

A Qualitative Study on Food Waste Management in Food and Beverage Businesses: The Case of Beykoz District

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Article Info	Abstract
Received: 02.07.2026 Revised: 22.09.2026 Accepted: 23.09.2026 Published: 15.10.2026 Keywords: Gastronomy, Food Waste, Internet of Thing (IoT), Food and Beverage Industry, Sustainability. Jel Code: Z00 Corresponding Author: Nur ERTÜRK Research Article https://doi.org/10.5281/zenodo.23373367	Sustainability and food waste management have become central to the global agenda in response to the rapid depletion of natural resources and escalating environmental challenges. The food and beverage sector, in particular, constitutes a critical component of these discussions due to its intensive consumption of energy and water, as well as the substantial amounts of waste generated throughout production and consumption processes. The aim of this study is to conduct an in-depth qualitative analysis of food waste management practices within food and beverage establishments, alongside an examination of their potential for digital transformation. In this context, the study explores businesses' levels of awareness regarding waste management, their digital infrastructures, their engagement with smart technologies such as the Internet of Things (IoT), and their perceptions of sustainability. The research population comprises restaurants and cafés operating in the Beykoz district of Istanbul. Data were collected through semi-structured, face-to-face interviews conducted with the managers or owners of eight establishments selected via purposive sampling. The data obtained were analyzed using qualitative content analysis. The principal findings indicate that waste management practices within these establishments are generally confined to compliance with legal requirements and the implementation of ad hoc practical measures. Systematic approaches such as source separation of waste and technology-supported inventory management remain limited. Furthermore, the findings reveal a low level of awareness concerning digitalisation and IoT technologies, while cost pressures and operational intensity emerge as significant barriers to the adoption of sustainable practices. These results suggest that local authorities should develop incentive-based policies, organise targeted training programmes, and provide support for digital infrastructure in order to facilitate the transition towards sustainable and smart restaurant models within the sector.

Introduction

Within the global economy, the food service sector employing millions of people and providing daily meals to consumers also emerges as a significant source of food waste. According to the 2021 Food Waste Index Report published by the United Nations Environment Programme (UNEP), 61% of food waste occurs at the household level, 26% within the food service sector, and 13% in the retail sector (Yalçınkaya, 2025). It is estimated that global food waste amounts to 1.05 billion tonnes, of which approximately 20% originates from the food service sector (Kip, 2025). Data from the Food and Agriculture Organisation (FAO, 2016) indicate that the economic cost of food loss and waste in industrialised countries is approximately USD 680 billion annually, while in developing countries this figure reaches USD 310 billion. Across farm-to-table supply chains particularly in developed economies the proportion of edible food lost or wasted each year is estimated to correspond to approximately 30–50% of total global food production intended for human consumption. In the Turkish context, UNEP data suggest that approximately 7.7 million tonnes of food are wasted annually. The average annual household food waste per capita is estimated at 93 kg (Seçer et al., 2023). Furthermore, Tekiner et al. (2021) report that total annual food waste in Türkiye reaches approximately 26 million tonnes, with an estimated economic impact exceeding TRY 555 billion.

In studies examining the impact of waste management within the food service sector, food waste is commonly categorised into three types: preventable waste (food that could have been consumed prior to disposal), potentially preventable waste, and unavoidable waste (typically consisting of inedible components) (Papargyropoulou et al., 2014). Within restaurants and catering establishments, food waste has been found to occur most frequently during the production stage, which accounts for the highest volume of waste. This is primarily attributed to overproduction, improper portioning, and the use of inappropriate food preparation and processing techniques (Güner and Çirişlioğlu, 2021).

On the one hand, the persistent levels of waste within the food and beverage industry, and on the other, the ongoing crises of global hunger and food insecurity, increasingly constitute a paradox that countries are struggling to address. According to reports published in 2025, 8.2% of the global population experienced hunger in 2024 (WHO, 2025). However, the fact that trillions of dollars' worth of food are wasted globally each year an amount sufficient to feed 821 million people four times over underscores a critical contradiction

at the core of the United Nations 2030 Agenda for Sustainable Development and its Sustainable Development Goals (FAO, 2018). In this context, food waste management is not merely an economic issue, but also represents a profound social justice and humanitarian concern. Data from the United Nations Framework Convention on Climate Change (UNFCCC, 2024) indicate that food waste accounts for approximately 8–10% of global greenhouse gas emissions. Consequently, the world is confronted not only with a challenge as severe as hunger, but also with significant environmental degradation. A key driver of this climate impact is the accumulation of organic waste in landfills, where it generates methane emissions. Methane is the second most potent greenhouse gas after carbon dioxide and contributes significantly to global warming (Mar et al., 2022). In the specific case of Türkiye, the carbon footprint associated with waste in the food and beverage sector is estimated at approximately 2.3 million tonnes of CO₂ annually (Hastaoğlu, 2025). These figures suggest that achieving the Paris Agreement target of limiting global warming to 1.5–2°C will be extremely challenging, given that up to 10% of global greenhouse gas emissions are attributed to food loss and waste (World Resources Institute, 2025).

In today's food and beverage industry, which is increasingly difficult to manage through traditional methods, food waste primarily arises from losses during the preparation stage, operational inefficiencies such as inadequate storage, menu and portion planning errors, and plate waste generated by environmentally unaware consumers (Kızarıklı et al., 2025). Within this context, the concept of "Gastronomy 4.0" reflects how digital transformation has introduced a new phase in the optimisation of such operational processes (Yıldız & Davutoğlu, 2020; Akay & Karaçeper, 2024). Internet of Things (IoT) systems technologies enabling sensor-based communication between interconnected objects render food waste visible within kitchen operations while simultaneously revealing new opportunities for improving waste management practices (Wen et al., 2018). In addition, IoT-based smart refrigerators and storage systems reduce spoilage-related waste by enabling real-time monitoring of product freshness and environmental conditions such as temperature and humidity (Protopappas et al., 2025).

More recently, artificial intelligence and computer vision technologies have further advanced food waste management practices within the food industry. In a study conducted by Sigala et al. (2025), the effectiveness of AI-based automated waste-tracking systems in reducing food waste was examined. The study employed deep learning-based monitoring devices capable of tracking food waste in real time across restaurants, institutional catering services, and hotels in different European countries (Germany, Switzerland, and Greece). Initial measurements indicated that food waste ranged between 76.2 and 151.9 g per meal across different establishments. Following implementation, the AI-enabled tracking system enhanced staff awareness, resulting in a reduction of food waste by 23–51% during the food preparation stage.

