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Managing Food Waste: A Thematic Study on Restaurants of Dhaka city

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ABSTRACT
Food waste represents a significant challenge within Bangladesh's food and hospitality industry and globally. Effective prevention strategies and technological management approaches are essential to maintaining food quality and enhancing the economic performance of the hospitality sector. The research aims to identify the most effective prevention and technological management practices. The research used 12 semi-structured interviews and thematic analysis, relying on deductive techniques to generate thematic content. The findings reveal several causes and stages contributing to food waste, with the highest levels observed during preparation and cleaning, as well as from leftover food on guests' plates. Recovery strategies and technological interventions, such as freezing and cooling systems, vacuum machines, intelligent packaging solutions, and other management tools, were identified as effective in mitigating food waste. Future research in food waste management will be necessary to identify and collect data and to develop operational recommendations, advancing sustainability and operational efficiency in the hospitality sector.

KEYWORDS: Food Waste, Hospitality Industry, Restaurants, Waste Management

1. Introduction

The tourism industry in Bangladesh is undergoing significant growth, presenting considerable potential to contribute to foreign exchange earnings. The hotel and tourism industries are intrinsically linked, with the expansion of hotels often reflecting broader economic development trends (Aditya & Kurniawati, 2023). However, alongside its economic contributions, the hotel sector is a significant source of waste generation and environmental degradation (Puspitayanti et al., 2024). Among the challenges faced, food waste stands

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out as a critical issue. Recognizing the gravity of the problem, the European Union has identified food waste reduction as a key sustainable development goal in its 2030 agenda (Lee & Huang, 2023). Digital transformation, which entails integrating technology into all organizational processes, offers promising opportunities to address these challenges by enhancing operational efficiency, collaboration, and client service (I'm et al., 2024). Leveraging technological solutions in the hospitality sector can effectively mitigate food waste, improve sustainability, and foster long-term economic and environmental benefits.

Food waste encompasses edible food discarded, spoiled, or otherwise rendered unsuitable for consumption (FAO, 2013). The hospitality sector is a substantial contributor to this issue, with the Food and Agriculture Organization (FAO) estimating that over one-third of food globally is lost or wasted annually (FAO, 2019). Effective management of food disposal systems is essential for environmental sustainability, cost reduction, and regulatory compliance (Singh et al., 2024). This study focuses on using digital technologies to mitigate food waste within the hotel and restaurant sectors in Bangladesh. It examines the sources and stages of food waste generation while providing an overview of the food and beverage sector in the hospitality industry. Innovative technological solutions, such as intelligent kitchen devices, real-time inventory management systems, and waste conversion strategies like composting, are explored for their potential to minimize food waste. These advancements address environmental concerns and improve operational efficiency, aligning with global sustainability goals in the hotel industry to ensure responsible business practices.

1.1 Background of study

This study examines how restaurants within the food and beverage sector utilize advanced technologies to address post-consumption food waste. It highlights the critical need for effective waste management from the guests' perspective, as improper handling of food waste can have adverse environmental consequences (Samsuddin et al., 2022). The food service industry has undergone significant evolution, incorporating innovations in food preparation and presentation. Its roots can trace back to the Sumerian period around 3000 BC. The sector projects to outpace other industries in growth over the next decade, driven by emerging technologies such as contactless service systems and QR code menus that redefine the future of food services (History of The Food Service Industry, 2024).

Despite these advancements, food waste remains a pressing sustainability issue, particularly within the hotel industry, where more than 12% of food has been wasted in recent years (Tostivint et al., 2016). Research on food waste in the hospitality sector is fragmented and limited, especially in developing nations (Kattiyapornpong et al., 2023). Food waste occurs throughout different stages of supply chain development which requires efficient waste reduction strategies for production sites and consumer viewpoints ("Food Waste," 2024). Technological solutions, such as automated inventory management systems and kitchen display technologies, offer significant potential to minimize food waste and enhance restaurant efficiency (RTN Editors, 2023). These innovations are critical for addressing sustainability challenges in the hospitality industry and ensuring long-term resource efficiency. Theories underpinning the research can inform the design of questions to explore specific constructs or relationships. Moreover, using the Theory of Planned Behavior may lead to questions about attitudes, perceived behavioral control, and social norms related to waste management.

1.2. Research Gap

The study explores digital technology usage for minimizing food waste in hotel restaurants while examining a field that receives limited academic attention in Bangladesh. While numerous qualitative and quantitative studies have conducted on food waste reduction and its environmental and economic implications in countries such as the Netherlands, Taiwan, Brazil, Indonesia, Thailand, Sweden, India, and the USA, limited research exists on the technological approaches to food waste management in Bangladesh. Researchers in Bangladesh have developed multiple studies to analyze both environmental effects and economic outcomes of food waste throughout the service sector. Research needs additional development to assess how technology can reduce food waste through quantitative and statistical evaluations of these sectors. The research tackles this knowledge gap by studying technology systems to manage sustainable food waste in Bangladesh's hospitality sector.

