



Technological Solutions for Food Waste Management

Results from NextGen

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Abstract

The goal of this report is to serve as a guide to technological solutions for food waste management. It describes the technologies and results of our pilot project for companies and organizations interested in reducing food waste through technological means. The report is a technology-focused practical resource created during the University of Vaasa's NextGen project. Our aim is to provide an accessible tool that can explain scientific and technological solutions in an understandable manner to a wide range of target audiences. We bring together both global and local perspectives, focusing on the opportunities provided by technology, such as digital infrastructures, smart scales, predictive models, and user-centered design principles for food waste management. The report presents the technological infrastructure developed in the NextGen project and demonstrates the benefits of waste management technologies in terms of data and savings.

The report outlines the multi-year development and piloting of the NextGen project. It describes the different project phases and explains how, starting with users, the system was designed to serve the diverse staff of the pilot site. The report covers both technical details from system architecture diagrams to practical demonstrations in the form of on-site waste scale photos. In this way, readers gain a comprehensive understanding of food waste management solutions used in the project. The aim of the report is to provide a blueprint for anyone interested in replicating or learning from the project's implementation and results. It walks through the entire cycle of food waste from measurement, monitoring, and predicting to eventual utilization. This cycle is closely accompanied by technology, which forms an integral part of the food waste reduction process. To support this aim, the report also presents detailed project outcomes, highlighting how systematic changes can achieve around a 40 percent reduction in food waste, as successfully demonstrated at the pilot site.

The report demonstrates how the project's outputs transform academic research into practical tools for businesses, organizations, educational institutions, industry, policymakers, and technology developers. By combining technological innovation, changes in practices, and participatory design, it illustrates how systematic change can be achieved at a practical level. The system developed during the project, as presented in the report, is a replicable model with direct environmental, economic, and social impacts, showcasing the need for and benefits of new food waste system innovations and investments.

ACKNOWLEDGEMENT

This report has been created as part of the NextGen project, coordinated by the University of Vaasa. The project's primary goal was to reduce food waste in buffet dining. The purpose of the report is to make technologies for food waste management comprehensible and accessible. The report is designed to meet the needs of various stakeholders in food waste management, offering practical solutions, tools, and tips for reducing food waste through technological means.

The primary target audience of this report consists of technology and service companies, startup communities and associations, research and educational organizations, educational institutions, non-governmental organizations, other companies and organizations interested in food waste management, senior management in the HoReCa industry, and other staff in the HoReCa industry (kitchen and service staff), as well as policymakers and governmental entities.

The novelty of this report lies in its multifaceted and technology-focused perspective, which is intended to inspire organizations and companies to take an interest in food waste management technologies and familiarize readers with food waste management research and development. This report examines technologies currently in use in organizations and companies, while also supporting the development of new solutions. The central themes of this report are related to technologies for measurement, tracking, prediction, data utilization, and continuous and participatory development of solutions. The report addresses data streams, infrastructures, algorithms, and models in detail.

The NextGen project has been co-funded by the European Union and the University of Vaasa. It has also been supported by Etelä-Pohjanmaan liitto. The NextGen project was conducted at the University of Vaasa by the WasteInsight team, which consisted of Juha Vänskä, Arja Kuusisto, Lotta Alhonnoro, Jyri Nieminen, Jyri Naarmala, Jani Södergård and Joni-Roy Piispanen. We want to thank our project partners Kuortane Sports Management Restaurants Oy, SmartKitchen Oy and MaRa Pohjanmaa. We also would like to thank the pilot staff who made great efforts toward achieving their goal of reducing food waste. On behalf of the NextGen project team, we thank you for your interest in food waste management and for reading this report.

Vaasa, 30.9.2025

Joni-Roy Piispanen

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1 FOOD WASTE IN GLOBAL, FINNISH, AND TECHNOLOGICAL CONTEXTS

Food waste management is a multifaceted challenge affecting societies and economies in different ways. While some food-waste-related challenges are universal, others are local. Each society addresses its situation and context with the resources available. These can be both behavioral and technological solutions, as seen in Figure 1. Moreover, technological maturity, adoption, and availability affect which options are feasible. This chapter aims to provide an overview of the global, local, and technological landscape related to food waste management.



Figure 1. Pilot Food Waste Bins

1.1 The Global Challenge of Food Waste

Food waste has become a global challenge with significant environmental, economic, and social consequences (Ahamed et al., 2016; Coşkun & Özbük, 2020). According to statistics, roughly 1.3 billion tons of food waste are produced yearly on a global scale, accounting for approximately one-third of all food produced for human consumption (McAdams et al., 2019; Joubert & Jokonya, 2021; Farahdiba et al., 2023). The food chain includes primary production, industry, trade, food services, and households, with households, manufacturing, and the hospitality industry generating the most food waste (Filimonau et al., 2020; Wu & Teng, 2022; Della Corte et al., 2025). To combat food waste, EU countries have expressed support for the UN's Sustainable Development Goals, aiming to halve per-capita food waste at the retail and consumer levels and to reduce waste throughout the entire food chain (Wang et al., 2017; Kfourri et al., 2022). Since 2020, EU countries have been required to report the amount of food waste they generate to the European Commission (Tehrani et al., 2020; Sigala et al., 2025).

The massive scale of food waste has cascading effects on many natural resources such as energy, water, and land, while also significantly contributing to greenhouse gas emissions (Filimonau et al., 2022a; Batool et al., 2024). The production and disposal of food waste generate an enormous carbon footprint estimated at 3.3 billion tons of CO₂-equivalent per year (Sakaguchi, Pak & Potts, 2018; Filimonau et al., 2019). Food production, processing, transportation, and disposal have an enormous global impact on emissions, producing four times as much CO₂-equivalent emissions as the actual food produced by weight (Vinck, Scheelen & Du Bois, 2019; Matzembacher et al., 2020; Liang et al., 2021). Globally, approximately one trillion dollars in annual expenses are linked to wasted food (Sehnm et al., 2022; Stoica, Micu & Stoica, 2022; Wu & Teng, 2022). For households, wasted food means wasted money, while for businesses, it represents inefficiencies in production and supply chains (Principato, Pratesi & Secondi, 2018; Di Pierro et al., 2023). At the same time, 10 percent of the world's population suffers from hunger, highlighting the moral imperative to address food waste as a means of redistributing resources more equitably (Dumitru, Iorga & Mustatea, 2021; Gruia et al., 2021).

Food waste impacts businesses, individuals, and society (Buczacki, Gładysz & Palmer, 2021). Reducing food waste is a global challenge, requiring governments, industries, and individuals to work collectively (Charlebois, Creedy & von Massow, 2015). Food waste affects all parts of the food chain, with each stakeholder experiencing its own challenges, ranging from financial troubles to impacts on wellbeing (Filimonau, Zhang & Wang, 2020; Gładysz, Buczacki & Haskins, 2020). Solutions for food waste are wide-ranging, including societal opportunities to improve supply chain efficiency, adopting better inventory management in businesses, and educating consumers on meal planning and food storage (Aamir et al., 2018). Food waste directly impacts pressures on the planet's resources, affecting greenhouse gas emissions, and being linked to social equity (Baul, Sarker & Nath, 2021; Yu & Li, 2021). Reducing food waste is a societal and individual responsibility, which can create a more efficient, ethical, and sustainable food system (Lang et al., 2020).

1.2 Food Waste Management in Finland

In Finland, food waste is a significant environmental, economic, and social issue. The country generates approximately 400 to 500 million kilograms of food waste annually (Katajajuuri et al., 2014; Silvennoinen, Nisonen & Pietiläinen, 2019). Finland's government has set climate-friendly food policy goals in line with the UN's Sustainable Development Goals and has committed to reducing food waste by 50 percent by 2030. To achieve this goal, Finland has taken active steps with measures including the creation of a roadmap to reduce waste at every stage of the food chain (Hartikainen et al., 2020). This has been the responsibility of the Natural Resources Institute Finland, which is building the national food waste monitoring

system in collaboration with industry stakeholders and different ministries in Finland (Hartikainen et al., 2020).

Furthermore, Finland has established a quality standard for food waste quantification, ensuring consistent and reliable data collection across the food chain (Hartikainen et al., 2020). Legislative actions have a marked impact on food waste, with certain regulations, such as those related to food labeling and storage temperatures, having been identified as major contributors to produced waste. Current efforts include reviewing and revising regulations to mitigate the impact of food waste and to provide the necessary tools for monitoring and management (Silvennoinen, Nisonen & Katajajuuri, 2022). Food waste policy affects all sectors of society helping address environmental concerns with significant economic and social implications.

1.3 Technology in Food Waste Management

Technology is increasingly playing an important role in addressing the challenges of food waste by providing solutions at all levels of the supply chain (Martin-Rios et al., 2018; Della Corte et al., 2025). From production to consumption, technology can provide tools that help governments, organizations, and individuals monitor, manage, and minimize food waste (Bharucha, 2018; Singh et al., 2024). Traditional methods of waste management often fall short and are riddled with inefficiencies. There is often a major lack of data, and traditional methods do not scale well to larger operations (Tatàno et al., 2017; Vizzoto et al., 2020). Technology fills these gaps by offering organizations data-driven approaches to identify and reduce waste (Wen et al., 2018; Martin-Rios, Hofmann & Mackenzie, 2020). Addressing food waste can offer organizations a competitive advantage by appealing to environmentally conscious customers. On the flip side, food waste is tied to an organization's image and has been linked to customer perceptions about trust and values (Filimonau & Sulyok, 2021; Filimonau, Nghiem & Wang, 2021).