Against this backdrop, the present study aims to conduct a qualitative and in-depth analysis of food waste management practices in food and beverage establishments and to explore their potential for digital transformation. Beyond assessing the role of digitalisation in operational efficiency and waste reduction, the study also considers its possible implications for customer experience and the expectations of external stakeholders, including local authorities, within this transformation process. Furthermore, it seeks to examine managerial awareness of smart technologies such as the Internet of Things (IoT), existing digital infrastructure capacities, and future technology investment intentions. The findings are expected to provide a comprehensive perspective on the sustainability and digitalisation challenges facing the sector and to contribute to the conceptual foundation for future "sustainable smart restaurant" models.

Conceptual Framework / Theory

The Concept of Sustainability and Its Historical Development

The concepts of sustainability and sustainable development have become among the most widely discussed themes in recent years, largely due to increasing concerns over environmental degradation. As sustainability is inherently a multidimensional concept, different academic disciplines have developed a variety of definitions and interpretative frameworks to address it. Although early concerns related to sustainability can be traced back to eighteenth- and nineteenth-century economists, the emergence of the notion of "sustainable development" is closely associated with the rise of environmental awareness in the twentieth century (Beder, 1994). The growing prominence of this awareness was significantly shaped by the first wave of modern environmentalism in the 1960s and 1970s, which extended global understanding of environmental crises beyond traditional nature conservation perspectives.

During this period, *The Limits to Growth*, published by the Club of Rome, was among the first works to explicitly highlight the tension between unlimited economic growth and the finite nature of global resources, thereby drawing attention to alternative pathways for sustainable development (Meadows, Meadows, Randers,

& Behrens III, 1972). The concept GenAIned widespread international recognition in 1987 with the publication of *Our Common Future* by the World Commission on Environment and Development (WCED). In this report, sustainable development was defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987). Over time, scholarly analyses of sustainable development have become more comprehensive, with increasing emphasis on its economic, social, and environmental dimensions. Munasinghe (2001) underlined the necessity of an interdisciplinary approach to achieving sustainability. From this perspective, the economic dimension focuses on improving human welfare through the consumption of goods and services, while the environmental dimension prioritises the protection of ecosystem integrity. The social dimension, in turn, emphasises the enhancement of human relationships and the enabling of individuals to achieve their aspirations (Munasinghe, 2009). Addressing critical global challenges such as poverty, inequality, and climate change situated at the intersection of these three dimensions requires their balanced and integrated consideration.

Sustainable Gastronomy

Sustainability is defined as ensuring the continuity of systems without causing the excessive exploitation of natural resources (Kaypak, 2012). Sustainable gastronomy, in this regard, encompasses a holistic assessment of the environmental, economic, and social impacts associated with food production, consumption, and post-consumption processes, beginning from pre-agricultural stages. This approach represents a culinary philosophy that considers the origin of food, the methods of production, its distribution to markets, and its presentation to consumers (United Nations, n.d.). Accordingly, sustainable gastronomy is conceptualised as an approach that integrates economic, social, and environmental dimensions while prioritising the well-being of future generations (Strezov, 2017; Malinowska et al., 2024).

Within the context of restaurant management, sustainable gastronomy extends beyond a sole focus on profitability to include the reduction of environmental impacts, the enhancement of social benefits, and the strengthening of collaboration with stakeholders (Malinowska et al., 2024). In this respect, restaurants are considered key actors in the implementation of the Sustainable Development Goals. The food and beverage industry is regarded as one of the service sectors with the highest environmental impact due to its intensive consumption of energy and water, as well as its substantial waste generation. Research indicates that restaurants are among the most energy-intensive enterprises within the retail sector, and that kitchen operations constitute a major determinant of overall water consumption. Moreover, a significant proportion of food waste is reported to originate from food and beverage establishments (Deng & Burnett, 2002).

These environmental impacts have brought sustainable gastronomy and environmentally responsible practices to the forefront of restaurant management. Within the scope of sustainable gastronomy, key areas of implementation include the use of local and seasonal products, environmentally responsible supply chain management, improved energy and water efficiency, food waste prevention, and overall waste reduction (Malinowska et al., 2024). While the economic dimension emphasises the support of local supply chains and long-term business resilience, the social dimension highlights fair working conditions, staff training, and the preservation of local gastronomic heritage as essential components of sustainable restaurant management (Malinowska et al., 2024).

Sustainable Restaurant Management

Sustainable restaurant management can be analysed within the framework of the Triple Bottom Line (TBL) approach, which encompasses environmental, social, and economic dimensions (Alhaddi, 2015). Within the existing literature, the environmental dimension is the most prominently emphasised aspect of sustainability (Apak & Gürbüz, 2022).

Economic sustainability, by contrast, is associated with the long-term financial viability of restaurant enterprises. Reductions in energy, water, and raw material consumption generate cost savings, while the adoption of environmentally and socially responsible practices enhances brand reputation and strengthens customer loyalty. In turn, these factors contribute to competitive advantage and the creation of new market opportunities for businesses (Apak & Gürbüz, 2022).

A content analysis conducted by Apak and Gürbüz (2022) revealed that sustainability research in Türkiye predominantly concentrates on the environmental dimension. In particular, issues such as energy and water conservation, waste management, and the development of sustainable menu offerings are given significant emphasis within the literature.

Waste Management and Food Waste in Restaurants

Restaurants represent a critical node within the global food supply chain, where food waste and associated management challenges are particularly prevalent. Food waste not only results in economic losses but also poses significant risks to environmental and social sustainability (Coşkun & Özgün, 2019).

Food waste generated in restaurants is generally categorised into three main groups: preparation waste, service (plate) waste, and spoilage waste. Preparation waste refers to both edible and inedible residues such as vegetable peels, bones, and fats generated during food preparation processes. Plate waste consists of uneaten food left on customers' plates, whereas spoilage waste arises from raw materials that expire or deteriorate due to deficiencies in storage and inventory management. Research indicates that vegetables constitute the food group with the highest waste generation in restaurants, and that the majority of food waste (79.3%) occurs during the service stage (Çirişoğlu & Akoğlu, 2021).