2. Literature Review

2.1 Food Loss and Waste (FLW) Definitions and Context

Food Loss and Waste (FLW) concepts are interrelated yet defined differently by various international organizations and national bodies. According to the FAO (2011), food loss refers to a reduction in the quantity or quality of food within the supply chain, typically occurring during production, post-harvest, and processing stages (Parfitt et al., 2010). Food waste, in contrast, encompasses edible food discarded due to surplus production, unsold items, or leftovers, often resulting from over-purchasing or inadequate storage practices (CalRecycle, 2009; Kusumah et al., 2024).

Key drivers include overproduction, stringent quality standards, consumer behavior, spoilage, and expiration (Kasavan et al., 2022; Hanis & Fernando, 2024). Food waste is further categorized as avoidable (e.g., consumable food discarded unnecessarily), unavoidable (e.g., rinds and bones), and potentially avoidable (e.g., potato peels depending on the context) (Bhajan et al., 2022). The effective management of food waste in luxury hotel restaurants necessitates integrating various technological tools, strategic processes, and organizational practices. Recent research suggests that while operational practices play a crucial role, addressing food waste solely from the perspective of staff behaviors and perceptions towards the food waste hierarchy is insufficient (Chawla et al., 2024). The applicability of specific waste management methods in high-end hospitality settings remains a critical issue, as some strategies may not align with the operational dynamics of luxury hotels, potentially creating implementation challenges.

One of the primary obstacles to food waste reduction within luxury hotel restaurants is the need to balance practical and theoretical approaches. Identifying various types of food waste and understanding their root causes is integral to developing effective waste management strategies (Tuan et al., 2024). Tuan et al. (2024) explored cost-control systems within Vietnamese hotel restaurants, emphasizing surplus food reuse and redistribution, particularly in response to the limited availability of donation banks and charities. Their study also underscored the potential for further research, highlighting gaps in existing case study-based theoretical frameworks.

Consumer behavior plays a pivotal role in food waste prevention to ensure the interrelationship among food waste reduction, sustainability, and the circular economy (Baybars et al., 2023). Using bibliometric analysis with R software, they identified emerging research trends related to food consumption, carbon footprint, and ecological impact, unlike previous studies that primarily focused on consumption patterns, the present research shifts towards a more holistic exploration of food waste management strategies in luxury hospitality settings. Öztürk et al. (2023) emphasized the significance of structured staff training programs, seminars, and operational guidelines in mitigating food waste within hotel restaurants. Their findings indicate that inefficient food preparation techniques, inadequate planning, and absent-minded personnel significantly contribute to food waste. Through semi-structured interviews, these studies identified key management approaches for enhancing operational efficiency and minimizing waste. Their study reinforces that a well-trained workforce, combined with effective policy interventions, is essential for implementing sustainable food waste management practices in the hospitality sector.

While technological interventions, consumer awareness, and regulatory measures remain integral to waste reduction, the success of such strategies hinges on their adaptability to the unique operational environment of high-end hospitality establishments. Further empirical research is needed to explore the effectiveness of these interventions, particularly in contexts where cultural, economic, and infrastructural factors influence waste management practices.

2.2 Waste Management and Sustainability

Effective waste management is essential for achieving environmental sustainability. Strategies such as categorising and recycling organic and inorganic waste, implementing buy-back policies, and using recyclable packaging have proven effective in mitigating food waste in hospitality settings (Puspitayanti et al., 2024). For instance, a Brazilian survey found that 60% of food waste occurs during meal consumption, with collective food services contributing 34% (Lins et al., 2021). On a global scale, UNEP (2021) reported that approximately 931 million tons of food—representing 17% of total available food—was wasted in 2019. Similarly, in North America, 170 million tons of food intended for human consumption is wasted annually, underscoring the urgency for effective consumer-level waste management (Commission for Environmental Cooperation, 2017). Within the hospitality sector, improper food waste management exacerbates environmental damage, highlighting the importance of sustainable practices (Kattiyapornpong et al., 2023).

There are two types of food waste in restaurants: customer-generated and kitchen-generated waste. Customer-generated waste accounts for approximately 30–35% of restaurant food waste, while kitchen-generated waste comprises 45–65%. These figures may vary depending on the restaurant's type and location. Customer-generated waste includes edible food left uneaten by patrons after their meals (Omari et al., 2023). Conversely, kitchen-generated waste arises during storage, preparation, and production processes, often due to overproduction, excessive cooking, inadequate storage, poor portioning, or preparation errors (O'Neill et al., 2024).

Several factors influence food waste generation in restaurants, particularly those related to consumer behavior. Socio-demographic, psychological, and psychographic characteristics play a role; for example, research indicates that females and frequent patrons tend to generate more food waste than males and infrequent diners (Vizzoto et al., 2021a). By exploring the underlying causes and adopting sustainable practices, the hospitality sector can significantly reduce food waste and its associated environmental and economic impacts.