Many of the challenges of food waste can be mitigated by technological means. Solutions such as predictive analytics enable monitoring of food waste in real-time, helping organizations anticipate potential sources of waste before they occur (Al-Obadi et al., 2022; Filimonau et al., 2022b). A proactive approach reduces environmental impacts and minimizes financial losses. A variety of technologies are currently being developed to tackle food waste in this manner (Principato et al., 2021). Artificial intelligence and machine learning tools are being designed to analyze data with the aim of predicting demand, optimizing inventory, and identifying patterns of waste (Sucheran & Olanrewaju, 2021; Filimonau et al., 2023). Environmental conditions like temperature and humidity can be monitored during storage and transport using Internet-of-Things (IoT) sensors (Aytaç & Korçak, 2021). Surplus food from restaurants

and grocery stores can be made available to consumers via mobile apps and platforms, providing affordable options while simultaneously reducing waste (Singh et al., 2024).

Technology is increasingly integrated into food waste management (Torrejón-Ramos, Medina-Salgado & Ortiz-de-Urbina-Criado, 2025). Many businesses use technological tools to intelligently manage their inventories. Smart refrigerators and storage systems can track expiration dates and suggest recipes to make use of ingredients nearing spoilage. Restaurants are analyzing their menus and recipes to minimize leftovers (Sucheran & Olanrewaju, 2021; Singh et al., 2024). Governments and organizations are also leveraging technology to monitor food waste on both national and global levels. For instance, the European Union helps track food waste metrics, which aid in policymaking and compliance with sustainability goals.

While technology is already a significant factor in food waste management, its potential has not been fully realized. Technological solutions require development, which in turn requires funding. Investments in research are needed to enhance collaborative efforts across sectors. Technology can help mitigate the effects of food waste and enable systemic changes needed to build a more sustainable food ecosystem. Technology can help shape a future where food waste is no longer a challenge but an opportunity for progress. We want to strive toward a future where everyone can partake in nourishing meals such as those seen in Figure 2 from the pilot environment. Toward this end, we present technological solutions for food waste management and results from the NextGen project for further advancement in this area.



Figure 2. Pilot Buffet-line

2 NEXTGEN PROJECT

NextGen was a project conducted by the University of Vaasa WasteInsight team that aimed to develop and test solutions for food waste management in the HoReCa sector. Our aim was to develop a new operational model and methods that promote behavioral changes to reduce food waste, in collaboration with staff and customers from our pilot group. Our pilot group consisted of a restaurant that served approximately 15000 customers a month. The aim was to pilot technological and organizational solutions to tackle food waste. Toward this end, we utilized user-friendly and user-centered design to develop solutions for food waste prediction and management. The NextGen project continues the University of Vaasa's WasteInsight team's systematic work to reduce food waste.

2.1 Project Timeline

The NextGen project was implemented over a two-year period between April 2023 and June 2025, as shown in Figure 3. The project consisted of four work packages with the shared goal of reducing food waste via different means, including demonstrations and workshops. From the perspective of technology, we developed, piloted, and coordinated the integration of technology and data-driven smart waste management solutions in the pilot group. This was done in combination with a push toward behavioral transformation and the adoption of sustainability-focused attitudes, behavioral models and actions in the pilot group.

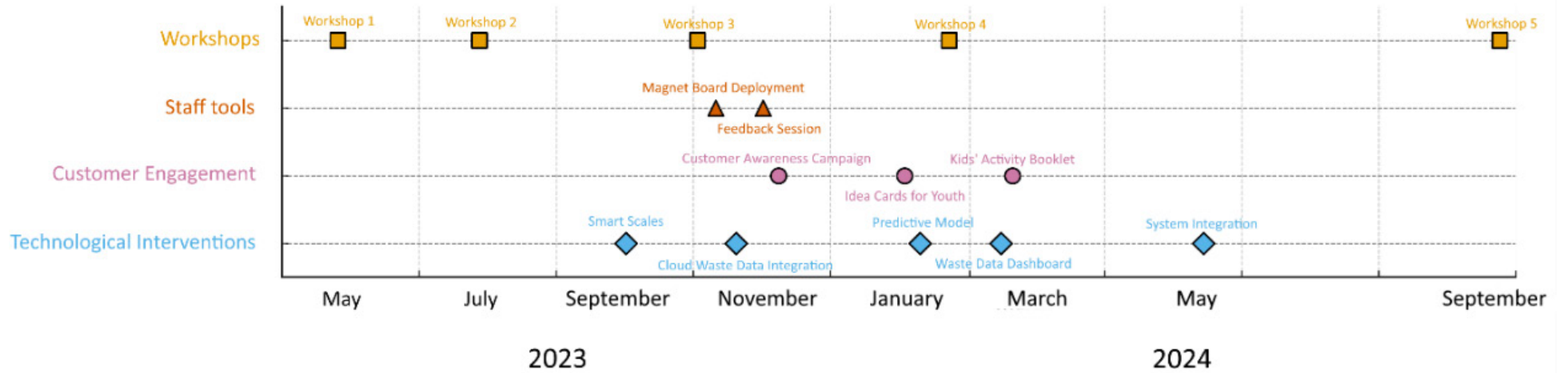


Figure 3. Project Timeline and Steps

We held five workshops in which we co-developed, tested, and deployed the tools developed during the project. The workshops were used for engaging with stakeholders with the aim of integrating different types of technological and organizational tools into the pilot environment and employee workflows. The tools consisted of staff tools, customer engagement tools, and technological tools. Staff tools were meant to facilitate ideation, continuous development, employee empowerment, behavioral change, and stakeholder engagement. The magnet board introduced into the pilot environment served as a tool that enabled staff to enact systematic changes. Customer engagement was achieved through an awareness campaign, idea cards, and activity booklets. These were meant to facilitate engagement with food waste-related themes and provide actionable tools for both customers and staff. Technological tools were integrated into the pilot through an iterative process, first by introducing the smart waste scales into the environment. This facilitated waste measurement and data collection on the types and amounts of waste produced. This information was integrated into the cloud, which enabled the training of a predictive model based on the data. The food waste data and predictions were combined within a data dashboard that was integrated into the pilot environment and made available to staff for data-driven decision-making. We followed this up with training and tutorial sessions with staff to ensure successful integration into employee workflows. By integrating data insights from the system, we managed to facilitate actionable decision-making through data at each step of the food waste management life cycle.

2.2 System Infrastructure

In our project, we aimed to use a comprehensive approach to tackle food waste management in the pilot location. Thus, we incorporated food waste scales, measuring systems, customer information systems, predictive models, and user-centered design principles into a holistic system. Figure 4 shows each layer and key component in our food waste management system that together enabled the pilot organization to tackle food waste. As the figure indicates, food waste management in our solution starts at the device layer, in which smart scales, sensors, and customer management systems collect the necessary data to facilitate intelligent data-driven food waste management. The data goes through to the integration layer, where APIs from our project partners provide the necessary functionality to turn raw data into actionable insights. The data is aggregated over time and combined with existing data to enable the accumulation of information and provide sufficient data for generating insights. This data is fed into the machine learning engine that uses a predictive model to find connections in the data, which enables it to make predictions about future waste. The prediction engine can be used to figure out how different variables, such as menus and recipes, affect produced waste. Predictions from the predictive analytics engine in our solution are visualized via user interfaces and data dashboards that are available both virtually and locally in the pilot

environment. This enables staff to incorporate insights directly and immediately into their workflows without needing to step away from their tasks to see the data. We used participatory design principles to build the user interface and data dashboards displayed in our pilot group's environment. This ensured that the data was useful for the staff while facilitating adoption and use.

