for an average of 1 hour. Field notes were taken during each interview to capture non-verbal cues, contextual details, and researcher observations, further complementing the interview data. All interviews were conducted in Malay, recorded using a smartphone, and later transcribed using NVivo software. Transcription included concurrent translation from Malay to English to ensure the data could be analyzed effectively in an international research context while preserving the nuances of the participants' responses. This iterative approach to data collection and analysis ensured the reliability and depth of the findings.

2.4. Data Analysis

The data were analyzed using thematic analysis, a qualitative method that enables the identification, analysis, and interpretation of patterns within the data. This approach was chosen for its flexibility and suitability for exploring participants' perspectives and experiences in depth. The analysis process (Figure 2) began with familiarization, during which all audio recordings were transcribed into NVivo software. Transcriptions were conducted in Malay, with translations into English done concurrently to ensure the accuracy and cultural nuances of the data were preserved.
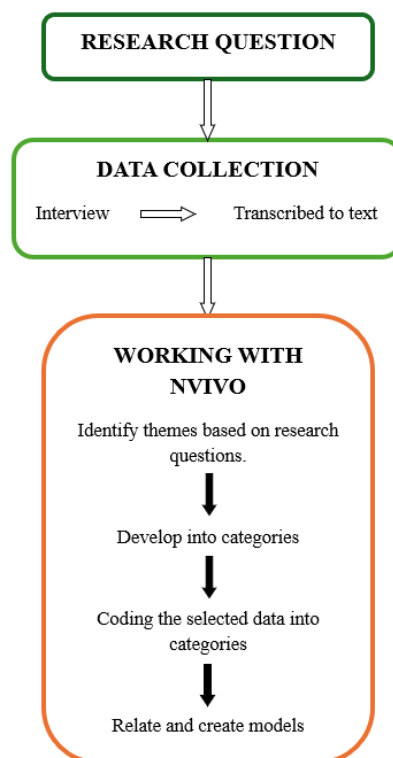

Figure 2.
Qualitative Data Analysis using NVivo.

The researcher carefully read and re-read the transcripts to gain an initial understanding of the content and context. Next, the coding process was initiated. Key phrases, concepts, and ideas were identified and systematically coded into meaningful units. These codes were then grouped into broader categories, which reflected recurring patterns and significant themes within the data. The researcher iteratively refined the categories to ensure they accurately represented the participants' responses. Themes were developed inductively, drawn directly from the data, and reviewed for consistency and coherence. Each theme was defined and named to encapsulate its essence and contribution to the research objectives.

This thematic analysis approach provides a robust framework for uncovering the underlying dynamics and issues within

the restaurant workplace, ensuring the findings are both meaningful and grounded in the data.

3. Results and Discussion

The interviews with restaurant managers and workers in the five districts of Selangor reveal several key themes surrounding food waste management practices, supported by thematic analysis. These themes include food waste reduction strategies, recycling and composting, inventory management, the use of technology, and the role of social programs.

Restaurant workers' input can be invaluable in identifying inefficiencies and developing practical strategies for reducing food waste, yet many establishments underutilize this resource [14]. Restaurant managers play a critical role in fostering a culture of sustainability, wherein they must not only implement food waste management systems but also ensure ongoing compliance by workers through training and accountability measures [15].

Table 1.
Descriptive characteristics of participants (*N*=10).

No.	Job Title	Gender	Restaurant Code	Years in F&B	Types of cuisine
1	Manager	Male	R1	3 years	Buffet & Ala Carte
2	Worker	Male	R1	2 years	Buffet & Ala Carte
3	Manager	Female	R2	3 – 4 years	Buffet & Ala Carte
4	Worker	Female	R2	2-3 years	Buffet & Ala Carte
5	Manager	Female	R3	8 years	Ala Carte
6	Worker	Female	R3	2 years	Ala Carte
7	Manager	Male	R4	15 years	Buffet & Ala Carte
8	Worker	Male	R4	3 years	Buffet & Ala Carte
9	Manager	Male	R5	3 years	Buffet & Ala Carte
10	Worker	Female	R5	3 years	Buffet & Ala Carte

Table 1 features a diverse group of participants, including both male and female managers and workers with varying levels of experience in the food and beverage industry, ranging from 2 to 15 years. Except for two managers and one employee who specialize solely in à la carte service, all participants work in restaurants that serve both buffet and à la carte cuisine.