Table 1: Categorizing food waste according to food commodities in restaurants

Commodities of Food Category	Included each Food Type as per Category
Dairy	Cheese, milk, yogurt, Ice cream and other dairy Goods
Fish and Seafood	Freshwater fish, Demersal fish, cephalopods, marine fish
Fruits	All kinds of fruits
Meat	Bovine meat, ovine meat, offal, and all other meat
Poultry	Poultry meat
Oils and fat	Olive oil, butter, and other vegetable oil,
Vegetables	All vegetables added with potatoes

Source: (Omari et al., 2023).

Table 1 has highlighted different food categories, including highly perishable and non-perishable items, high- and short-mileage food products, and solid and liquid food types, which are collected from the study of Omari et al. (2023). The FIFO (First In, First Out) method in storage and cooking processes plays a crucial role in managing these variations effectively.

2.3 Sources and Stages of Food Waste

The Food and Agriculture Organization reports that annual food waste reaches 1.3 billion tonnes worldwide, accounting for one-third of global food production (Gustavsson et al., 2011). Food waste (FW) arises from various sources, including food processing industries, agricultural activities, and commercial and household kitchens, as depicted in Figure 1 (Sharma et al., 2020; Saber et al., 2022; Sahoo et al., 2023).

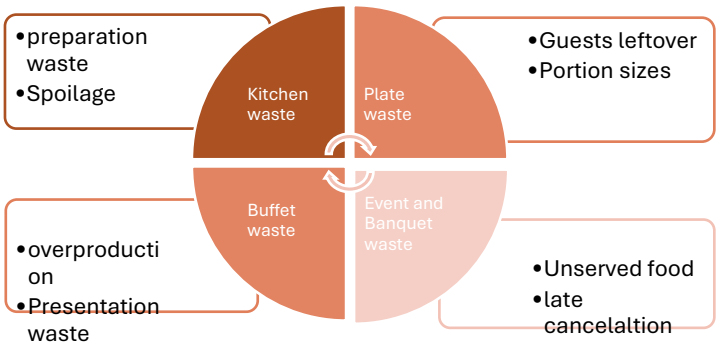

Figure 1: Sources of food waste (Sahoo et al., 2023)

The hospitality sector generates food waste through multiple sources and points throughout its operational process. Kitchen waste typically arises during food preparation and spoilage, often due to improper cooking or excessive storage. Guests produce plate waste because the food portions served are generally larger than what they can finish eating. Buffet waste stems from overproduction due to inaccurate demand forecasting, and from food presentation displays. Additionally, event and banquet services contribute to FW through unserved food or last-minute cancellations. Guest cancellations, often prompted by weather changes or unforeseen circumstances, further exacerbate the problem. The stages of food waste in the hospitality industry are summarized in table 2.

Table 2: The stages of food waste

Causes/ Stages of Food Waste	Details
Purchasing and storage stage	• Purchase high-perishable food • High mileage food • Non- perishable food
Food Preparation	• Preparation and cleaning process • Cooking process
Consumers	• Guests' leftover food • Lack of knowledge of ingredients and item
Menu planning	• Too many or too few • Too complex • Knowledge of ingredients
Promotion	• Promotion frequency • Forecasted guests
Unforeseen Factors	• Weather • Consumers value

Source: (Lee & Huang, 2023)

Minimizing food waste enhances sustainability in hotels while reducing operational costs. Three effective strategies to reduce food waste comprise supplying safe surplus food donations to charitable organizations together with portion control measures and recycling programs. According to Öztürk et al. (2023) and the Bio Intelligence Service (2010), several factors contribute to food waste in the food and beverage (F&B) sector. The lack of standardized portion sizes is a significant issue, often leading to excessive food waste. Logistic challenges, such as difficulty accurately estimating customer numbers, frequently result in overstocking. Cultural attitudes also play a role, with some practices, such as taking home leftovers, being less accepted in specific regions. Food waste awareness has a low base but rising steadily among people who are developing environmental knowledge. Additionally, meeting diverse consumer preferences, particularly in school cafeterias, presents a further challenge. The multicentred obstacles facing food waste management in the F&B industry reveal why specific actions must be developed.

2.4 Transformation and Stages of Technology to Reduce FW in Hotels

Many restaurants now leverage computerized POS systems for predictive analysis, utilizing the industry's simpler supply chains and shorter lead times than retail. These systems, combined with big data technologies, enable accurate forecasting of perishable product sales and optimized purchasing to meet consumer demand (Gómez-Talal et al., 2024). Artificial intelligence advancement and machine learning enhance predictive analytics ultimately improving food demand forecasting and reduction. Automation is transforming culinary operations, with robots in commercial kitchens increasing efficiency and ensuring consistent portion control. These innovations minimize overcooking, reduce overstock, and lower food waste (Gupta et al., 2022; Smith et al., 2023). Mobile applications also play a key role in waste mitigation, allowing restaurants to monitor inventory and offering consumers access to discounted surplus food items, thus reducing overall waste (Carter & Lee, 2022; Singh et al., 2024).