The causes of food waste in restaurants vary depending on the complexity of operational processes. When analysed through the service blueprint framework, these causes emerge at different stages, including physical evidence (e.g., menu design and portion sizing), customer actions (e.g., over-ordering), front-of-house staff activities (e.g., incorrect order taking), and back-of-house kitchen operations (e.g., preparation errors and staff negligence) (Coşkun & Özbük, 2019). In particular, staff negligence and insufficient training are identified as significant contributors to food waste generation (Çirişoğlu & Akoğlu, 2021).

The impacts of food waste are multidimensional. From an economic perspective, food waste represents the loss of embedded resources such as raw materials, labour, energy, and water. From an environmental perspective, the decomposition of food waste in landfill sites produces methane, a highly potent greenhouse gas that contributes significantly to climate change. Furthermore, the unnecessary use of water and land resources in the production of discarded food intensifies environmental pressures (Çirişoğlu & Akoğlu, 2021).

The most effective strategy for preventing food waste is the adoption of zero-waste and waste-free kitchen practices grounded in the Zero Waste philosophy, which prioritises waste reduction at source, reuse, and recycling (Tavus, 2025). Key waste reduction strategies that restaurants can implement include:

1. Waste tracking and measurement: Conducting systematic waste audits to identify the type, timing, and location of waste generation as a foundational step for improvement.

2. Menu engineering: Revising high-waste menu items and applying holistic cooking approaches such as "root-to-stalk" use.

3. Technological solutions: Employing smart scales and digital monitoring systems to track waste data in real time.

4. Staff training and awareness: Providing continuous training for kitchen and service staff on effective waste management practices.

5. Valorisation: Supporting circular economy practices through composting organic waste or redirecting it to animal welfare facilities (Tavus, 2025).

The Internet of Things (IoT) Impacts In Restaurants

The Internet of Things (IoT) is defined as a socio-technical system that enables physical objects to generate data through sensors, software, and network connectivity, and to integrate this data into automated or semi-automated decision-making processes (Atzori, Iera, & Morabito, 2010). In the service industry, IoT applications have created transformative effects on operational efficiency, resource management, customer experience, and sustainability. Within this context, the restaurant sector has become an increasingly important focus of IoT-related research due to its high labour intensity, fluctuating demand patterns, and significant levels of food waste generation.

The existing literature predominantly examines IoT adoption in restaurants from the perspective of operational optimisation. Applications such as inventory tracking, temperature and humidity control, cold-chain monitoring, and energy consumption management via sensor-based systems are primarily designed to reduce costs and improve efficiency (Ben-Daya, Hassini, & Bahroun, 2019). In this respect, IoT contributes to sustainability by enhancing food safety, reducing spoilage, and thereby minimising food waste, as demonstrated in studies focusing on smart kitchen technologies and automated inventory management systems.

In Türkiye, digital transformation and smart city policies are developed within a comparable framework. The draft National Smart Cities Strategy and Action Plan (2024–2030) envisions an "advanced society, advanced technology, and a sustainable and resilient world," aiming to translate digital infrastructure into economic, social, and environmental benefits. This strategy emphasises stakeholder collaboration, innovative

solutions, and sustainability principles in order to promote the diffusion of digital technologies across various sectors (Republic of Türkiye Ministry of Environment, Urbanisation and Climate Change, 2024).

Nevertheless, research indicates that IoT applications in restaurants often remain limited and fragmented. While sensor-based lighting systems, contactless payment solutions, and basic digital infrastructures are relatively common, these systems frequently lack integrated data strategies that would support strategic decision-making. In particular, in small and medium-sized enterprises (SMEs), including family-run restaurants, cost pressures, limited technical expertise, cybersecurity concerns, and staff adaptation challenges are identified as key barriers to the strategic adoption of IoT technologies (Ahmetoglu et al., 2022). IoT applications in restaurants are also widely discussed in relation to customer experience and satisfaction. Digital ordering systems, smart menus, and feedback mechanisms enhance customer experience by improving speed, convenience, personalisation, and transparency (Pantano & Di Pietro, 2012). However, some studies suggest that excessive digitalisation may reduce face-to-face interaction, resulting in neutral or limited effects on customer experience in certain hospitality contexts (Ivanov & Webster, 2019).

Finally, the literature identifies several barriers to the wider diffusion of IoT, including limited digital awareness, insufficient training, infrastructural deficiencies, high implementation costs, and inadequate public support. The National Smart Cities Strategy and Action Plan (2024–2030) seeks to address these challenges and promote more inclusive digital transformation at the local level, formally recognising IoT as strategically important for both economic development and sustainability objectives (Republic of Türkiye Ministry of Environment, Urbanisation and Climate Change, 2024).

Method

This study is designed as a qualitative, field-based investigation aimed at examining the current state of waste management, digitalisation, and sustainability practices within restaurant businesses. The research constitutes the first phase in the development process of the “Sustainable Smart Restaurant Kit” and adopts an exploratory approach that prioritises understanding the operational, cultural, and structural dynamics of the sector prior to proposing solution-oriented interventions. Accordingly, the methodology conceptualises waste generation and digital practices in restaurants not merely as technical processes, but as multi-layered phenomena embedded within workload distribution, habitual behaviours, cost pressures, and organisational culture. The study was conducted in restaurants and cafés operating in the Beykoz district of Istanbul. Using a purposive sampling method, interview requests were extended to 21 businesses representing different scales and organisational structures. However, due to field constraints and institutional limitations, semi-structured, face-to-face interviews were ultimately conducted with 8 businesses.

Data were collected through a semi-structured interview guide covering participants’ knowledge of waste management practices, food waste generation, digital infrastructure, IoT-based solutions, sustainability perceptions, and perceived barriers. In the development of the interview form, the studies of Karakuş (2020), Erik & Pekerşen (2019), Eter (2024), and Akay & Karaçeper (2024) were utilised, alongside a comprehensive review of the relevant literature. The interviews were conducted with individuals who held multiple operational responsibilities within their establishments and possessed direct knowledge of day-to-day processes, predominantly managers or owners. This ensured that the data obtained were closely aligned with routine practices and decision-making processes, particularly within kitchen and service operations. In cases where interviews could not be conducted due to time constraints and institutional barriers, these limitations were documented as contextual data, contributing to a broader understanding of the sector’s approach to sustainability and digital transformation. Data saturation was assessed progressively throughout the interview process. Following each interview, the researchers reviewed the emerging codes and compared them with those identified in previous interviews. Saturation was considered to have been reached when successive interviews no longer generated substantively new codes, categories, or dimensions relevant to the research questions. By the eighth interview, the analysis primarily produced repetitions or further elaborations of previously identified codes rather than substantively new categories. Therefore, the eighth interview was considered the point at which data saturation was reached.