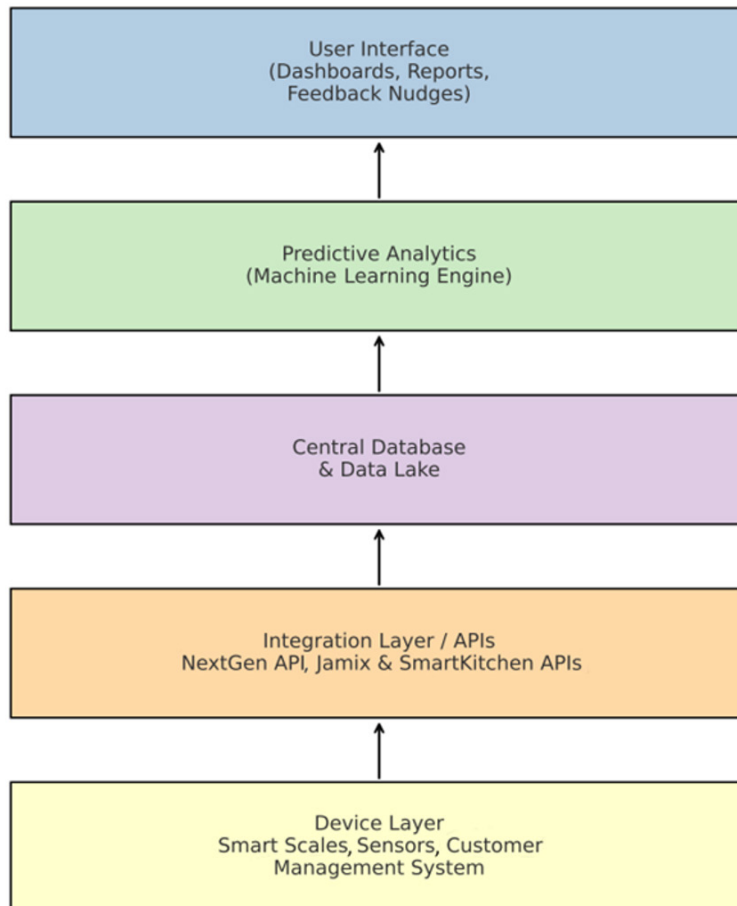


Figure 4. NextGen System Architecture

The NextGen System Architecture C4 model depicted in Figure 5 combines elements and systems from different partners and stakeholders. It visually represents the components, connections, and flow of processes within the system. It provides a comprehensive overview of the system structure and functionality. The NextGen system infrastructure consists of the sources of data (Customer Management System, Smart Scales), APIs by our project partners and our own (Jamix API, SmartKitchen API, NextGen API), the predictive model, and the user interface that displays the data. The system architecture outlines the different layers and components that comprise the system developed in our project. The graph provides a blueprint others can follow to operationalize food waste management. Subsequent sections elucidate the purposes of each system and component.

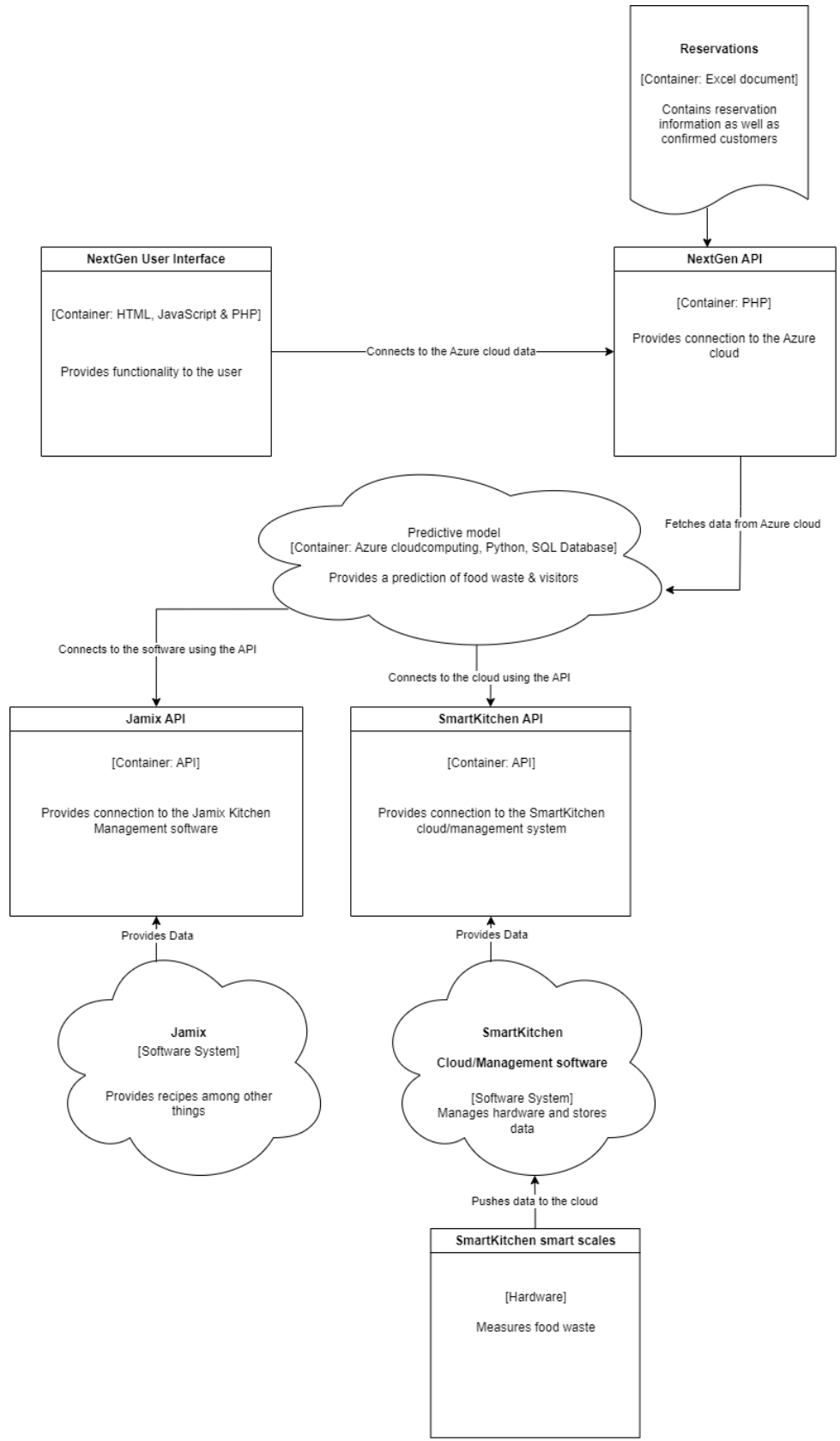


Figure 5. NextGen System Architecture C4 model

3 FOOD WASTE MANAGEMENT CYCLE

The food waste management cycle consists of measuring, tracking, predicting, and utilizing data. Each step builds on the previous one and facilitates the development of further insights into the organization's food waste management operations. Each step is also accompanied by a description of technological solutions, which integrate into employee workflows and help make food waste management more approachable. As the chapter outline indicates, food waste management is an involved process and requires proactivity at each step of the waste management cycle. None of the steps or phases can be omitted without losing the benefits of waste reduction. Yet, when implemented systematically, food waste management can have noticeable impacts on both sustainability of operations and financial performance. As such, food waste management via technological means is highly incentivized for organizations, and there is an increasing number of options available for organizations to choose from. This enables each organization to choose the technological solutions that best fit its situation.

3.1 Measuring

At the foundation of food waste management are waste scales that quantify how much food goes into the bin. These devices measure the weight of produced food and help categorize food that goes to waste. They integrate with other infrastructures to allow the collection and analysis of data, enabling businesses to track waste patterns and identify inefficiencies. Waste scales in our pilot were used to monitor kitchen, service line, and plate waste daily. This data was collected systematically and logged into a database for further processing. By integrating food waste scales into the pilot environment, the first steps toward food waste management could be taken. Figure 6 shows a food waste scale monitor from our pilot group. Categories of food waste as seen on the monitor are line waste (jakeluhävikki), plate waste (lautashävikki), lunch salads (lounassalaatit), dinner salads (päivällissalaatit), kitchen waste (keittiön biojäte), dinner (päivällinen), and lunch (lounas). The monitor also indicates the amount of waste in kilograms and has a back button. The amount of food is calculated before and after serving customers.

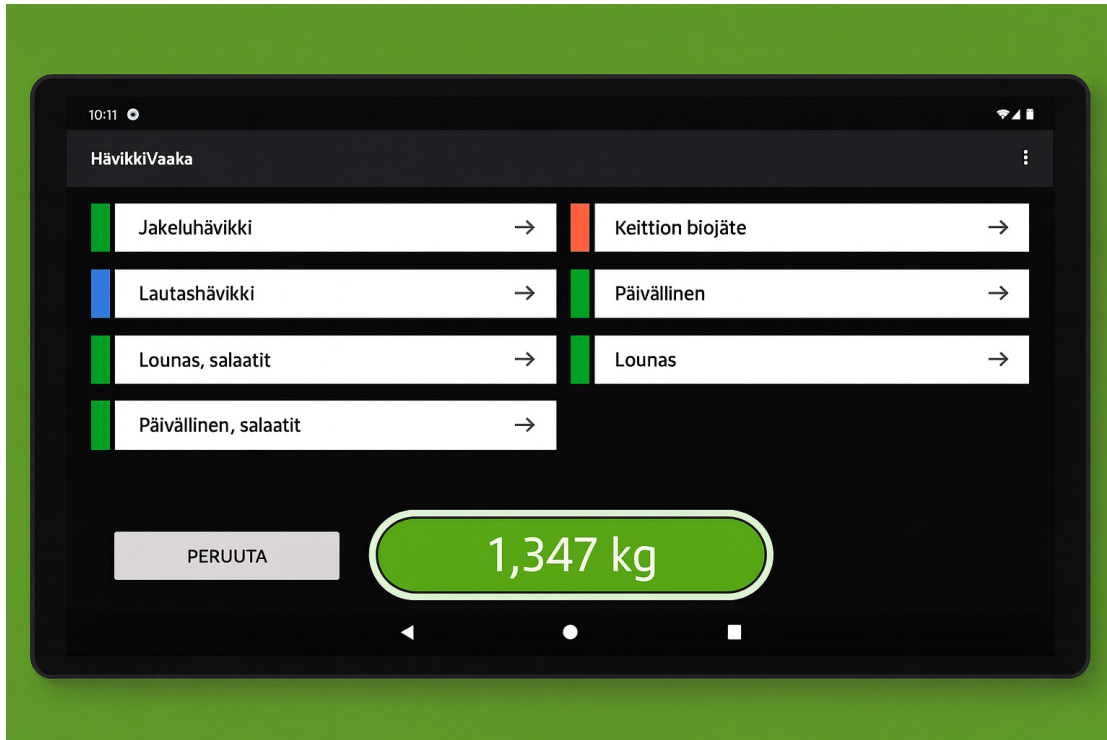


Figure 6. Categories of Measured Waste

Measurable categories of food waste in our pilot were divided into three main types: service line, kitchen, and plate waste, which is the industry standard. This is also the case with the SmartKitchen Oy waste scales utilized in the NextGen project. These are the key categories of food waste that help identify where waste occurs in professional kitchens. Service line waste encompasses unserved food, such as leftovers from serving lines or buffets. This is often surplus food that can no longer be offered to customers and goes to waste. Kitchen waste is food waste that comes from the preparation of food during kitchen operations. Plate waste, on the other hand, refers to uneaten customer food that is left on plates. Breaking waste into these categories helps kitchens see where waste occurs and develop targeted interventions to reduce waste.