Recent technological strategies focus on advanced solutions such as IoT sensors for monitoring storage conditions, which provide real-time data on temperature and humidity to prevent spoilage (Santos et al., 2021; Sultana et al., 2024). Digital transformation in hospitality encompasses user-friendly tools that connect employees, guests, and management, enhancing accessibility and engagement. Other strategies include brand alignment with sustainability goals, social media campaigns to raise awareness, mobile apps for waste tracking, blockchain technology for process optimization, and content strategies like blog posts to educate guests about reducing food waste (Chowdhary, 2024). These innovations underscore the importance of digital tools in addressing the complex challenge of food waste in the hospitality industry.

2.5 The Relationship between Hospitality Industry's Food Waste and Technology

Technology significantly reduces food waste in the hospitality sector by facilitating more intelligent decision-making, tracking, and operational efficiency. This study examines various technological tools and methods to address food waste effectively (Martin-Rios et al., 2020). Procurement and waste tracking software, such as real-time inventory systems, alerts staff about products nearing expiration, while tools like Leanpath and Winnow identify high-waste categories (Kopanaki et al., 2021). Forecasting demand using machine learning helps predict guest counts, preventing overproduction, while menu optimization tracks less popular dishes to refine portion sizes and planning.

Innovative kitchen technologies, including automated portion control and AI-enabled storage, ensure consistent serving sizes and prevent spoilage by monitoring storage conditions (Fatimah et al., 2020). Surplus food apps like Too Good To Go and Olio enable waste reduction through redistribution, while food donation platforms facilitate the transfer of excess food to charities. Guest engagement systems, such as interactive ordering and buffet monitoring with AI cameras, reduce plate waste by guiding portion choices and monitoring consumption patterns. Automation in food preparation, such as robotic cooking systems, ensures precision in portioning, reducing

overproduction and improper cooking. The hospitality industry can reduce the environmental effects of food waste through sustainability improvements enabled by advanced technological implementations.

2.6 Theoretical underpinning

Using the Theory of Planned Behavior (TPB) in research on food waste management in hotels involves examining three core components—attitudes, perceived behavioral control, and social norms—that influence behavioral intentions and actions. TPB is a widely used psychological framework by Ajzen (1991) to predict and explain human behavior in specific contexts. This theory provides a robust framework for understanding and influencing behaviors by addressing psychological and contextual factors. In the hospitality industry, it can be a valuable tool for identifying barriers and facilitators of sustainable practices, such as food waste management, and for developing targeted strategies to promote behavioral change. The research questions developed from TPB enabled an understanding of food waste management by stressing individual attitudes towards behavior evaluation specifically for hotel food waste practices. Positive attitudes toward reducing food waste will likely enhance the intention to adopt sustainable practices. This research investigates both hoteliers' behavioral attitudes and societal pressures regarding performance of the subject behavior. These can include influences from colleagues, management, and broader industry standards.

By combining these components, researchers have used TPB to design an interview guide to identify the factors influencing hotel food waste management behaviors. TPB has also allowed researchers to evaluate the gaps between behavioral intentions and actual practices in food waste management. The researchers developed particular interventions which include worker training alongside policy changes combined with technological assistance to eliminate wellness program obstacles. Finally, assessing how social and organizational influences shape the adoption of sustainable practices has been easier for researchers in this current study.

3. Research Model

This study explores how the food and beverage sector at Pan Pacific Sonargaon Dhaka can leverage digital technologies to mitigate food waste. The specific objectives are as follows:

- To analyse food waste management practices in hotel restaurants, focusing on the impacts of food waste and the strategies employed to address different types of waste.
- To explore the role of digital transformation in reducing food waste within the hotel’s food and beverage operations.
- To assess hoteliers' attitudes and social norms, examining their influence on the relationship between restaurants and food waste.

The research relies on a phenomenological design to examine how participants experience food waste management tools including food waste apps and smart kitchen devices as a means to reduce hotel food waste.

3.1 Employing Semi-Structured Interviews for Data Collection: A Methodological Framework

This study utilizes semi-structured interviews as the primary method for data collection, chosen for their inherent flexibility and ability to facilitate an in-depth exploration of participants' perspectives (Filimonau et al., 2020). Semi-structured questions allow researchers to investigate interviewees' responses comprehensively while providing the adaptability needed to address emerging themes and observations, such as kitchen operations and waste management practices (Jones et al., 2013). The semi-structured approach combines structured and unstructured interviews, enabling researchers to delve deeply into participants' thoughts and experiences regarding food waste reduction through technological applications and devices in hotel restaurants and kitchens (Sobaih, 2023).