Table 2.
Main themes, sub themes and quoted texts.

Theme	Subtheme	Quoted Text
1. Food Waste Reduction Strategies	Using an Inventory System	"Conduct stock inventory to track incoming and outgoing goods. Use the inventory to forecast upcoming operating costs. Promote food innovations such as meatballs and burgers to prevent food waste." (R1)
	Recycling (3R Method)	"We do use the 3R method. Our food waste is placed in a separate trash bin, and another team will compost the food waste to be turned into fertilizer and other products." (R4)
		"Banana peels are used as feed for livestock (goats), while solid waste is collected, resold, or recycled (milk tins, drink cups, plastics, paper bags). Liquid waste is packed and disposed of in the trash bin. Trucks will go to each area to collect the waste and take it to recycling centres." (R3)
		"Used oil is separated, and other waste is placed in recycling bins." (R1)
		"Separate dry and wet food waste before disposing of it in the trash bin." (R5)
		"Separate waste into food waste, solid waste, and liquid waste." (R3)
		"Wet food stock is bought daily to avoid wastage, while dry stock is updated with the restaurant owner if it is running low." (R2)

	Separating Wet and Dry Food Waste	"Wet food stock is bought in different quantities on weekdays and weekends due to varying customer numbers." (R5) "Reduce the quantity of raw or dry ingredients to prevent excess." (R3)
	Purchasing Wet Goods According to Needs	"For meat waste, we innovate by creating new food products like meatballs and burgers to sell to customers." (R1) "Food is made on the spot according to customer orders." (R2) "Food is made on the spot according to customer orders." (R4)
	Menu Innovation	
	Preparing Food Based on Real-Time Orders	
2. Recycling and composting practices	Recycling	"Collect recyclable waste." (R3)
	Using a Decomposition System	"We are almost zero waste because all our food waste is composted and reused as fertilizer. We use composting machines and insects like black soldier flies and worms." (R4)
	Staff Training or Emphasis	"Yes, there is training for one to two weeks before employees take on any specific role." (R1) "Yes, there is food handling training". (R3&R4)
	Monitoring Food Waste Management	"Monitoring is done daily based on the percentage of wastage and sales." (R1)
3. Technology Integration	Inventory System	"We rely on inventory to identify food expiration dates." (R1)
	Food Waste Decomposition System	"We are almost zero waste because all food waste is composted and reused as fertilizer. We use composting machines and insects like black soldier flies and worms." (R4)
	Using Applications	"We use the 'Didan' app and Microsoft Teams to track orders and compare them with inventory." (R1)
	Setting Benchmarks	"We make more organized food stock purchases to avoid overbuying." (R3) "The inventory system aims to keep wastage below 40%, specifically 39% and under." (R1)
4. Social and Humanitarian Programs	Awareness Programs	"We have a program where, when students attend, we discuss and raise awareness about the process of food