Waste scales generally have digital interfaces that allow staff to record additional information. Waste scales in our pilot allowed staff to log waste data uniformly to minimize manual errors and provide a detailed record of waste patterns. As indicated in Figure 7, detailed instructions are provided for users to minimize errors and to help categorize food waste correctly and efficiently.



Figure 7. Sorting of Food Waste

Figure 8 shows the two critical steps, 1) preparation (valmistus) and 2) waste (hävikki), at which point the food is measured.

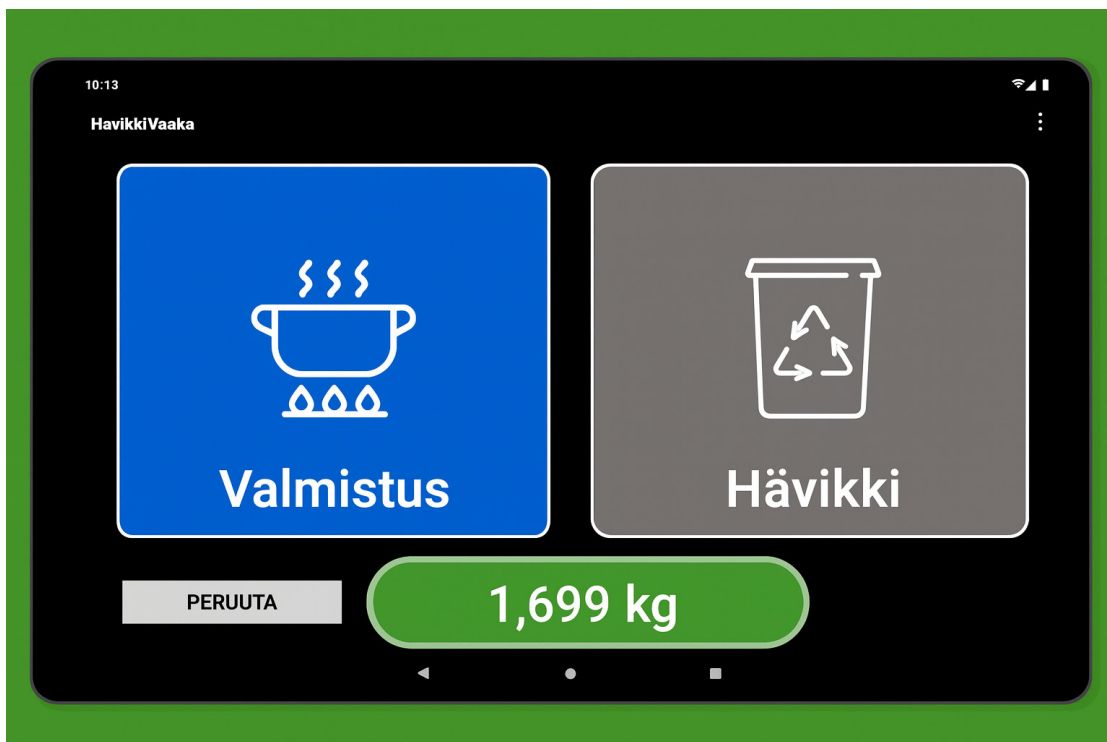


Figure 8. Smart Kitchen Food Waste Measurement User Interface

Clear instructions ensured that food waste data was logged efficiently, reducing the need to train new workers on the job. This reduces the need for constant oversight and frees up resources for other, more pressing tasks. Embedding waste management into every step of kitchen and dining area operation and the daily activities of employees had a critical effect on behaviors and resulted in systematic changes.

Systematically measuring waste allowed kitchen staff to make data-driven decisions about food production quantities, leading to the adjustment of recipes. Food waste scales offer immediate feedback on waste quantities, helping employees make better decisions. Food waste scales in our pilot were integrated with software systems to provide real-time data analytics. By analyzing waste data, the pilot staff were able to identify trends in recurring overproduction of carbohydrates like potatoes and rice, as well as certain salads that led to large, repeated amounts of food waste. This allowed the kitchen to adjust preparation quantities, leading to reduced waste.

3.2 Tracking

Organizations can effectively cut costs and improve efficiency by tracking food waste. This process is multifaceted and necessitates the tracking of spoiled products, surplus food from preparation, and food left uneaten by customers in order to make insights possible. Waste scales in our pilot enabled staff to weigh and categorize waste by type and source. This data helped the kitchen notice inefficiencies and identify patterns of consistent overproduction of certain foods. In our pilot, certain carbs and salads were consistently overproduced, which signaled a need to readjust portion sizes and led to the refinement of menus and recipes.

Spoiled products, overproduction, trimmings, and plate leftovers can all be itemized during kitchen operations, allowing staff to break down where waste occurs. This level of granularity helps staff and management make effective changes. Inefficiencies, such as over-ordering ingredients, poor storage practices, or large portion sizes, can be identified in the data, providing clear targets for action. Figure 9 shows a breakdown of food waste from a waste scale in our pilot.

Päivällinen/Gratinoitua ananasbroileria	29.24
Päivällinen/Keitetyt perunat	14.734
Päivällinen/Koskenlaskijankasvis-soijahöystö	6.41
Päivällinen/Marjakiisseli	13.73
Päivällinen/Nakkikastike	25.16
Päivällinen/Parsakaali	4.806
Päivällinen/Riisi, pitkäriisi	10.256
Päivällinen, salaattit/Kaaliraaste marinoitu	6.397
Päivällinen, salaattit/Kurkku tuore	
Päivällinen, salaattit/Perunasalaatti, valmis atria	
Päivällinen, salaattit/Tomaatti, kirsikkatomaatti	
Päivällinen, salaattit/Vihersalaatti	

Kategoria	Nimike	Määrä	Syy	Raportointi	Aika	Tuhoa
Päivällinen, salaattit	Kaaliraaste marinoitu	0,7 kg	Määrittelemättä		14:05	X
Lounas	Riisi, basmati	0,7 kg	Määrittelemättä		14:09	X
Päivällinen	Parsakaali	2,0 kg	Määrittelemättä		19:06	X
Päivällinen, salaattit	Kurkku tuore	1,8 kg	Määrittelemättä		19:07	X
Päivällinen	Riisi, pitkäriisi	2,1 kg	Määrittelemättä		19:08	X
Päivällinen	Nakkikastike	5,0 kg	Määrittelemättä		19:09	X
Yhteensä		12,2 kg				

Figure 9. Depiction of Food Waste Categorization

In our pilot, food production and customer demand were effectively aligned by tracking, itemizing, and categorizing food waste systematically, which in turn facilitated prediction of potential waste. Over time, these practices led to substantial savings in operational costs and decreased waste produced in the pilot's operations. The results can be seen in Figure 10. Waste tracking and itemization also allowed the pilot to comply with regulations and helped demonstrate their commitment to responsible resource management.

Customer Management Systems are used in tandem with waste tracking to predict customer volumes and waste. By tracking both data streams, overproduction can be mitigated. Predicting customer volumes allows kitchens to adjust staffing, inventory, and production schedules to meet demand more accurately. In the pilot, both visitor amounts and food waste were tracked.