This method granted the researcher direct access to hotel restaurants and kitchens, facilitating a close examination of food waste management practices in a real-world context. Staff members at the hotel assisted with interviews while providing important information and relevant data and documentation. Primary data sources included direct observations of kitchen operations, staff activities, and restaurant services, alongside analyzes of interview transcripts and on-site documentation. Secondary data sources such as research articles, newspapers, blogs, webpages, magazines, and review papers complemented the primary data, enriching the research with additional context and supporting evidence.

The researcher observed key processes along the food management continuum, including food receiving, storage, preparation, menu planning, cooking, serving, and post-service activities. The focus was on tracking points where food waste occurred and how restaurants discarded waste as well as their waste management techniques during mealtimes. It involved quantifying food waste percentages across categories such as raw foods, vegetables, and dairy, and identifying contributing factors such as improper or overcooking (Wang et al., 2017).

3.2 Developing Semi-Structured Interview Questions

The formulation of semi-structured interview questions by a systematic process involving theoretical frameworks, literature reviews, research objectives, and practical considerations. Several studies conducted by Sobaih (2023), Fatimah et al., (2020), and Wang et al., (2017) about food waste practices in the hospitality industry provided the basis for developing restaurant operators' questions which revealed common elements regarding operational challenges and digital technology adoption. This approach ensured that the questions aligned with the study's objectives, providing a robust framework for data collection.

The interview questions cover three key segments. For instance, the demographic profile that has gathered participant details, including age, gender, role, and work experience. Additionally, the current study highlighted the food waste causes, sources, and stages by exploring the reasons behind food waste, its origins, and the processes contributing to it. Lastly, the guidelines and possible trends have been explored to identify the strategies and technological interventions for managing food waste.

3.3 Study Context and Participant Selection

The study conducted semi-structured interviews with 12 participants from Pan Pacific Sonargaon Dhaka (PPSD) during their official working hours. Data saturation occurs when no new information or themes emerge during data collection, and additional data cease to provide new insights or enhance understanding of the research topic.

Then, the participants were assigned unique codes (e.g., "P1," "P2") linked to the hotel name to maintain confidentiality. The demographic profiles of some selected participants, as outlined in Table 3, include age, gender, designation, work experience, and departmental affiliation. This diversity in participant backgrounds ensured a comprehensive understanding of food waste management practices within the hotel's food and beverage sector.

Table 3: Demographic Profile of Some Participants

Code	Age	Gender	Designation	Work Experiences	Methods
P1	48	Male	Director of F&B	25	Interview
P2	36	Male	Senior Catering Manager	15	Interview
P3	32	Male	Assistant Catering Manager & Brand Ambassador	7	Interview, Observation
P4	38	Male	Sous Chef-Indian Cuisine	14	Interview
P5	34	Male	Assistant Sous Chef	10	Interview, Observation
P6	30	Male	Sales Officer	8	Interview

Source: Respondent Profile

3.4 Data Collection and Analysis

An additional analysis technique involved thematic qualitative methods as a supplement to observations and interviews. This approach allowed the researcher to systematically identify, analyze, and interpret patterns in the collected data. The thematic analysis enabled the extraction of key insights related to the causes of food waste, the effectiveness of technological interventions, and potential areas for improvement. Document analysis served as a part of the interview procedure where the researcher requested daily food waste reports from both head and sous chefs.

By combining qualitative insights with empirical observations, this study contributes to the growing body of literature on sustainable food waste management in the hospitality sector, providing actionable recommendations for adopting digital technologies to reduce waste. These findings offer valuable implications for both academic researchers and industry practitioners seeking to enhance sustainability in hotel operations.

The researcher conducted interviews between December 15th and 30th 2024 which corresponded with the busiest time for the hospitality sector. Each interview commenced with the participants

introducing themselves and sharing their experiences related to food waste in the hospitality industry. The sessions concluded with discussions on potential future trends for mitigating food waste. The interviews stretched from 40 to 45 minutes in duration for direct meetings with both service personnel and chefs. Researchers made audio recordings during the sessions for later transcription which led to coded analysis. The interview questions aimed to address the research problem and objectives, focusing on the following:

1. *What are the causes of food waste in the hospitality industry?*
2. *How do hotel staff perceive the importance of food waste management in reducing operational costs and environmental impacts?*
3. *What food items get discarded the most often in this hotel facility?*
4. *What technological equipment does this hotel use to reduce food waste?*
5. *What systems and procedures at PPSD should be modified to decrease food waste?*
6. *What are the challenges of managing food waste in the hospitality industry?*
7. *What programs does the hotel supply its workforce to handle food waste properly?*
8. *How do industry benchmarks or guidelines influence food waste management practices in hotels?*

3.5 Data Analysis Methods

The data analysis in this study employed a thematic qualitative deductive approach, leveraging pre-set codes to systematically identify, analyze, and interpret the interview data. The interviewer used this methodology because it provided flexibility while reaching deep levels of meaning in participant responses. Through qualitative methods analysis, the researcher achieved direct alignment between study goals and research inquiries.