	Feeding Animals with Food Waste	waste decomposition. We see this program having a positive impact on students." (R4) "We give food waste to stray animals." (R5)
	Supporting the Community	"We make efforts to ensure customers finish their food before ordering more." (R1) "We advise the public to develop skills in food management to reduce waste and food disposal." (R3) "Collaborate with 'TetraPark' to recycle sold milk cartons." (R4)
5. Challenges and Suggestions for Improvement	Customers	"The challenges arise from customers purchasing more food than necessary." (R3) "The main challenge is the varying number of customers daily." (R3) "Food does not always meet customer tastes, leading to unfinished meals." (R2)
	Lack of Employees	
	Staff	"Employee shortages are a major challenge. (R4) We need more staff to clean up food waste left by customers." (R5)
	Innovating New Menu Items	"Challenges also arise from staff when they prepare more food than ordered." (R1
	Providing Pre-Set Menu Options	"My suggestion is to innovate new food items from other types of food waste." (R3)
	Setting Food Portion Sizes	"Offer set menu options to customers." (R5)
	Retort Process	"Serve rice in appropriate portions on the customer's plate." (R5) "Encourage staff to prepare food in correct portions to avoid wastage." (R4) "Limit the use of large bowls for dipping sauces." (R1) "A suggestion to further reduce food waste is to use the retort process." (R1

Table 2 highlights key themes and strategies related to food waste management, including food waste reduction methods, recycling practices, technological integration, social programs, and the challenges faced by restaurant professionals. It provides detailed subthemes such as inventory systems, separating wet and dry waste, composting, and innovative menu creation, supported by direct quotes from participants. These insights emphasize practical approaches like real-time food preparation, the 3R method (reduce, reuse, recycle), and staff training, while also addressing challenges like fluctuating customer demand and employee shortages. The text also underscores the role of technology and community engagement in fostering sustainable food waste management practices.

3.1. Food Waste Reduction Strategies

The findings indicate that most restaurants have adopted various methods to minimize food waste. For instance, several restaurants focus on stock management by purchasing fresh ingredients in smaller quantities and monitoring inventory to reduce over-ordering. This practice is particularly common in establishments like R2, where stocks of perishable items are updated daily to avoid wastage. Some restaurants also practice "just-in-time" food preparation, where meals are only cooked when an order is placed, as seen at R4. This real-time preparation approach helps reduce both food spoilage and the risk of over-preparing food items, particularly during off-peak hours. An effective management system can help to reduce the generation of food waste as much as possible and lower the cost of operating [16].

Restaurants have also begun innovating by repurposing food waste into new products. For example, surplus meat is converted into meatballs and burgers at R1, providing a creative solution to reducing wastage. Such innovations not only reduce waste but also contribute to business profitability by offering customers new menu options, aligning with the findings that innovative menu planning can mitigate food waste [14]. Initiatives aimed at improving food waste reuse patterns, such as reusing leftovers, can have a significant impact on reducing food waste, even though food expenditures also hold considerable potential for waste reduction [17]. Previous studies support this conclusion, suggesting that practices like

freezing leftovers and enhancing cooking skills can effectively reduce food-waste behavior [18, 19].
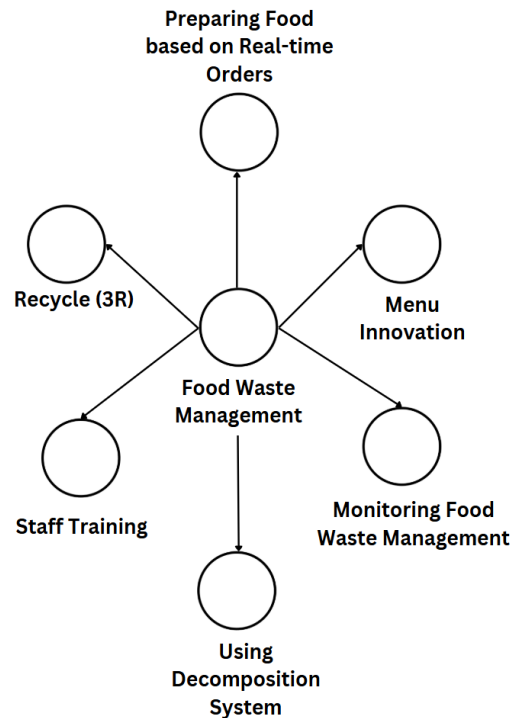

Figure 3.
Framework of food waste reduction.