Total Waste	2023				2024								2025								Total	Total waste Change g/D	
	September	October	November	December	January	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April			May
Diners	15919	16453	15593	12912	18066	19761	17420	14931	13980	17339	21235	17061	16972	16661	16747	12147	18208	17662	17327	14845	14835	346074	
Total waste in grams	2819365	2572995	2340781	2346780	2549974	2139580	1912188	1326709	1291718	1776933	1548473	1460046	1117756	1302594	1416296	1220188	1174217	1322676	1358180	1163310	1071153	35231912	-75,30
Total waste in grams per diner	177,11	156,38	150,12	181,75	141,15	108,27	109,77	88,86	92,40	102,48	72,92	85,58	65,86	78,18	84,57	100,45	64,49	74,89	78,39	78,36	72,20	101,80	-42,52 %
Kitchen biowaste	2023				2024								2025										
	September	October	November	December	January	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	Total	
Biowaste in grams	2361906	2099172	1894981	1930981	2038954	1654092	793485	549764	517579	893929	620978	698638	344354	485257	672410	615982	509328	574451	571513	461057	458629	20747440	Biowaste Change g/D
Biowaste in grams per diner	148,37	127,59	121,53	149,55	112,86	83,70	45,55	36,82	37,02	51,56	29,24	40,95	20,29	29,13	40,15	50,71	27,97	32,52	32,98	31,06	30,92	59,95	-88,42
% of total waste	83,77 %	81,59 %	80,96 %	82,28 %	79,96 %	77,30 %	41,50 %	41,44 %	40,07 %	50,31 %	40,10 %	47,85 %	30,81 %	37,26 %	47,48 %	50,48 %	43,37 %	43,42 %	42,07 %	39,64 %	42,82 %	58,89 %	-59,59 %
Plate waste	2023				2024								2025										
	September	October	November	December	January	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	Total	
Plate waste in grams	457459	473823	445800	415799	511020	485488	470398	342588	374955	476130	525100	503332	423073	465734	451946	366407	441917	473820	475360	450088	375028	9405265	Plate waste Change g/D
Plate waste in grams per diner	28,74	28,80	28,59	32,20	28,29	24,57	27,00	22,94	26,82	27,46	24,73	29,50	24,93	27,95	26,99	30,16	24,27	26,83	27,43	30,32	25,28	27,18	-1,56
% of total waste	16,23 %	18,42 %	19,05 %	17,72 %	20,04 %	22,69 %	24,60 %	25,82 %	29,03 %	26,79 %	33,91 %	34,47 %	37,85 %	35,75 %	31,91 %	30,02 %	37,63 %	35,83 %	34,99 %	38,69 %	35,01 %	26,70 %	-5,43 %
Line waste	2023				2024								2025										
	September	October	November	December	January	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	Total	
Line waste in grams							648305	434357	399184	406874	402395	258076	350329	351603	291940	237799	222972	274405	311307	252165	237496	5079207	Line waste Change g/D
Line waste in grams per diner							37,22	29,09	28,55	23,47	18,95	15,13	20,64	21,10	17,43	19,58	12,25	15,54	17,97	16,99	16,01	20,53	-16,69
% of total waste							33,91 %	32,74 %	30,90 %	22,90 %	25,99 %	17,68 %	31,34 %	26,99 %	20,61 %	19,49 %	19,00 %	20,75 %	22,93 %	21,68 %	22,17 %	14,42 %	-44,84 %

Figure 10. Itemization of Food Waste with Targets

The data includes monthly totals of food waste broken down into three categories: 1) Kitchen Waste, 2) Plate Waste, and 3) Service Line Waste. For each month, we have the total waste in grams, the waste in grams per diner, and each category's percentage share of the total waste. Below, we visualize and break down the food waste data over the project period to illustrate trends and the effects of project interventions. The line graph in Figure 11 shows how the amount of food waste evolved from month to month for each waste category.

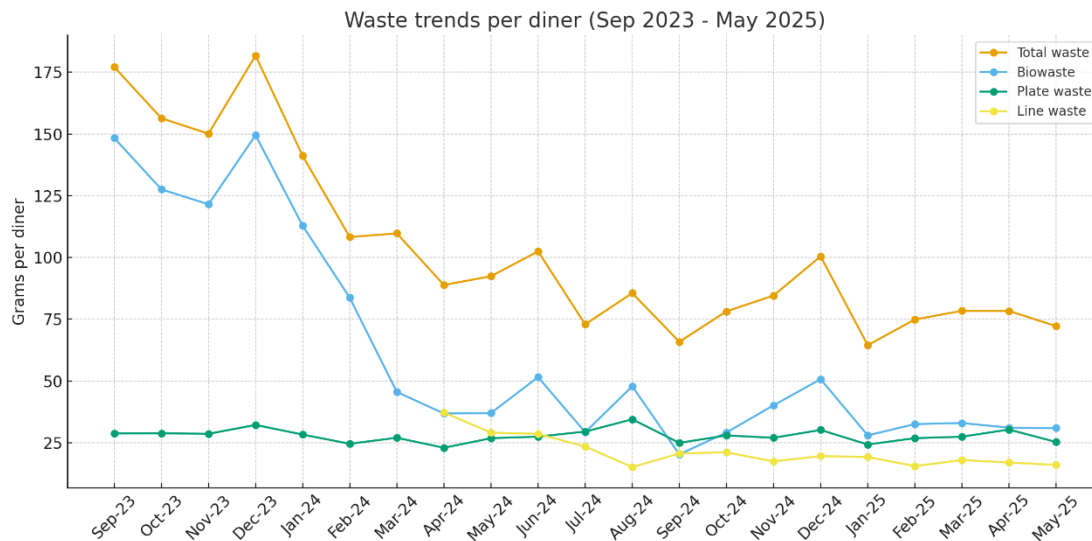


Figure 11. Line Plot of Changes in Monthly Food Waste

In our pilot, monthly food waste was tracked by category throughout the period from September 2023 until June 2025. The orange line, seen in Figure 11, represents the total food waste each month, which declines markedly over the tracking period. In September 2023, total waste was 175 grams per diner and in May 2025, it was 75 grams per diner. The blue line, seen in Figure 11, represents kitchen biowaste, which was a major source of waste in our pilot in the first half of the tracking period. Through systematic changes, the kitchen was able to dramatically reduce waste in the first months of the project. This reduction in waste was attributed to the introduction of waste scales, organizational changes, and shifts in staff attitudes. Kitchen biowaste was further reduced in the following months until the project's end. In September 2023, kitchen biowaste was 150 grams per diner and in May 2025, it was 30 grams per diner. The green line, seen in Figure 11, indicates that plate waste stayed relatively steady throughout the project, moving between 25 and 30 grams per diner per month. This constitutes a consistent portion of total waste, which was not affected by project interventions. Plate waste is a consistent issue in the sector, especially in buffet-style restaurants. The yellow line, seen in Figure 11, shows that service line waste was zero throughout the first months of the project due to the later installation date of the scale meant to track it. Starting from March 2024, once waste scales for service line waste were put into place, service line waste accounted for roughly 15 to 35 grams per diner per month. As we

can see in the food waste data from our pilot, changes in operational procedures, technological interventions, and behavioral nudging can significantly reduce food waste, which in our pilot was a 42.52 percent average reduction in produced monthly food waste.

3.3 Predicting

With the waste data measured and tracked, the next step is to predict future waste so proactive steps can be taken. Toward this end, the collected data undergoes processing to extract meaningful and actionable information for staff. In our pilot, the processed data was fed into a predictive model, which predicted future waste based on historical data, real-time inputs, and advanced algorithms. Predictive models generally rely on vast amounts of data, which are continually collected via different systems, such as food waste scales, customer management systems, and peripheral information sources. The predictive model for our pilot was trained on waste data from a few months of operation, which enabled the establishment of a baseline for the model. After the initial training, the model was continually fed new waste data and eventually retrained with this newly collected data. This continuous process enabled the predictive model to identify patterns and correlations within the data. In this manner, predictive models establish a foundation for accurately anticipating future waste and taking proactive actions to prevent waste.

The predictive model used in NextGen functions by modeling the relationships between menu items, recipes, portion sizes, and food waste. By utilizing machine learning algorithms, the model can refine predictions over time, learning from past data. For example, because of measuring and tracking waste in our pilot, the kitchen identified that major categories of carbohydrates, such as potatoes, rice, and pasta, produced a high amount of waste. Additionally, certain vegetarian options were shown to consistently result in more waste due to low customer preference. These insights enabled the pilot kitchen to make informed decisions and reduce waste. In the case of major carbohydrates, the decision was made to further utilize leftover amounts of produced food, for example, making flatbread out of leftover potato mash. As we can see, predictive models enable a multitude of preventive measures, providing recommendations to staff, such as modifying recipes or adjusting production. This proactive approach helps kitchens plan more efficiently, reducing overproduction and mitigating the costs of food waste.

Predictive models can utilize collected data from sales patterns, customer metrics, menu preferences, inventory levels, and historical waste records, to name a few. Predictive models can also incorporate external data sources and variables. In-season ingredients, holidays, weather, and promotional events all affect food waste in different ways by influencing food consumption behaviors. By identifying patterns in human behavior and kitchen operations,

predictive models can make correlations in the data to establish a foundation for accurate waste prediction.

3.4 Utilizing

Measuring, tracking, and predicting food waste do not by themselves reduce food waste if the data is not usable by staff. Data dashboards and user interfaces are needed to make data useful and help staff make informed decisions. This requires making complex data easy to understand for a varied audience, which might include staff with less experience using technology. Raw data and analytical output need to be transformed into understandable visualizations such as charts, graphs, and heatmaps to allow staff and managers to easily interpret waste trends and patterns without needing specialized technical expertise. In our pilot, we co-designed user interfaces with staff to empower them and make data-driven decision-making feasible without needing to understand the technical complexities under the hood of the system. Figure 12 depicts one of the data dashboards developed for our pilot group. It presents predictions about daily and weekly waste, showing relevant data for staff. The user interface gives access to key information and allows the user to navigate and seek out relevant details when necessary. By providing relevant data at key points during operational hours, staff are empowered to quickly access task-specific information without unnecessarily interrupting workflows. The data pipeline thereby removes the burden on employees during busy hours of the day and enables efficiency at each step.