The thematic analysis provided a structured framework for processing the interview data (Braun and Clarke, 2006). Pre-set codes, informed by the literature and research objectives, were applied to categorize the data into themes. These codes facilitated the identification of patterns and key insights related to food waste management practices, technological interventions, and associated challenges in the hospitality industry.

The thematic approach offered several advantages, such as the depth of understanding in capturing the complexities of participants' perspectives and experiences. Secondly, it offered flexibility in refining codes and themes as new insights emerged during the analysis. Lastly, it helped to achieve relevance by focusing on pre-set codes, the analysis remained closely aligned with the research objectives, ensuring that findings addressed the core issues under investigation.

3.6 Ensuring Trustworthiness

The study maintained principles of neutrality and avoidance of biases as described by Sandelowski (1986) to guarantee analysis trustworthiness. The following research-based measures determined the study's trustworthiness:

1. Separate Coding: The interview transcripts were independently reviewed and coded by researchers with academic and professional expertise. This step minimized the risk of subjective interpretation and enhanced the reliability of the findings.
2. Contrast and Consolidation: The independently coded data identified inconsistencies or overlaps. This iterative process allowed for the refinement of themes and ensured that the final findings were comprehensive and robust.
3. Clarity: The investigation process received detailed documentation beginning with categorization at the start until theme development completion to increase the analysis credibility.

4. Analysis Findings and Discussions

4.1 Examining Food Waste Reduction through Technology in the Hospitality Industry

This study examines food waste in the hospitality industry and explores the role of technology in addressing this global challenge. The chapter presents findings from the research methodology and analyzes the data about the study's objectives and existing literature. While various causes of food waste identification, key issues include inaccurate guest forecasting, improper purchasing practices, and limited knowledge of ingredient utilization. Based on previous research, this study focuses on the technological management of food waste at Pan Pacific Sonargaon Dhaka (PPSD).

The hotel utilizes advanced technologies such as vacuum machines, blast chillers, cooling systems, and freezing equipment to align food storage practices with waste prevention strategies. As a result, the study found that PPSD generates minimal food waste daily, demonstrating effective resource management. Table 4 shows the summary of food waste percentages that occurred during each day. The chapter concludes with recommendations to address challenges in food waste management, highlighting the critical role of integrating technology into hospitality operations to optimize waste reduction efforts.

Table 4: Percentage of daily food waste depending on food stages (Source: Fieldwork Data\ from Interview Participant).

Stages	Demonstrator	Percentage
Purchasing	High Perishable Food	0.5%
	High Mileage Food	No
Food Preparation	Preparation & Cleaning Improper & overcooking	15%-18% 0.5%
Consumers	Leftover on Plates	20%
	Lack of Knowledge of Ingredients	0.5% -less
Menu Planning	Too many or too few	No
Promotion Frequency	The number of walk-in guests depends on the day Weekend	0.5% No waste
Unavoidable Factors	Weather	0.5-less

The table presents the percentage of daily food waste during working hours, as reported by the Assistant Sous Chef of PPSD. At the procurement stage, only 0.5% of food is wasted, primarily due to high-perishability items and damaged or spoiled goods being rejected by purchasing staff. During the preparation and cleaning stage (e.g., peeling, chopping, and cutting), 15–18% of food waste occurs, categorised as unavoidable. Improper or overcooking results in just 0.5% of waste, as chefs use thermometers to ensure accurate cooking temperatures.

The most significant proportion of waste, approximately 20%, stems from leftover food on guests' plates, which is considered unavoidable. However, efforts help to minimize this by having service staff provide guests with detailed explanations of food preparation and cooking processes, helping them make informed choices. Additionally, during menu planning for Café Bazar, Pool Café, Lobby Lounge, and Jharna Grill in PPSD, unfamiliar items are excluded, resulting in no food waste. According to the Sous Chef of Indian Cuisine along with the Assistant Sous Chef and Senior Catering Manager, the total amount of excess food prepared beyond daily budget amounts to 5 percent because of forecasting inaccuracies in weather changes.

The Pareto chart shows how hospitality food waste divisions between different phases and waste origin points within the industry. The chart highlights the most significant causes, emphasizing the importance of addressing leftover food on plates and food preparation issues to maximize waste reduction efforts. The study employed Pareto analysis for its variables (tourists' comments) to identify future improvements for the Kelantan tourism sector according to Srfahani et al. (2016). The research adopts this principle and aims to investigate food waste groups and then examine their subsequent actions based on their levels of severity.