This NVivo framework (Figure 3) emphasizes waste reduction through actionable strategies such as preparing food based on real-time orders and monitoring food waste levels. Additional practices, including staff training, menu innovation, and using decomposition systems, further support waste minimization. Recycling plays a central role in this framework, ensuring a sustainable and environmentally friendly approach to managing waste.

3.2. Recycling and Composting Practices

Recycling remains a core component of the restaurants' waste management strategies, with many establishments separating food waste for reuse or recycling. For example, R4 and R3 both recycle food waste by composting or using it as animal feed. These practices are indicative of a broader commitment to sustainability, with one restaurant manager mentioning the use of composting technology to achieve near-zero waste. The results echo prior studies suggesting that composting and recycling can significantly reduce food waste sent to landfills [20].

Composting is more environmentally friendly and cost-effective to landfilling and incineration. Composting is a biological process that converts organic waste into valuable products of compost, which can then be used to improve soil fertility [21]. Composting can be done with two types of waste: domestic waste, which comes from cafeterias, dormitories, faculties, office buildings, and other centers, and landscape waste, which is the end product of landscape activities within the campus, such as tree trimming, grass cutting, dried leaf collection, and others [22]. Mostly, 'Green Campus' uses the composting alternative. The composting method is primarily used to manage organic waste, which constitutes the largest portion of waste in the overall waste composition. Additionally, recovering recyclable materials directly at the source is a crucial approach to educating the public and reducing the amount of waste sent for disposal [23].
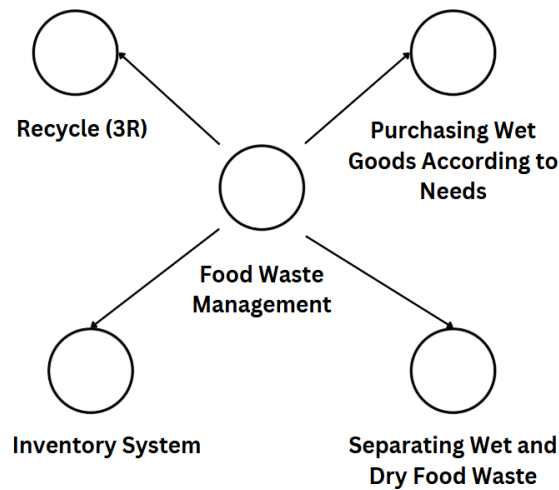
Figure 4.
Food waste management framework.

This framework (Figure 4) from NVivo outlines essential practices for effective food waste management, including recycling, separating wet and dry food waste, and utilizing inventory systems. Purchasing wet goods based on actual needs is highlighted as a preventive measure to reduce unnecessary waste. Together, these strategies form a structured and efficient approach to minimizing food waste.

3.3. Technology Integration

Although technology plays a role in food waste reduction, the integration of advanced technological solutions remains limited. The use of inventory management systems is highlighted in the interviews, with R1 relying on these systems to track food expiration dates and forecast stock needs. However, other establishments noted the lack of such tools, indicating a need for wider adoption of technologies like real-time inventory monitoring and decomposition machines, which can reduce waste more effectively [15].
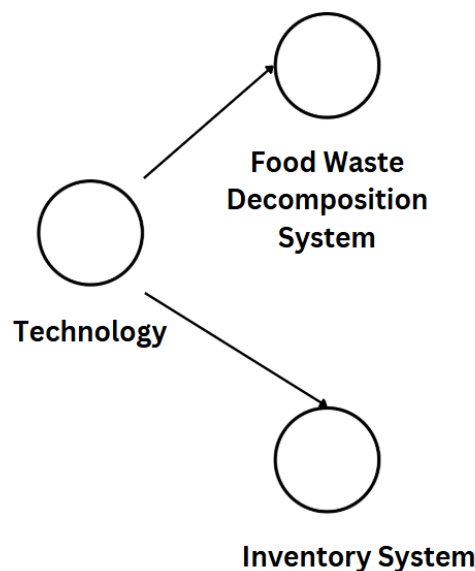

Figure 5.
Framework of technology in food waste management.