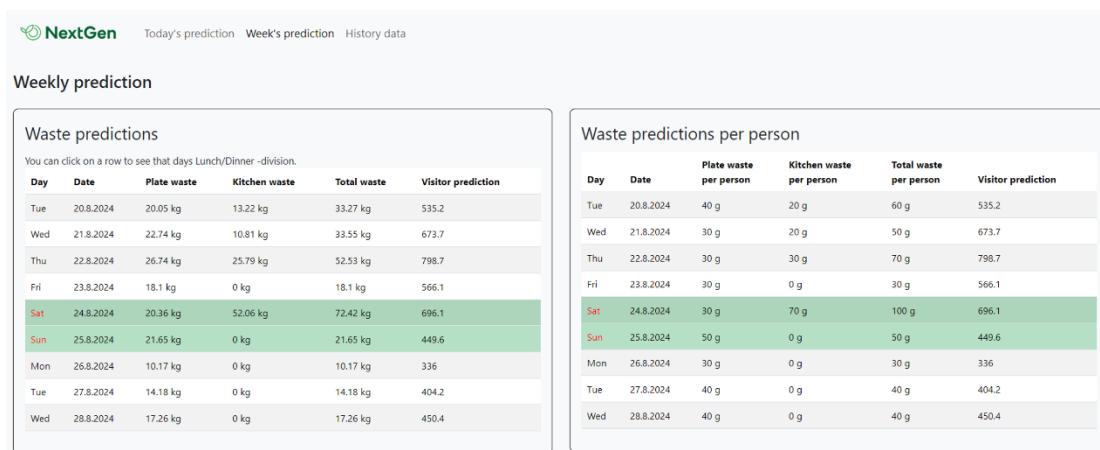


Figure 12. NextGen User Interface Data Dashboard

Data dashboards that display real-time data can help staff get a perspective on important metrics like visitor volume predictions, current inventory status, levels of produced waste, and prediction accuracy. These insights allow the staff to adjust, such as scaling production or reallocating resources whenever and wherever needed. As Figure 13 indicates, through

user-centered and accessible design, we were able to turn data into a tool for workers. This resulted in increased efficiency and reduced waste.

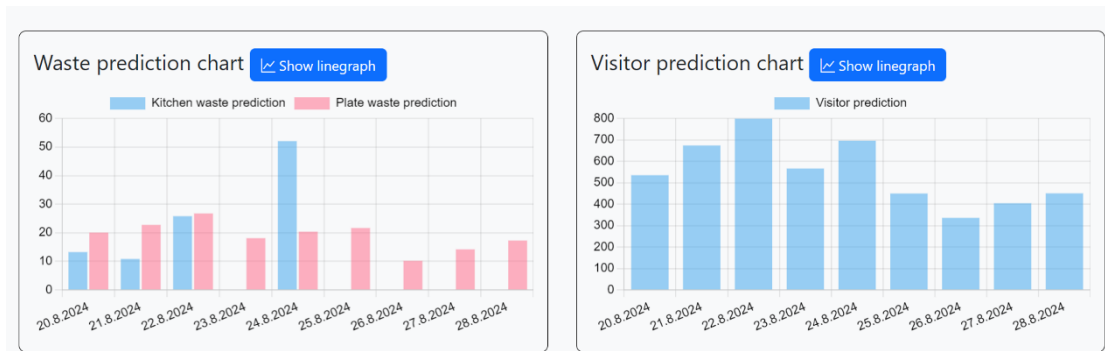


Figure 13. Waste and Visitor Prediction Charts

User interfaces made it possible to deliver actionable recommendations to staff, which enabled us to translate predictive model outputs into practical suggestions. By displaying waste data, staff were able to align food production with predicted demand. This data also allowed teams to work together by being on the same page about what is happening in different locations. User interfaces displaying key data ensure that all staff members work collectively toward the same goal of reducing food waste. This further enables new staff to gain a comprehensive view of the kitchen operations, empowered by data. User interfaces thereby bridge the gap between predictive analytics and effective operational strategies.

3.5 User-centered Design

We aimed to continuously develop and improve operations through iterative changes in the pilot environment. This approach was chosen to allow staff to familiarize themselves with the changes that were made. Feedback from the pilot group's staff was continually incorporated into the development and design of solutions. This entailed testing and gathering feedback constantly to empower staff and facilitate participatory design of solutions. Additionally, this enabled us to receive continual feedback from end users who interacted with technology daily. We also engaged with broader audiences by presenting results at different events, receiving feedback from other stakeholders. As the project phase map seen in Figure 14 indicates, active stakeholder engagement and user-centered design were cornerstones of our approach. This was a deliberate choice, since our aim was to provide actionable tools for staff.

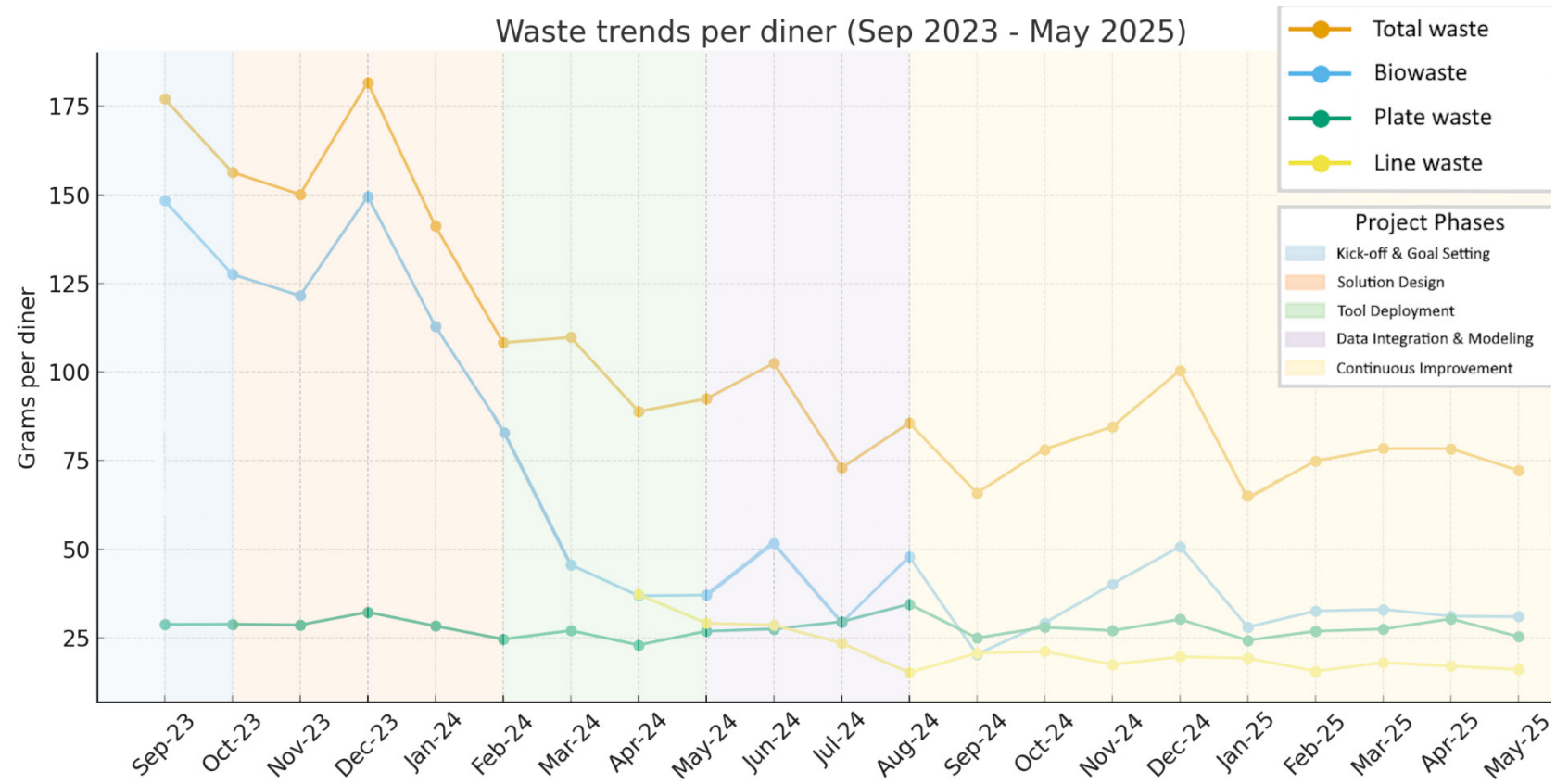


Figure 14. Project Phases and Food Waste Reduction

Technology and other intervening measures were developed and implemented iteratively, allowing for more permanent adoption and long-lasting changes in behavior. This entailed holding workshops consistently throughout the project's life cycle and iteratively introducing and incorporating new technologies into the pilot environment. This promoted employee empowerment and led to a shallower learning curve, which resulted in enthusiasm and willingness to adopt technologies. Due to the extended timeline of the project, we were able to develop and implement solutions with staff in an ongoing manner, which further enhanced user adoption and motivation.