The collected data were analysed using qualitative content analysis. During the coding process, key themes such as insufficient waste separation practices, systemic inadequacies, limited digital literacy, cost pressures, and operational intensity emerged prominently. This methodological approach aims to provide a reliable and context-sensitive foundation for translating the findings into design-, policy-, and practise-oriented sustainability solutions. Ethics Approval: For this study, ethics committee approval was obtained from the Beykoz University Scientific Research and Publication Ethics Committee in its meeting numbered 10 on 28.06.2024, with decision number 7.

Reliability

The trustworthiness of the study was assessed in accordance with the qualitative research criteria of credibility, dependability, confirmability, and transferability (Lincoln & Guba, 1985). Credibility was supported through the use of a pre-prepared semi-structured interview guide across all interviews. Using the same interview guide ensured consistency in the topics addressed while allowing participants to elaborate on their experiences and perspectives. Before data collection, the interview guide was reviewed by two subject-matter experts, and their feedback was incorporated into the final version of the guide. This process helped ensure that the questions were relevant to the research objectives and appropriate to the context of food and beverage businesses. Credibility was further supported through maximum variation in the participating businesses and participant profiles. Interviews included participants with different roles, such as business owners and managers, and were conducted across establishments with different characteristics, including cafés and restaurants. This diversity was used to capture a range of perspectives rather than to treat participant diversity as a form of triangulation. Dependability was addressed by providing a systematic and transparent account of the data collection and analysis procedures. The same semi-structured interview guide was used across interviews, while the stages of participant selection, interviewing, coding, and category development were documented and followed consistently. Emerging codes were reviewed in relation to the research questions and compared with previously identified codes throughout the analytical process. Confirmability was enhanced by grounding the findings in participants' accounts and by repeatedly reviewing the original interview transcripts during the coding and interpretation stages. The researchers compared emerging codes and categories with the original data to ensure that the findings remained closely connected to participants' statements. This process also helped distinguish participants' reported experiences from the researchers' subsequent interpretations. Transferability was addressed through a detailed description of the research context, participating businesses, participant roles, and data collection procedures. The study does not seek statistical generalisation; rather, the contextual details provided allow readers to assess the extent to which the findings may be applicable to other food and beverage businesses or comparable settings. The findings are therefore interpreted within the specific context of the participating businesses in Beykoz.

Findings

Table 1. Please Briefly Describe Yourself and Your Role Within the Business

Question Directed to Participants	Please briefly describe yourself and your role within the business.	
Theme	Code	Frequency
Job Role	Multitasking	6
	Operational Responsibilities	7
	Managerial Role	4
	Financial Responsibilities	2
Industry Experience	Extensive Industry Experience (10+years)	5
	New Employee (1-3 years)	3
	Long-Term Employment within the Business	4
Business Structure	Restaurant/Cafe	3
	Service Quality	3
	Family-Owned Business	2
Workload	Not Performing All Tasks	5
	Operational Competence	5
Personal Background	Educational Background	2
	Nationality	1
	Age	1

The majority of participants reported performing operational responsibilities (n=7) and showed a propensity to conduct multiple tasks (n=6), as indicated in Table 1. This could be explained by the varied workload structure that is inherent in restaurant and café operations. A significant percentage of the participants had extensive industry experience (n=5) and demonstrated a high degree of expertise with their companies' operational procedures (n=4). All phases of business operations were actively participated in by the four participants who held managerial or owner positions.

The least frequently reported categories, on the other hand, were age (n=1), nationality (n=1), and educational background (n=2), suggesting that participants defined themselves primarily through their professional roles and work-related experiences.

Table 2. How do you manage waste in your restaurant?

Question Directed to Participants	How do you manage waste in your restaurant?	
Theme	Code	Frequency
Waste Separation Practice	Limited or No Separation	5
	Partial Separation	3
	Reuse	1
Management of Organic Waste	Donating to Stray Animals	6
	Composting	1
	Inability to Utilize Due to Hygiene Concerns	1
Waste Oil Management	Collected by Licensed Companies	8
Recycling Practices	Waste Separation	4
	Lack of Separation Facilities	2
	Lack of Knowledge	1
Waste Reduction Strategies	Efforts to Reduce Food Loss	2
	Use of Ready-Made Products	1
	Reuse	1
Operational Constraints and Barriers	High Workload / Operational Intensity	2
	Lack of Recycling Infrastructure	2
	Low Volume of Food Waste	1

Table 2 shows that whereas organic waste was typically provided to stray animals (n=6), waste oils were collected by licensed companies in the majority of enterprises (n=8). These procedures might be favoured due to operational convenience and hygiene considerations. Recycling methods were only partially implemented (n=4), which may be related to insufficient infrastructure and awareness, whereas waste separation practices were mostly limited or nonexistent (n=5). Reuse (n=1), composting (n=1), and the use of ready-made products (n=1) were among the least frequently reported codes, offering insight into the low adoption of sustainable waste management practices.

Table 3. How do you evaluate the effectiveness of your current waste management practices?

Question Directed to Participants	How do you evaluate the effectiveness of your current waste management practices?	
Theme	Code	Frequency
Insufficiency of Waste Management System	System Insufficiency	6
	Lack of Waste Separation	5
	Need for Improvement	4
	Staff Shortage	3
	Limited Implementation	3
Strengths	Feeding Animals	4
	Waste Oil Management	3
	Prevention of Food Waste	2
	Social Benefit	1
Role Ambiguity	Limitations of Family-Owned Businesses	2
	Lack of Employee Involvement	1
Emotional Perspective	Moral Satisfaction	2
	Experienced Chefs	1

Nearly all participants assessed the current waste management system as weak (n=6), insufficient (n=5), or in need of improvement (n=4), as shown in Table 3, with the absence of waste separation (n=5) emerging as the most significant problem. The most effective practise was identified as the collection of waste oils by licensed companies (n=8), while donating organic waste to animals (n=6) was perceived as both a strength and a source of moral satisfaction, particularly in small-scale establishments. Operational intensity (n=2), staff shortages (n=3), and the small-scale nature of the businesses (n=2) were regarded as the main barriers to establishing a more professional waste management system.

Table 4. How knowledgeable are you about smart waste management and IoT (Internet of Things)-based solutions?