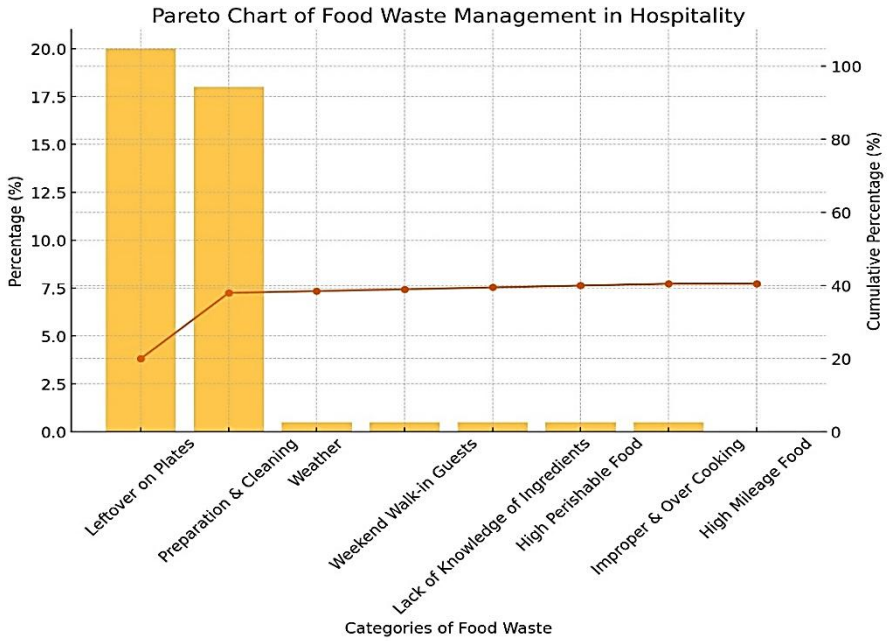

Figure 1: Pareto chart of food waste management in the hospitality sector

Following these findings, the chefs, Senior Catering Manager, and Director of F&B highlighted their use of a range of techniques and technologies to manage food waste, including FIFO (First In, First Out), blast chillers, ovens, and color-coding systems to detect food expiry dates. These methods demonstrate the positive impact of technology in mitigating food waste at PPSD. The outcomes of this study present original findings about technological food waste management systems because Bangladesh lacks research on this topic. Research findings boosted industry-wide comprehension about food waste management practices to create specific operational methods for boosting efficiency and sustainability. During research it was possible to identify both the behavioural and social norms and attitudes held by hoteliers regarding food waste.

4.2 Final Themes and Findings

The rigorous analytical process yielded a set of well-defined themes that provide valuable insights into food waste management in the hospitality sector. These themes include:

- Causes and Stages of Food Waste: Identification of critical points in the food supply chain contributing to waste.
- Behavioral and social norms towards food waste
- Technological Interventions: Evaluation of digital tools and processes for reducing food waste.
- Operational Challenges: A study explores the difficulties that prevent effective waste management strategy implementation.
- Best Practices: In addition to recommendations hotels should follow best practices to introduce sustainable practices in their food and beverage operations to enhance.

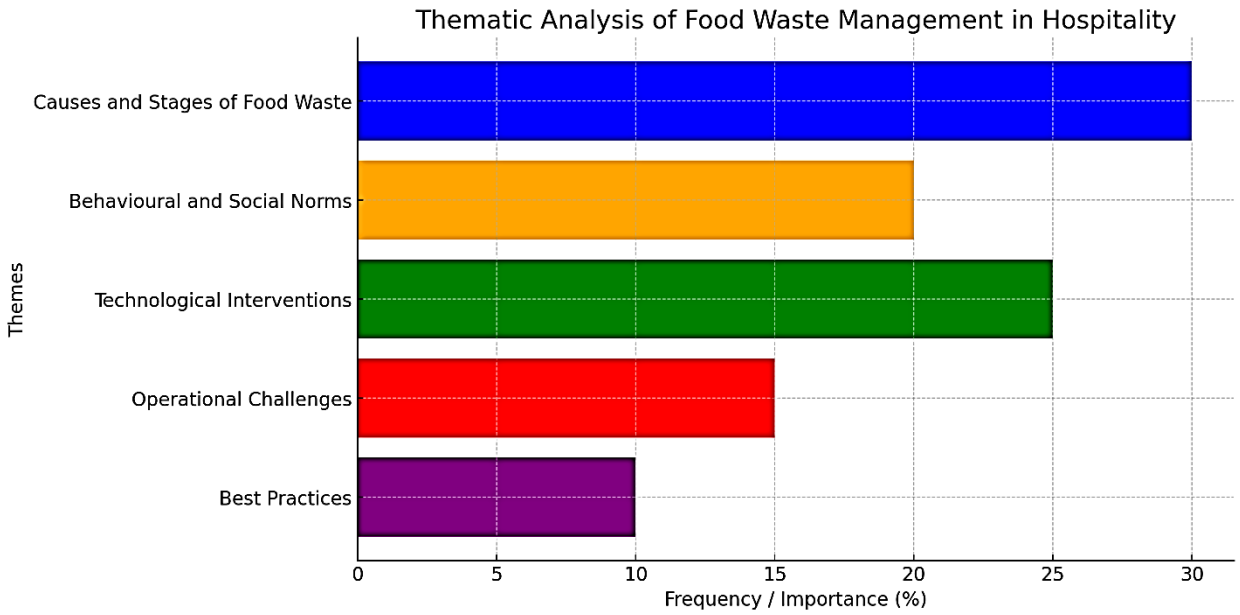

Figure 2: Food waste management: Key themes according to the responses of the participants

By adopting a systematic and transparent approach to thematic analysis, this study contributes credible and actionable insights into food waste mitigation strategies in the hospitality industry. The findings offer a foundation for future research and practical applications aimed at enhancing sustainability and operational efficiency.