User-centered design, usability, and accessibility were key factors for our design process. They were essential in creating solutions that supported technology integration in the pilot environment. As such, we were able to ensure that technology was tailored to the preferences and skills of the intended users. We involved users throughout the design process, from requirements engineering to prototyping, thereby creating solutions with clear aims and goals. Technological solutions in our pilot had minimal learning curves and seamlessly integrated into daily operations, making waste management tools more likely to be adopted and consistently used. Simplicity, responsiveness, and time efficiency were core factors in our design, so staff could quickly access critical information and make informed decisions without wasting time, leading to less frustration and errors. Accessibility was also a major contributing factor, as our aim was to accommodate diverse user needs. Together, these principles ensured that technologies were not only functional but also accessible to a wider cohort of users.

Toward these ends, we utilized workshops, demos, interviews, and co-design measures to build the systems, architecture, and design flow in a user-centered manner. The information received from end-users highlighted which aspects of the technology should be further developed and how user groups can best utilize the data received from the technologies in their daily operations. For instance, the initial design included daily and weekly information about waste and customer levels that were displayed to the user, but based on feedback from staff we included a navigation feature that allowed users to switch back and forth between different days. This was seen as especially helpful by the staff for the purposes of comparison. Another useful design feature that was added based on feedback was the inclusion of a dish-based search functionality into the history tab of the user interface. Staff wanted to compare how different dishes have performed on different days and also wanted to see what else was served on those days to more accurately estimate desirability. Feedback from end-users also provided tools for designing the predictive model, user interface, and data pipeline from the perspectives of accessibility and clarity by emphasizing overlaps and contradictions in the needs and capabilities of different user groups. For instance, kitchen staff were mostly interested in the history data and wanted to do comparison between different dishes and waste amounts. Meanwhile, service staff were more interested in visitors, waste amounts and

daily predictions. Thus, we designed tabs in the UI in a manner that would best suite different user groups and would enable them to locate the specific information they need easily. Feedback gathered during the workshops clarified the level of detail and formats in which the data is genuinely useful to them (e.g. metrics and units), as well as how this data should be presented (e.g. types of charts, graphs and tables that were most useful) to enhance staff efficiency rather than acting as a barrier or hindrance to task execution.

4 FUTURE DEVELOPMENT

In recent years, organizations have increasingly started to incorporate artificial intelligence and machine learning into the food waste management cycle. Recent trends indicate that artificial intelligence and machine learning are becoming more visible and integrated parts of HoReCa sector operations. Data and intelligent decision-making have transformed food waste from an inevitable cost of doing business to a manageable issue. Technology has transformed food waste management from a reactive, imprecise endeavor into a proactive, data-driven science. Currently, kitchens can mitigate food waste and take preventive measures in near real-time. Pilots and prototypes are steadily being adopted by organizations and new solutions and innovations are increasingly being seen in organizational operations.

Yet, there is still a lot that can be done. Underutilized data streams and broader data ecosystems hold significant potential for improving food waste management. Tapping into broader data economies and ecosystems can significantly enrich predictions and preventive measures. For instance, a sudden shift in weather conditions or a local event could tremendously affect customer volumes. Information regarding such phenomena is already available, but it requires collaboration with external stakeholders and entities. Sector crossing collaboration could enable organizations and companies to make new insights. This would enable kitchens to anticipate fluctuations and prepare accordingly, reducing waste and improving operational efficiency. By leveraging these underutilized data streams, food waste management systems can become more dynamic, adaptive, and precise over time.

In Finland and the broader Nordic region, a combination of technological innovation, environmental consciousness, and cross sector collaboration have led to impressive results. The developments of the last five years have given plenty of reasons for optimism and with continued innovation, we can significantly reduce the amount of food that ends up in landfills. Successes in food waste management are continuously seen leading to new benchmarks. We feel that our pilot exemplifies one such benchmark. Food waste management enables us to save resources, protect the environment, and move closer to a more sustainable and efficient food system. This is the vision we are actively pursuing, and we hope you will join us in the fight against food waste.

References

- Aamir, M., Ahmad, H., Javaid, Q., & Hasan, S. M. (2018). Waste not, want not: a case study on food waste in restaurants of Lahore, Pakistan. *Journal of Food Products Marketing*, 591-610. <https://doi.org/10.1080/10454446.2018.1472695>
- Ahamed, A., Yin, K., Ng, B. J., Ren, F., Chang, V. C., & Wang, J. Y. (2016). Life cycle assessment of the present and proposed food waste management technologies from environmental and economic impact perspectives. *Journal of Cleaner Production*. <https://doi.org/10.1016/j.jclepro.2016.04.127>
- Al-Obadi, M., Ayad, H., Pokharel, S., & Ayari, M. A. (2022). Perspectives on food waste management: Prevention and social innovations. *Sustainable Production and Consumption*, 190-208. <https://doi.org/10.1016/j.spc.2022.02.012>
- Aytaç, K., & Korçak, Ö. (2021). IoT based intelligence for proactive waste management in Quick Service Restaurants. *Journal of Cleaner Production*. <https://doi.org/10.1016/j.jclepro.2020.125401>
- Batool, F., Kurniawan, T. A., Mohyuddin, A., Othman, M. H., Aziz, F., E., A.-H. H., . . . Anouzla, A. (2024). Environmental impacts of food waste management technologies: A critical review of life cycle assessment (LCA) studies. *Trends in Food Science & Technology*. <https://doi.org/10.1016/j.tifs.2023.104287>
- Baul, T. K., Sarker, A., & Nath, T. K. (2021). Restaurants' waste in Chittagong city, Bangladesh: Current management, awareness on environmental hazard and perception towards potential uses. *Journal of Cleaner Production*. <https://doi.org/10.1016/j.jclepro.2021.126073>
- Bharucha, J. (2018). Tackling the challenges of reducing and managing food waste in Mumbai restaurants. *British Food Journal*, 639-649. <https://doi.org/10.1108/BFJ-06-2017-0324>
- Buczacki, A., Gładysz, B., & Palmer, E. (2021). HoReCa food waste and sustainable development goals—A systemic view. *Sustainability*. <https://doi.org/10.3390/su13105510>
- Charlebois, S., Creedy, A., & von Massow, M. (2015). "Back of house"—focused study on food waste in fine dining: the case of Delish restaurants. *International Journal of Culture, Tourism and Hospitality Research*, 278-291. <https://doi.org/10.1108/IJCTHR-12-2014-0100>
- Coşkun, A., & Özbük, R. M. (2020). What influences consumer food waste behavior in restaurants? An application of the extended theory of planned behavior. *Waste Management*, 170-178. <https://doi.org/10.1016/j.wasman.2020.08.011>
- Della Corte, V., Amin, M., Sepe, F., Luongo, S., & Cobanoglu, C. (2025). Exploring the impact of environmental management on sustainable concerns in restaurants. *British Food Journal*. <https://doi.org/10.1108/BFJ-04-2024-0327>
- Di Pierro, R., Frasnetti, E., Bianchi, L., Bisagni, M., Capri, E., & Lamastra, L. (2023). Setting the sustainable development targets for restaurants and Italian HoReCa sector. *Science of the Total Environment*. <https://doi.org/10.1016/j.scitotenv.2022.158908>

- Dumitru, O. M., Iorga, C. S., & Mustatea, G. (2021). Food waste along the food chain in Romania: an impact analysis. *Foods*. <https://doi.org/10.3390/foods10102280>
- Farahdiba, A. U., Warmadewanthi, I. D., Fransiscus, Y., Rosyidah, E., Hermana, J., & Yuniarto, A. (2023). The present and proposed sustainable food waste treatment technology in Indonesia: A review. *Environmental Technology & Innovation*. <https://doi.org/10.1016/j.eti.2023.103256>
- Filimonau, V., & Sulyok, J. (2021). 'Bin it and forget it!': The challenges of food waste management in restaurants of a mid-sized Hungarian city. *Tourism Management Perspectives*. <https://doi.org/10.1016/j.tmp.2020.100759>
- Filimonau, V., Algboory, H., Mohammed, N. K., Kadum, H., Qasem, J. M., & Muhialdin, B. J. (2023). Food waste and its management in the foodservice sector of a developing economy: An exploratory and preliminary study of a sample of restaurants in Iraq. *Tourism Management Perspectives*. <https://doi.org/10.1016/j.tmp.2022.101048>
- Filimonau, V., Coşkun, A., Derqui, B., & Matute, J. (2022a). Restaurant management and food waste reduction: factors affecting attitudes and intentions in restaurants of Spain. *International Journal of Contemporary Hospitality Management*, 1177-1203. <https://doi.org/10.1108/IJCHM-07-2021-0899>
- Filimonau, V., Fidan, H., Alexieva, I., Dragoev, S., & Marinova, D. D. (2019). Restaurant food waste and the determinants of its effective management in Bulgaria: An exploratory case study of restaurants in Plovdiv. *Tourism Management Perspectives*. <https://doi.org/10.1016/j.tmp.2019.100577>
- Filimonau, V., Matyakubov, U., Allonazarov, O., & Ermolaev, V. A. (2022b). Food waste and its management in restaurants of a transition economy: An exploratory study of Uzbekistan. *Sustainable Production and Consumption*, 25-35. <https://doi.org/10.1016/j.spc.2021.09.018>
- Filimonau, V., Nghiem, V. N., & Wang, L. E. (2021). Food waste management in ethnic food restaurants. *International Journal of Hospitality Management*. <https://doi.org/10.1016/j.ijhm.2020.102731>
- Filimonau, V., Todorova, E., Mzembe, A., Sauer, L., & Yankholmes, A. (2020). A comparative study of food waste management in full service restaurants of the United Kingdom and the Netherlands. *Journal of Cleaner Production*. <https://doi.org/10.1016/j.jclepro.2020.120775>
- Filimonau, V., Zhang, H., & Wang, L. E. (2020). Food waste management in Shanghai full-service restaurants: A senior managers' perspective. *Journal of Cleaner Production*. <https://doi.org/10.1016/j.jclepro.2020.120975>
- Gładysz, B., Buczacki, A., & Haskins, C. (2020). Lean management approach to reduce waste in HoReCa food services. *Resources*. <https://doi.org/10.3390/resources9120144>
- Gruia, R., Florescu, G. I., Gaceu, L., Oprea, O. B., & Țane, N. (2021). Reducing environmental risk by applying a polyvalent model of waste management in the restaurant industry. *Sustainability*. <https://doi.org/10.3390/su13115852>