This framework (Figure 5), created in NVivo, illustrates the relationship between "Technology" and its child nodes: the "Food Waste Decomposition System" and the "Inventory System." It represents how technology serves as the backbone for effective food waste management and resource tracking. The decomposition system focuses on reducing waste impact, while the inventory system ensures efficient resource utilization and accountability.

3.4. Social and Humanitarian Initiatives

Another emerging theme is the involvement of restaurants in social initiatives. The findings show that while some restaurants are not yet actively participating in community programs to reduce food waste, there is potential for future engagement. For example, R4 collaborates with community programs that promote recycling and environmental education. Expanding such efforts could further strengthen the role of restaurants in promoting sustainable practices beyond their immediate operations. Some restaurants have begun engaging with local social programs, donating excess food to charities or participating in community-driven sustainability initiatives. However, this practice is not widespread, and there is potential for more restaurants in Selangor to engage in such activities.
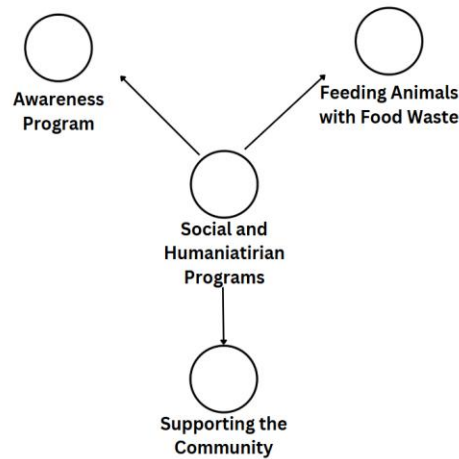
Figure 6.
Social and humanitarian programs framework.

This NVivo framework (Figure 6) visualizes "Social and Humanitarian Programs" as the central node, with child nodes focusing on specific initiatives: "Awareness Programs," "Feeding Animals with Food Waste," and "Supporting the Community." It highlights a socially conscious approach by repurposing waste, raising awareness, and directly engaging with the community to address broader societal challenges.

3.5. Challenges and Suggestions for Improvement

Despite the efforts to reduce food waste, challenges such as fluctuating customer demand and labor shortages persist. Some restaurants face difficulties forecasting the number of customers, leading to over-preparation, which ultimately results in waste. The thematic analysis further emphasizes this issue, noting that many establishments lack effective menu and stock synchronization, exacerbating food waste.

To address these challenges, the interviewees suggested several potential improvements, including increasing public awareness through social programs and enhancing portion control. For example, some restaurants have introduced portion control strategies, such as limiting the use of large bowls for sauces. These measures not only help reduce food waste but also encourage more sustainable consumption patterns among customers.