Question Directed to Participants	How knowledgeable are you about smart waste management and IoT (Internet of Things)-based solutions?	
Theme	Code	Frequency
Lack of Knowledge	No Formal Training	8
	Lack of Practical Experience	8
	Insufficient Knowledge	8
	No Prior Awareness	4
Traditional Approaches	Traditional Methods	2
	Lack of Record-Keeping and Digital Systems	1
Environmental Awareness	Biodegradability / Decomposition in Nature	1

As presented in Table 4, a lack of knowledge regarding smart waste management and IoT-based solutions was observed among the majority of participants, with no formal training (n = 8), lack of practical experience (n = 8), and insufficient knowledge (n = 8) emerging as the most frequently reported codes. The least frequently cited codes were the lack of record-keeping and digital systems (n = 1) and environmental awareness (n = 1), indicating that participants were more accustomed to traditional approaches (n = 2).

Table 5. Are IoT (Internet of Things) or sensor-based systems used in your restaurant?

Question Directed to Participants	Are IoT (Internet of Things) or sensor-based systems used in your restaurant?	
Theme	Code	Frequency
Sensor-Based Systems	Sensor-Enabled Equipment (e.g., lighting, soap dispensers, faucets, towel dispensers, air fresheners, timers)	9
	Security Cameras	2
	Automatically Operated Equipment	2
	Refrigeration Failure Alarm System	1
Digitalisation and Automation in Inventory Management	Use of Digital Ordering Systems	4
	Digital Inventory Management System	4
	Development of Proprietary Software	1
Energy Efficiency	LED Lighting	3
	Energy-Efficient Use of Machinery	2
Lack of IoT Systems	Basic (Sensor-Level) Use Only	5
	Not Used	4

As shown in Table 5, the use of sensor-enabled equipment (e.g., lighting systems, soap dispensers, faucets) was widespread among the majority of participants (n=9), indicating that IoT applications were largely limited to basic and simple implementations. The use of digital ordering and inventory management systems was moderate (n=4 each). Refrigeration failure alarm systems (n=1) and the development of proprietary software (n=1) were the least frequently reported codes, indicating that advanced digitalisation and automation techniques are still lacking.

Table 6a. Perceived Impact of Smart Technologies and Digital Solutions on Customer Experience

Question Directed to Participants	Perceived Impact of Smart Technologies and Digital Solutions on Customer Experience	
Theme	Code	Frequency
Customer Experience	Speed	6
	Convenience	4
	Comfort	3
	Transparency	2

The majority of participants thought that smart technologies would improve customer experience mainly in terms of speed (n=6) and convenience (n=4), as shown in Table 6a. Comfort (n=3) and transparency (n=2) were also perceived as favourable outcomes. Malfunction (n=1), application-related problems (n=1), cost reductions (n=1), and real-time features (n=1) were the least frequently reported codes, suggesting that participants tended to focus primarily on basic experiential benefits.

Table 6b. How would you evaluate the impact of smart technologies and digital solutions on customer satisfaction if they were implemented in your restaurant?

Question Directed to Participants	How would you evaluate the impact of smart technologies and digital solutions on customer satisfaction if they were implemented in your restaurant?	
Theme	Code	Frequency
Customer Satisfaction	Satisfaction	5
	Service Quality	3
Customer Interaction	Feedback	2
	Communication	2
Operational Efficiency	Order Speed	3
	Order Accuracy and Organisation	2

As shown in Table 6b, most participants indicated that smart technologies would enhance customer satisfaction primarily in terms of overall satisfaction (n=5) and service quality (n=3). Another notable operational benefit was order speed (n=3). The least frequently reported codes included feedback (n=2), communication (n=2), and order accuracy and organisation (n=2), suggesting that the primary focus remained on satisfaction and service quality.

Table 6c. How do you evaluate the impact of the smart technologies and digital solutions currently used in your restaurant on customer experience?

Question Directed to Participants	How do you evaluate the impact of the smart technologies and digital solutions currently used in your restaurant on customer experience?	
Theme	Code	Frequency
Enhancement of Customer Experience	Convenience	2
	Speed	2
	Modern Appearance	1
	Transparency	1
Limited Impact	Limited Use	2
	Minor Advantage	1
	Standardized Systems	1
Perceived Risks and Limitations	Environmental Degradation / Biodegradability Concerns	1

Participants stated that the current smart technologies had limited impact on customer experience, as shown in Table 6c. The restricted scope of these impacts was associated with factors such as limited use (n=2) and organisational constraints (n=2), even though speed (n=2) and convenience (n=2) improvements were noted. Modern appearance (n=1), transparency (n=1), and risk of malfunction (n=1) were the least frequently reported codes, indicating that the reach and influence of existing systems remain limited. Overall, the results demonstrate that although current digital applications have the potential to enhance customer experience, the extent and functionality of the technologies employed directly determine their effectiveness. Positive impact / enhancement of customer experience was the most commonly cited theme, with most participants indicating that digitalisation improves the dining experience.

Table 6d. How do you evaluate the impact of the smart technologies and digital solutions currently used in your restaurant on customer satisfaction?

Question Directed to Participants	How do you evaluate the impact of the smart technologies and digital solutions currently used in your restaurant on customer satisfaction?	
Theme	Code	Frequency
Customer Satisfaction	Faster Service	2
	Operational Convenience	2
	Feedback Monitoring	1
	Modern Environment	1
Neutral Impact	Digitalisation Makes a Difference	2
	Mismatch with Digitalisation	2
	Standardization of Sensor-Based Systems	1
Technical Infrastructure Issues	Technical Infrastructure Issues	1
	Increased Risk of Malfunction	1

As presented in Table 6d, participants evaluated the impact of existing smart technologies on customer satisfaction as limited. Faster service (n=2) and operational convenience (n=2) emerged as positive effects, whereas incompatibility with digitalisation (n=2) and the perception that digitalisation does not create a significant difference (n=2) highlighted existing limitations. The least frequently reported codes included feedback monitoring (n=1), modern environment (n=1), standardization of sensor-based systems (n=1), insufficient internet connectivity (n=1), and increased risk of malfunction (n=1), indicating that current technologies have a constrained impact and involve certain risks. In some establishments, it was emphasized that digitalisation may not align with organisational culture due to customers' preference for face-to-face interaction, potentially resulting in adverse effects on customer satisfaction rather than improvements. Technical issues were also reported, including poor internet speed and overuse of technology, which could increase the likelihood of system breakdowns and negatively affect service reliability and speed. Overall, although digitalisation shows potential for enhancing customer satisfaction, its effectiveness appears to depend on the type of organisation, client profile, technical infrastructure, and the scope and quality of implementation.