4.3 Key Responses from Participants

- *"Food waste occurs during receiving and storage, preparation and cooking, menu planning, and as leftovers on guests' plates. The hotel spares minimal waste in dairy products, bakery goods and meat and seafood categories. Before products become expired the hotel provides them to their staff for consumption. (P2, P5).*

  The hotel actively implements measures to reduce waste by distributing surplus inventory to prevent expiration.

- *"Most waste arises during preparation (e.g., peeling, chopping, and cutting) and from leftovers on guests' plates. However, our food waste is lower than other hotels in Bangladesh due to preventive techniques."* (P3, P4, P5)
  According to the Assistant Chef preparation and leftovers combined generate a total of 35% of food waste in the workplace.

- *"We use intelligent packaging, vacuum machines, blast chillers, refrigerators with digital technology, and ultrasonic high-pressure equipment. The staff uses extra food items for waste management. (P5)*
  The hotel employs advanced technologies and surplus redistribution practices to mitigate food waste.

The study also identified challenges:

- *"There is a lack of public and employee awareness, insufficient government initiatives, limited training programs, unskilled manpower, and inadequate knowledge about food waste management and technological solutions."* (P1, P3)

- *The health and safety policies prohibit the donation of uneaten food from guest plates hence it gets served to staff members during their work hours. The remaining leftover food gets discarded. Working staff can consume leftover food as meals during their shifts while hospital management discards the remaining food.* (P1, P6)

Participants highlighted the need for systematic changes:

- *"We should introduce training programs twice yearly to improve staff competence and knowledge of food safety and health policies. It would help mitigate food waste through technological solutions."* (P1, P2)

This study contributes to the existing body of knowledge providing recommendations for Pan Pacific Sonargaon Dhaka to implement effective methods for managing food waste. It highlights persistent gaps in health regulations and staff training that require attention. Zainab Samsudin et al. (2022)

explored various technological and preventative strategies for addressing food waste, forming a foundation for the current research. The theoretical framework of this study builds on existing research, specifically the theory of TPB in the hospitality industry. This framework can be further applied in the current study by AI-Enabled Food Storage, by menu optimization that will help in tracking rarely ordered dishes and leftover items to guide portion adjustments and menu planning, along with standardizing the serving sizes, reducing plate waste in banquets and buffets. Moreover, by integrating emerging technologies and strategies, mainly focusing on observing customer behavior to mitigate food waste in hotel restaurants. The significant finding of this study based on the TPB theory is that it can guide the exploration of psychological and contextual factors influencing practices. Secondly, employees in the hospitality industry may feel motivated to engage in food waste management if they perceive their peers or supervisors value such practices. Food waste management attitudes of hotel managers show dependence on their beliefs about how reducing waste generates cost reduction alongside sustainability benefits.

4.4 Limitations and Future Research

This study found it challenging to go into five-star hotels to conduct observations and interviews, especially with high management staff including executive chefs, directors, and managers. Nevertheless, the study included several drawbacks. First, because of time constraints, only a few interviewees participated in this interactive session. Second, logistical issues prevented the researcher from visiting several hotels, such as time limits and transportation expenses. The research needs refinement through greater participant numbers and survey data collection methods to eliminate these present limitations. Research investigating technological approaches to food waste management remains absent throughout all available publications in Bangladesh. A quantitative study on this subject might offer thorough data analysis and insights, improving our knowledge of methods for reducing food waste.

5. Conclusion

Food waste management is a pressing issue with significant environmental and socio-economic implications. This study has identified technological approaches and strategies for addressing food waste, emphasizing the need for immediate and effective action to mitigate its impact on society. Different sources and development stages of food waste were identified in the research such as inadequate cooking methods and excessive food preparation along with mediocre portion sizes and unused food on guest plates as well as factors beyond control. Recommendations include public awareness campaigns, staff training programs, and adopting advanced technologies to minimize food waste.

The study underpinning the TPB demonstrates several technological and preventive measures to tackle food waste. These include reusing surplus food within two days of preparation, donating excess food to charities or food banks if quality standards are maintained, distributing surplus food among staff, and raising awareness through campaigns to educate customers, the public, and hotel employees about food waste management. The researcher also outlined several technological approaches for managing food waste

within the hospitality industry. By addressing the research questions comprehensively, this study provides valuable insights into strategies for reducing food waste in hotels and the wider hospitality sector.

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Conflicts of Interest

The authors declare no conflict of interest.

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