Training programs for staff are reported as another critical element in waste management strategies [22]. Several restaurants provide food handling courses to workers, ensuring they are equipped with the knowledge necessary to minimize waste during preparation and service. This is consistent with prior research, which suggests that effective training can improve compliance with food waste management practices and reduce the overall volume of waste produced by restaurants.
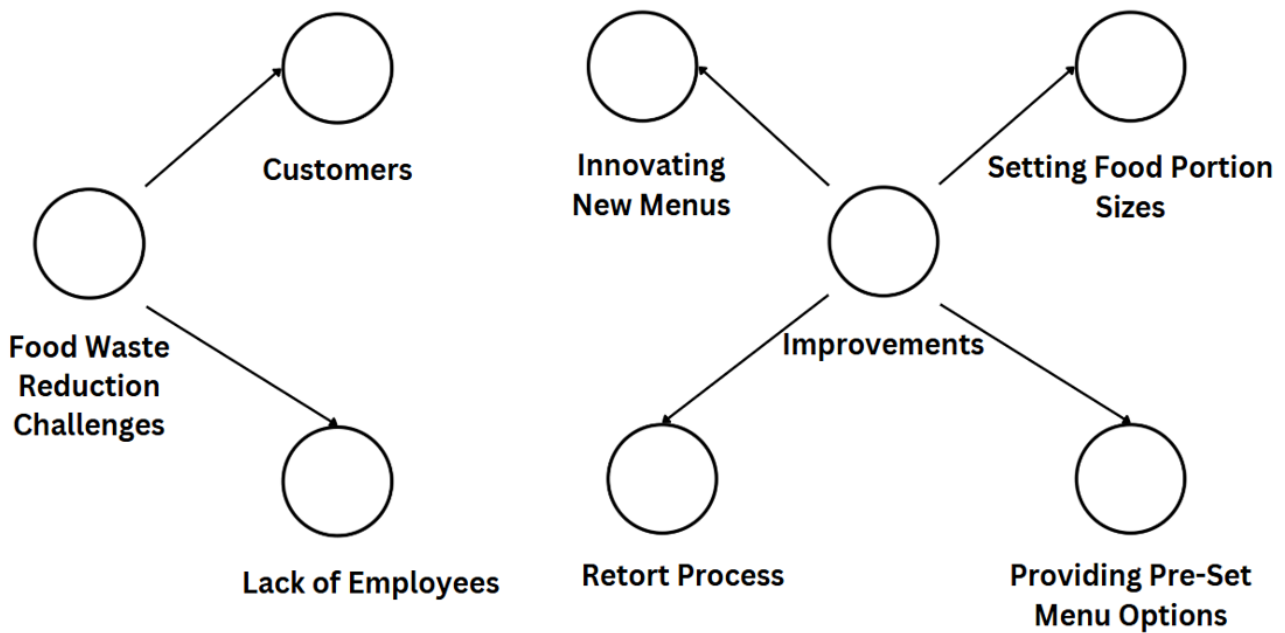
Figure 7.
Challenges and improvements in food waste management.

This NVivo framework (Figure 7) identifies key challenges in reducing food waste, including customer behavior and a lack of sufficient employees. Customers significantly influence waste levels through their preferences and demands, while workforce shortages pose barriers to implementing effective strategies. Overcoming these challenges is vital for the success of food waste reduction efforts. Meanwhile, the NVivo framework (Figure 7) outlines "Improvements" as the core category, linking it to four actionable initiatives: "Providing Pre-Set Menu Options," "Setting Food Portion Sizes," "Innovating New Menu Items," and "Retort Process." The framework emphasizes improving operational processes and customer satisfaction while reducing waste, showing how targeted enhancements can contribute to sustainability and efficiency.

According to Figure 8, minimizing food waste in restaurants requires the use of techniques including just-in-time meal preparation, repurposing leftover products, and implementing sophisticated inventory systems. Composting and recycling methods, when combined with technology like decomposition machines, support sustainability objectives and lessen their negative effects on the environment [24]. Raising public awareness and working with community programs can also help advance sustainable practices while tackling practical issues like labor shortages and varying demand. However, as highlighted by Mahamod et al. [25] in their study on urban park facilities, there exists a significant gap between the public's awareness of recycling campaigns and their actual recycling behavior. This disparity highlights the need for more effective strategies and infrastructural support to minimize the gap.

Figure 8.
Infographic of the food waste management strategies.

4. Conclusion

Overall, the thematic analysis of the interview findings indicates that while restaurants in Selangor have made significant progress in reducing food waste, several areas still need improvement. The adoption of inventory management systems, real-time food preparation, menu innovation, and recycling practices has all contributed positively to waste reduction. However, gaps remain in the integration of technology, staff training, and greater involvement in social programs.

By addressing these gaps, particularly in the areas of technological integration, staff education, and broader community engagement, the restaurant sector in Selangor can play a more substantial role in mitigating food waste. This would not only contribute to the sustainability of the local food system but also align with broader global efforts to reduce waste and promote more sustainable practices in the food industry.

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