Table 7. How do you evaluate your restaurant's current digital infrastructure and technological equipment?

Question Directed to Participants	How do you evaluate your restaurant's current digital infrastructure and technological equipment?	
Theme	Code	Frequency
Digital Infrastructure	Functional	6
	Problematic	2
Digital Systems	POS System	3
	Sensors	2
	Customer Loyalty Programmes	1
	Online Ordering Systems	1
Business Characteristics	Small-Scale Business	4
	Family-Owned Business	2
Customer Interaction	Face-to-Face Interaction	3
	Customer Loyalty	2
Cost Efficiency	Sensors	1
	Security Systems	1

Table 7 shows that most participants considered their restaurants' digital infrastructure to be functional (n=6), with small-scale business structures (n=4) and the use of POS systems (n=3) being frequently mentioned. Customer loyalty programmes (n=1), online ordering systems (n=1), cost reductions through sensors (n=1), and security systems (n=1) were the least frequently reported codes, suggesting that the range of technological equipment remains limited. In this context, the digital infrastructure appears to primarily support fundamental operational functions rather than extending to a more comprehensive, organisation-wide technology framework, and its use is largely determined by business type and organisational culture.

Table 8. Does your business have plans to invest in or implement new technologies and digital transformation initiatives?

Question Directed to Participants	Does your business have plans to invest in or implement new technologies and digital transformation initiatives?	
Theme	Code	Frequency
Technological Investment	No investment plan	3
	Limited investment	2
	Strategic investment	1
Robotics and Automation	Robot waiter	2
	Opposition to robotic technologies	1
Labour and Cost Factors	Efficiency and labour	3
	Staff shortage	2
Gastronomic Values	Handcraft and culinary mastery	2
	Traditional production	1

According to Table 8, most participants reported that they either have no plans to invest in new technologies (n=3) or intend to make only limited investments (n=2). This tendency can largely be explained by concerns related to labour and cost factors, including workforce and operational efficiency challenges (n=3) and staff shortages (n=2), which are particularly common in small-scale restaurant operations. Although some participants indicated that they are considering robot waiter applications (n=2), there appears to be no explicit opposition to robotic technologies (n=1). The least frequently mentioned codes—traditional production (n=1), strategic investment (n=1), and aversion to robotic technology (n=1)—suggest that long-term and large-scale technological investments were not frequently mentioned by the participating businesses. Another notable finding is the emphasis on gastronomic values, such as handcraft, culinary expertise, and traditional production, which appears to be associated with some reservations regarding technology integration. These findings may suggest that, for some participants, perceptions of digital transformation are related not only to economic considerations but also to the perceived value of traditional culinary practices. Accordingly, the integration of technology in gastronomy may involve a balance between maintaining traditional culinary practices and pursuing operational efficiency.

Table 9. Which practices do you implement in your restaurant to reduce food waste?

Question Directed to Participants	Which practices do you implement in your restaurant to reduce food waste?	
Theme	Code	Frequency
Portion Management	Standardized portion sizes	5
	Flexible portioning	1
Inventory Management	Minimum stock / use of fresh products	2
Reuse and Redistribution	Donation to stray animals	4
	Consumption by staff	3
	Donation to people in need	3

Table 9 shows that portion control, particularly the use of standardized portion sizes (n=5), is the most commonly employed approach to prevent food waste. This suggests that restaurant operators consider portion control an efficient and manageable strategy. However, flexible portioning (n=1) appears to be used less frequently, indicating limited operational flexibility in portion control procedures. Regarding reuse and redistribution of food waste, the most common methods are donation to stray animals (n=4), staff consumption (n=3), and donation to individuals in need (n=3). Rather than formalized waste reduction strategies, these activities reflect a tendency toward informal, socially oriented solutions. Maintaining minimal stock levels and prioritizing the use of fresh products (n=2) are examples of inventory management practices observed at relatively low frequency, suggesting that systematic planning and forecasting methods are generally not employed. Overall, the results indicate that, instead of comprehensive, technology-supported, or policy-driven methods, food waste reduction efforts are primarily based on pragmatic, experience-driven, and ethically motivated approaches.

Table 10a. What are the most significant barriers you encounter in the process of reducing food waste?

Question Directed to Participants	What are the most significant barriers you encounter in the process of reducing food waste?	
Theme	Code	Frequency
Cost Pressure	Rising food prices	3
	Difficulty reflecting costs on the menu	2
	Investment costs	1
Cultural Barriers	Lack of waste separation habits	1
	Waitstaff behaviour	1
	Customer demand behaviour	1
Operational Barriers	Staff habits	1
	Infrastructure deficiencies	1
	Franchise approval process	1
	Uneaten food	1

The majority of participants face cost-related pressures in their efforts to prevent food waste, as shown in Table 10a. The most significant obstacles are rising food prices (n=3) and challenges in reflecting these expenses on menu prices (n=2). Cultural and operational hurdles were reported less frequently (each n=1), suggesting that issues such as customer demand, staff habits, and infrastructural deficiencies have a relatively smaller impact. Inadequate waste separation procedures, expectations of unlimited consumption, and excessive bread consumption are examples of habitual behaviours influenced by cultural factors among both customers and employees. Conversely, operational impediments are linked to institutional limitations that hinder the implementation of waste reduction strategies, such as inadequate municipal waste services and lengthy franchise approval processes. On the other hand, effective operational control mechanisms and increased staff knowledge play a significant role in preventing food waste in certain establishments, where barriers are considered minor.

Table 10b. What are the most significant opportunities you encounter in the process of reducing food waste?

Question Directed to Participants	What are the most significant opportunities you encounter in the process of reducing food waste?	
Theme	Code	Frequency
Stock and Order Management	Accurate quantity planning	6
	Cost-quality balance	3
Efficiency and Profitability	Cost advantage	4
	Increased profitability	2
Sustainability and Environmental Impact	Recycling	1
	Environmental benefits	1

Accurate quantity determination (n=6) emerges as the most commonly cited opportunity in the process of reducing food waste, as shown in Table 10b. Participants primarily mentioned issues related to stock and order management. Waste reduction strategies are also considered to be significantly influenced by factors related to cost and profitability (cost advantage (n=4); increased profitability (n=2)). The least frequently reported codes were those related to recycling (n=1) and environmental benefits (n=1), suggesting that environmental factors had limited influence on actual implementation. However, some businesses highlighted sustainability-related advantages, such as improved customer satisfaction and environmental benefits. Overall, rather than being motivated solely by environmental concerns, the identified opportunities are primarily focused on operational efficiency, cost control, and maintaining product quality.