- Hartikainen, H., Riipi, I., Katajajuuri, J.M., Silvennoinen, K. (2020). From Measurement to Management: Food Waste in the Finnish Food Chain. In: Närvänen, E., Mesiranta, N., Mattila, M., Heikkinen, A. (eds) *Food Waste Management*. Palgrave Macmillan, https://doi.org/10.1007/978-3-030-20561-4_16
- Joubert, R. L., & Jokonya, O. (2021). A systematic literature review of factors affecting the adoption of technologies in food waste management. *Procedia Computer Science*, 1034-1040. <https://doi.org/10.1016/j.procs.2021.01.298>
- Katajajuuri, J. M., Silvennoinen, K., Hartikainen, H., Heikkilä, L., & Reinikainen, A. (2014). Food waste in the Finnish food chain. *Journal of cleaner production*, 322-329. <https://doi.org/10.1016/j.jclepro.2013.12.057>
- Kfourti, T., Fernandes, A. C., Bernardo, G. L., Proença, L. C., Uggioni, P. L., Rodrigues, V. M., & da Costa Proença, R. P. (2022). Sustainable solid waste management in restaurants: The case of the Ecozinha Institute, Brazil. *International Journal of Gastronomy and Food Science*. <https://doi.org/10.1016/j.ijgfs.2021.100464>
- Lang, L., Wang, Y., Chen, X., Zhang, Z., Yang, N., Xue, B., & Han, W. (2020). Awareness of food waste recycling in restaurants: evidence from China. *Resources, Conservation and Recycling*. <https://doi.org/10.1016/j.resconrec.2020.104949>
- Liang, Y., Song, Q., Liu, G., & Li, J. (2021). Uncovering residents and restaurants' attitude and willingness toward effective food waste management: a case study of Macau. *Waste management*, 107-116. <https://doi.org/10.1016/j.wasman.2021.05.021>
- Martin-Rios, C., Demen-Meier, C., Gössling, S., & Cornuz, C. (2018). Food waste management innovations in the foodservice industry. *Waste management*, 196-206. <https://doi.org/10.1016/j.wasman.2018.07.033>
- Martin-Rios, C., Hofmann, A., & Mackenzie, N. (2020). Sustainability-oriented innovations in food waste management technology. *Sustainability*. <https://doi.org/10.3390/su13010210>
- Matzembacher, D. E., Brancoli, P., Maia, L. M., & Eriksson, M. (2020). Consumer's food waste in different restaurants configuration: A comparison between different levels of incentive and interaction. *Waste Management*, 263-273. <https://doi.org/10.1016/j.wasman.2020.07.014>
- McAdams, B., von Massow, M., Gallant, M., & Hayhoe, M. A. (2019). A cross industry evaluation of food waste in restaurants. *Journal of Foodservice Business Research*, 449-466. <https://doi.org/10.1080/15378020.2019.1637220>
- Principato, L., Di Leo, A., Mattia, G., & Pratesi, C. A. (2021). The next step in sustainable dining: the restaurant food waste map for the management of food waste. *Italian Journal of Marketing*, 189-207. <https://doi.org/10.1007/s43039-021-00032-x>
- Principato, L., Pratesi, C. A., & Secondi, L. (2018). Towards zero waste: An exploratory study on restaurant managers. *International Journal of Hospitality Management*, 130-137. <https://doi.org/10.1016/j.ijhm.2018.02.022>

- Sakaguchi, L., Pak, N., & Potts, M. D. (2018). Tackling the issue of food waste in restaurants: Options for measurement method, reduction and behavioral change. *Journal of Cleaner Production*, 430-436. <https://doi.org/10.1016/j.jclepro.2017.12.136>
- Sehnm, S., Pereira, L. H., Junior, S. S., Bernardy, R. J., & Lara, A. C. (2022). Management of food waste in restaurants by way of circular practices. *Journal of Material Cycles and Waste Management*, 1020-1036. <https://doi.org/10.1007/s10163-022-01377-x>
- Sigala, E. G., Gerwin, P., Chroni, C., Abeliotis, K., Strotmann, C., & Lasaridi, K. (2025). Reducing food waste in the HORECA sector using AI-based waste-tracking devices. *Waste Management*, 77-86. <https://doi.org/10.1016/j.wasman.2025.02.044>
- Silvennoinen, K., Nisonen, S., & Katajajuuri, J.-M. (2022). Food Waste Amount, Type, and Climate Impact in Urban and Suburban Regions in Finnish Households. *Journal of Cleaner Production*. <https://doi.org/10.1016/j.jclepro.2022.134430>
- Silvennoinen, K., Nisonen, S., & Pietiläinen, O. (2019). Food waste case study and monitoring developing in Finnish food services. *Waste Management*, 97-104. <https://doi.org/10.1016/j.wasman.2019.07.028>
- Singh, V., Archana, T., Singh, A., & Tyagi, P. K. (2024). Utilizing Technology for Food Waste Management in the Hospitality Industry Hotels and Restaurants. In A. Singh, P. Tyagi, & A. Garg (Eds.), *Sustainable Disposal Methods of Food Wastes in Hospitality Operations* (pp. 287-295). IGI Global Scientific Publishing. <https://doi.org/10.4018/979-8-3693-2181-2.ch019>
- Stoica, D., Micu, A. E., & Stoica, M. (2022). Causes and strategies for plate waste management in the HoReCa sector. "Ovidius" University Annals, Economic Sciences Series, 753-762. Retrieved October 17, 2025, from <https://econpapers.repec.org/RePEc:ovi:oviste:v:xxii:y:2022:i:2:p:753-762>
- Sucheran, S. (2021, March). Food Waste Management of Restaurants in KwaZulu-Natal South Africa. In *11th Annual International Conference on Industrial Engineering and Operations Management*, <https://doi.org/10.46254/AN11.20210011>
- Tatàno, F., Caramiello, C., Paolini, T., & Tripolone, L. (2017). Generation and collection of restaurant waste: Characterization and evaluation at a case study in Italy. *Waste Management*, 423-442. <https://doi.org/10.1016/j.wasman.2017.01.020>
- Tehrani, M., Fulton, L., & Schmutz, B. (2020). Green cities and waste management: The restaurant industry. *Sustainability*. <https://doi.org/10.3390/su12155964>
- Torrejón-Ramos, M., Medina-Salgado, M. S., & Ortiz-de-Urbina-Criado, M. (2025). The Horeca Supply Chain: An analysis of the Food and Loss Waste Management literature characteristics. *WPOM-Working Papers on Operations Management*. <https://doi.org/10.4995/wpom.22095>
- Vinck, K., Scheelen, L., & Du Bois, E. (2019). Design opportunities for organic waste recycling in urban restaurants. *Waste Management & Research: The Journal for a Sustainable Circular Economy*, 40-50. <https://doi.org/10.1177/0734242X18817714>

Vizzoto, F., Tessitore, S., Iraldo, F., & Testa, F. (2020). Passively concerned: Horeca managers' recognition of the importance of food waste hardly leads to the adoption of more strategies to reduce it. *Waste Management*, 266-275.

<https://doi.org/10.1016/j.wasman.2020.04.010>

Wang, L. E., Liu, G., Liu, X., Liu, Y., Gao, J., Zhou, B. ..., & Cheng, S. (2017). The weight of unfinished plate: A survey based characterization of restaurant food waste in Chinese cities. *Waste Management*, 3-12. <https://doi.org/10.1016/j.wasman.2017.04.007>

Wen, Z., Hu, S., De Clercq, D., Beck, M. B., Zhang, H., Zhang, H. ..., & Liu, J. (2018). Design, implementation, and evaluation of an Internet of Things (IoT) network system for restaurant food waste management. *Waste management*, 26-38.

<https://doi.org/10.1016/j.wasman.2017.11.054>

Wu, C. M., & Teng, C. C. (2022). Reducing food waste in buffet restaurants: a corporate management approach. *Foods*. <https://doi.org/10.3390/foods12010162>

Yu, Q., & Li, H. (2021). Life cycle environmental performance of two restaurant food waste management strategies at Shenzhen, China. *Journal of Material Cycles and Waste Management*, 826-839. <https://doi.org/10.1007/s10163-020-01157-5>