Table 11a. How should central and/or local governments (e.g., Beykoz Municipality) contribute to the digital transformation process in the restaurant industry?

Question Directed to Participants	How should central and/or local governments (e.g., Beykoz Municipality) contribute to the digital transformation process in the restaurant industry?	
Theme	Code	Frequency
Education and Awareness	Digital awareness	2
	System usage training	2
Role of the Municipality	Incentives	2
	Support mechanisms	2
Monitoring and Process Management	System use	2
	Waste reduction	2

As shown in Table 11a, participants emphasized that education and awareness programmes should be the primary means by which central and local governments support the digital transformation process, particularly through enhancing digital awareness (n=2) and providing system usage training (n=2). Another important factor in promoting technology adoption in the restaurant industry is the municipality's role in offering institutional support and incentives (n=2 each). Additionally, participants highlighted the use of digital technologies and their significance in reducing food waste, identifying process management and monitoring as key areas for public involvement (n=2 each). Consequently, companies are considered to have opportunities to enhance productivity, reduce costs, and minimize waste through improved digital infrastructure and tracking systems. Participants perceived the involvement of public authorities in this context as focusing on raising awareness, providing supportive interventions, and delivering technology infrastructure to facilitate sustainable, long-term digital transformation.

Table 11b. How should central and/or local governments (e.g., Beykoz Municipality) contribute to the sustainability process in the restaurant industry?

Question Directed to Participants	How should central and/or local governments (e.g., Beykoz Municipality) contribute to the sustainability process in the restaurant industry?	
Theme	Code	Frequency
Waste Management	Recycling	4
	Food waste reduction	2
Inspection and Regulation	Inspections and penalties	2
	Licensing and capacity control	1
Lack of Institutional Initiative	Insufficient local government involvement	2
	Lack of commitment / goodwill	2

Participants emphasized that recycling programmes (n=4) and food waste management practices (n=2) should be among the primary ways in which local governments contribute to sustainability in the restaurant industry, as shown in Table 11b. Although reported less frequently, codes related to institutional initiative deficiencies (insufficient local government involvement [n=2]; lack of commitment or goodwill [n=2]) and inspection and regulation (inspections and penalties [n=2]; licensing and capacity control [n=1]) collectively indicate perceptions of insufficient existing institutional support. Consequently, participants recommended a combination of regulatory control, awareness-raising initiatives, and supportive infrastructure to advance sustainable practices in restaurants. These findings suggest that local government support should extend beyond conventional waste management measures and encompass broader sustainability-oriented initiatives, including the development of appropriate infrastructure and support mechanisms for digital and technological solutions. In this regard, a more coordinated and proactive approach by public authorities may facilitate the integration of sustainability practices with the digital transformation of restaurant operations.

Table 12a. What are the major challenges you encounter in the field of digital transformation, and what solutions do you propose to address these challenges?

Question Directed to Participants	What are the major challenges you encounter in the field of digital transformation, and what solutions do you propose to address these challenges?	
Theme	Code	Frequency
Human Resources and Competencies	Lack of digital awareness	2
	Lack of experienced personnel	2
Adaptation to Technology	Difficulty in adaptation	1
	Technological knowledge gap	1
Development and Solution Proposals	Education and awareness-raising	2
	Optimisation	1

The results indicate that, in order to effectively support digital transformation in the restaurant industry, both local and central governments should focus on human resources and competency development, as shown in Table 12a. The most prominent challenges identified by participants were a lack of digital awareness (n=2) and a lack of skilled personnel (n=2). The least frequently reported codes related to technology adaptation, including difficulty in adaptation (n=1), technological knowledge gaps (n=1), and optimisation proposals (n=1). This pattern suggests that development and improvement initiatives related to digital transformation remain limited. Overall, the findings indicate that advancing digital transformation in the restaurant industry requires greater attention to human capital, digital awareness, and technological competencies.

Table 12b. What are the major challenges you encounter in the field of sustainability, and what solutions do you propose to address these challenges?

Question Directed to Participants	What are the major challenges you encounter in the field of sustainability, and what solutions do you propose to address these challenges?	
Theme	Code	Frequency
Cost	High costs	5
	Product spoilage	4
	Opportunities for savings	4
	Workforce management	3
Awareness	Sustainability awareness	4
	Employee awareness	4
	Government support	3
	Customer awareness	2
Customer Interaction	Customer demand and expectations	3
	Face-to-face communication	3
	Loyalty programmes	2

Participants perceive high operational costs (n=5), product spoilage (n=4), and limited opportunities for cost savings (n=4) as the most significant challenges in the sustainability domain, as shown in Table 12b. Awareness deficits also stand out, with employee awareness (n=4) and sustainability awareness (n=4) identified as major issues. Codes reported less frequently, such as customer awareness (n=2) and loyalty programmes (n=2), suggest that internal organisational practices and financial constraints, rather than external

factors, are the primary drivers of these challenges. These findings underscore the economic, operational, and social dimensions of sustainability and highlight the need for active engagement of both internal and external stakeholders for successful implementation.

Conclusion and Recommendations

The aim was to reveal the levels of knowledge, perceptions, and challenges faced by restaurant and cafe businesses in the Beykoz district of Istanbul regarding waste management, digitalisation, and sustainability through a qualitative study. The findings of the research indicate that the practices in the businesses are shaped particularly by cost concerns and operational efficiency perspectives, and that a strategic understanding of sustainability has not yet been adopted. Research findings on waste management have revealed that in the majority of the businesses interviewed, waste management practices are limited to legal obligations (such as giving waste oils to licensed firms) and practical solutions (such as giving organic waste to street animals). The almost non-existent practise of waste separation at the source (Table 2) is consistent with the participants' assessment of the current waste management system as "inadequate" (Table 3). This situation contradicts the emphasis in the literature that food waste in all operations of restaurant management should be reduced in a planned and systematic manner (McAdams et al., 2019; Pirani & Arafat, 2016; Vizzoto et al., 2021). However, in the study conducted by Çirişoğlu and Akoğlu (2021) in restaurants in Istanbul, it is also observed that there are systemic deficiencies in waste management and that the issue is a widespread problem.

Although feeding animals with organic waste, which is among the sustainable waste management methods, is considered a social responsibility, it ranks lower in the waste hierarchy. Zero waste hierarchy, it is stated that in cases where waste is unavoidable, methods such as recycling, composting, energy recovery, and as a last resort, disposal, should be preferred in that order (ZWIA, 2022; Tavus, 2025). The fact that it was observed in only one establishment in the present study indicates both a lack of knowledge and insufficient infrastructure (support for municipal composting applications, physical space, etc.) necessary for such practices. In Table 9, portion control is preferred as the most common method for reducing food waste, while the limited use of stock management and technology-supported methods indicates that waste management is conducted through traditional practices. This finding aligns with studies that indicate cost pressure and operational challenges are among the greatest barriers to reducing food waste (Pirani & Arafat, 2016).

The extremely low level of knowledge among participants regarding smart waste management and Internet of Things (IoT) based solutions is one of the most striking findings of the research (Table 4). The current technology usage is largely limited to basic sensor-equipped equipment (lighting, faucets, etc.) and POS systems (Table 5, 7). This situation indicates that despite Akay and Karaçeper (2024) stating that the restaurant industry has high potential for digital transformation, there is a significant "knowledge and application gap" in the industry.

The reasons underlying the participants' reluctance to invest in new technologies (Table 8) are the perception of high costs, the lack of qualified personnel, and the current operational intensity. These barriers are frequently mentioned in the literature as the main challenges faced by SMEs in developing countries during their technology adaptation processes. Despite the abundance of theoretical and up-to-date information on the benefits of adopting the Internet of Things (IoT), most businesses continue to refrain from using it due to the lack of existing empirical evidence and the slow or non-adoption of new technologies. (Ali et al., 2023). One important finding is that resistance to technology is based not only on economic but also on cultural foundations. The emphasis on gastronomic values such as "handcrafted" and "mastery" (Table 8) reflects concerns that automation and robotic technologies may conflict with the "traditional" experience of restaurants. As seen in Tables 6a, 6b, and 6d, participants acknowledge that technology can improve customer experience in terms of speed and convenience, but they believe that the current limited applications do not make a significant difference in customer satisfaction. This finding indicates that financial investment alone is not sufficient for the successful integration of technology; a strategic approach that is also aligned with the business culture, customer profile, and service understanding is necessary.

When participants were asked about opportunities to reduce food waste, the prominence of topics such as inventory management and cost advantages over environmental benefits (Table 10b) indicates that the perception of sustainability among participants is largely shaped by economic motivations like "reducing costs" and "increasing efficiency." The lower awareness of the environmental and social dimensions of sustainability (Table 12b) suggests that sustainability is perceived in the industry not as a holistic business model but rather as an operational efficiency tool. This finding aligns with the study by Sünnetçioğlu and Yılmaz (2015), which indicated that some restaurant managers in İzmir lack knowledge about sustainability, while others are heavily focused on time and cost due to pressure from their management stemming from their limited authority. Participants have very high expectations from central and local governments in sustainability

and digital transformation processes. Especially the expectations for strengthening education and awareness efforts, incentives, and inspection mechanisms (Table 11a, 11b) indicate that businesses are struggling to achieve this transformation on their own and need a corporate roadmap. This situation highlights once again the importance of corporate support and guidance, as businesses are either unaware of or do not participate in such programmes. In the literature, as an example of green restaurant initiatives within this corporate roadmap, it is also noted that environmentally friendly practices in restaurants can contribute to customer growth and provide a competitive advantage as a marketing element (Şahingöz & Güleç, 2019).

In conclusion, this study has shown that the practices of sustainability and digitalisation in the examined restaurants and cafes are still in the initial stages, with implementations generally limited to individual efforts, legal obligations, and cost concerns. Waste management is far from a systemic approach, and the adaptation of digital technology is limited due to low awareness and high cost perception. Sustainability, on the other hand, is evaluated more for its economic benefits rather than its environmental and social dimensions.

Conclusion and Implications

In line with these findings, the recommendations for the industry and its stakeholders have been classified under two main headings: practical results and theoretical implications.

Practical Implications

The research findings provide various recommendations to stakeholders such as food and beverage establishments, as well as local and central governments.

Recommendations for Food and beverage establishments

- In-house training programmes on food waste management, composting, circular economy, and current digital technologies should be organized.
- Platforms should be created where businesses with successful sustainability and technology practices can share their experiences.
- Businesses should develop strategic plans that view sustainability not as a cost issue, but as a tool for creating long-term value and strengthening brand image.

Recommendations for Local and Central Governments

- Municipalities should establish the necessary infrastructure for the separate collection and composting of organic waste and encourage businesses to participate in this system.
- Energy-efficient equipment procurement, digital technology investments, and participation in green certification programmes should be incentivized for small-scale businesses.
- Guides should be prepared for the use of "Sustainable Restaurant" standards, and inspections should be conducted within this framework.

Theoretical Implications

This study offers several theoretical contributions to the literature on sustainability and digitalisation and suggests new directions for future research.

Recommendations for Academics

- This study was conducted in a limited geographical scope with a qualitative approach. In future studies, measuring the industry's sustainability and digitalisation levels in a broader geography and with mixed methods will deepen the findings.
- In terms of customer experiences also guiding the industry, "Examining consumers' attitudes and expectations toward sustainable and technology-focused restaurants" will be beneficial in directing businesses to make investments.
- The Internet of Things and the development of new technological systems at lower cost through collaboration between universities and the industry will also promote the widespread use of digitalisation by making it less cost-focused.

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Author Contributions

Author 1: Formal Analysis, Methodology, Formal Analysis, Visualization, Writing – Review & Editing.

Author 2: Conceptualization, Writing – Original Draft, Supervision, Project Administration.

Author 3: Data Curation, Investigation, Methodology.

Author 4: Writing – Original Draft, Writing – Review & Editing.

(The author contribution statements are defined according to the CRediT taxonomy as follows: Conceptualization; Methodology; Software; Validation; Formal analysis; Investigation; Resources; Data curation; Writing – Original draft; Writing – Review & Editing; Visualization; Supervision; Project administration; Funding acquisition.)

Declaration of 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.

Ethical approval

Yes. This study was approved by the Beykoz University Scientific Research and Publication Ethics Committee (Decision No. 7, Meeting No. 10, Date: 28 June 2024).

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All works cited within the study must be included in the references section. Moreover, no publication not cited in the study should be included in the references section. The references section is extremely important in terms of scientific ethics, and authors must select their references with great care. This is a requirement that falls under the responsibility of the authors.