PR3: Development of ADVANCE Roadmap
Task 3.3: Design and Development of Roadmap – HORECA SMEs

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Abbreviations

Abbreviation	Definition
HoReCa	Hotel, restaurant, café accommodation and food service activities
SMEs	Small and medium enterprises
GA	Gap Analysis
CE	Circular Economy
MSW	Municipal solid waste

Executive summary

This report provides a Roadmap for HoReCa SMEs in the context of Task 3.3 (Design and Development of Roadmap - A step-by-step methodological framework for implementing the food waste targets). The first part of the report (Section 2) discusses the background information required to develop a HoReCa -related food waste (FW) reduction Roadmap (e.g., importance of the problem, legislative framework, main barriers and drivers, etc.). The second part of the report (Section 3) analyses the Roadmap development process, and, more specifically how to:

- Conduct a FW survey to understand the scale and scope of FW in the municipality and to identify where, how, and why FW occurs.
- Develop a food waste reduction plan that will include the vision, targets, and priorities of the plan, the strategies and actions for reducing FW across the municipality, the roles and responsibilities of various stakeholders, the identification of funding and resources required to implement the plan, as well as the potential risks.
- Raise awareness to educate the community about the importance of reducing FW and how they can contribute to this target through campaigns, workshops, and events.
- Implement FW reduction practices and follow a timeline.
- Monitor the progress towards FW reduction targets regularly and adjust strategies as necessary.

The Action Plan illustrates the main actions of the FW prevention and reduction Roadmap along with rationale and indicative methods/means and an indicative timeline. By following these steps and continually refining and expanding efforts, a HoReCa business can make significant progress in reducing FW. However, the characteristics particular characteristics of each business should be considered, and, thus, the Action Plan should be customised to fit these specific needs.

The last part of the report (Section 4) focuses on existing best practices, i.e., successful examples from FW management initiatives, as well as from applications of Industry 4.0 technologies that have been used by HoReCa businesses to achieve advance FW prevention and reduction.

1 Introduction

ADVANCE is an EU co-funded project, which is funded by the Erasmus+ programme under the Action "KA220-VET - Cooperation partnerships in vocational education and training" (Agreement no. Project 2021-1-EL01-KA220-VET-000033247).

The main objectives of the ADVANCE project are, as follows:

- To assess the current food waste management practices in selected municipalities and SMEs in the HoReCa sector and compare the assessment results with the best practices in the relevant fields.
- To develop a concrete set of Circularity Indicators that will be used to describe both the current and the future description – monitoring of food waste management.
- To assess the gap between the baseline assessment and the requirements posed by the EU Circular Economy Action Plan using the Circularity Indicators.
- To develop two Roadmaps for municipalities and HoReCa SMEs and a step-by-step methodology to implement the EU Circular Economy Action Plan requirements regarding food waste.
- To prepare all the above as training/educational materials and implement training courses in selected municipalities and SMEs in the HoReCa sector.
- To develop an Open Education Resource online platform which will include & host all the above.

In this direction, ADVANCE will produce the following results:

- Baseline assessment (**PR1**) of the current waste food waste management practices in Municipalities and HoReCa SMEs – the baseline assessment will also include benchmarking to existing best practices in EU.
- Gap Analysis methodology and tool (**PR2**) between current and required, according to the EU targets, waste management practices relevant to food waste. The main outcome of the Gap Analysis will be the Circularity Gap Indicators that could be used in other cases too. These indicators concern both the municipalities involved and the HoReCa SMEs that will participate in the program.
- Development of Roadmaps (**PR3**) – The Roadmaps will be developed in two different types, one for Municipalities and one for HoReCa SMEs.
- ADVANCE Course (**PR4**) – Creation of a training material broken down into certain learning modules for waste management adopted to the needs of target groups
- Open Education Resource (OER) (**PR5**) – An Online Platform, which will include and host interactively all the above.

This document presents the food waste reduction Roadmap for HoReCa SMEs. Specifically, the Roadmap consists a step-by-step methodological process for implementing the food waste targets. A special part of the Roadmap will be to demonstrate how Industry 4.0 can help municipalities to achieve better food waste management and advance food waste prevention.

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2   Setting the stage for the Roadmap

2.1   Scope of Food Waste Reduction

Food loss and food waste have increasingly captured the attention of the public, academic community, and political sphere, leading to a surge in related research (Aschemann-Witzel et al., 2015; Godfray et al., 2010; Gruber et al., 2016). It has been estimated that approximately one-third (1/3) of the food produced goes to waste, resulting in significant resource, energy, environmental, and socio-economic consequences (Eshel et al., 2014).

According to the UNEP Food Waste Index for 2021, the global generation of food waste in 2019 amounted to roughly 931 million tonnes. Among this, households accounted for 61%, food service for 26%, and retail for 13% of the total waste. In 2012, the EU-28 region witnessed food waste estimated at 88 million tonnes, with European households contributing to more than half of this wastage, equivalent to nearly 47 million tonnes annually (Stenmarck et al., 2016). The financial cost associated with this food waste was estimated at approximately €143 billion, with households being responsible for around €98 billion of this total (Stenmarck et al., 2016). In 2020, marking the inaugural year of EU-wide food waste monitoring under Annex III of Commission delegated decision 2019/1597, the EU generated nearly 59 million tonnes of food waste, equivalent to 131 kg per inhabitant, and valued at €132 billion. Of this total, households contributed around 31 million tonnes of food waste (53% of the total), while restaurants and food services accounted for approximately 5 million tonnes (Eurostat, 2023a). A more detailed analysis is shown in Table 1 Table 2. In 2021, based on the most up-to-date sources from WWF-UK (WWF-UK, 2021) and UNEP's Food Waste Index (UNEP, 2021), it was estimated that EU wasted 153.5 million tonnes of food (Feedback EU, 2022). It is noted, however, that these estimates do not follow the methodology set out in Annex III of Commission delegated decision (EU) 2019/1597. As indicated in the Feedback EU report, the primary distinction arises in terms of food waste originating from primary production, as approximately 10% of primary production food waste, equating to nearly 9 million tonnes, aligns with the EU's measurement methodology. Meanwhile, food waste stemming from households and the food service sector is estimated at 32.5 million tonnes and 10.5 million tonnes, respectively.

Table 1. Food waste by sector of activities (in tonnes)

	Total (aggregate changing according to the context)	Primary production of food - agriculture, fishing and aquaculture	Manufacture of food products and beverages	Retail and other distribution of food	Restaurants and food services	Total activities by households
EU-27	58,512,559	6,067,377	11,806,452	4,079,709	5,275,265	31,283,755
Belgium	2,881,897	38,699	1,862,177	73,591	88,333	819,097
Bulgaria	596,844	228,472	156,435	15,708	14,375	181,854
Czechia	972,445	27,022	100,339	64,394	37,941	742,749
Denmark	1,286,488	66,452	596,599	99,500	62,544	461,392
Germany	10,922,321	190,203	1,612,505	762,352	1,860,980	6,496,282
Estonia	166,513	23,612	31,622	19,976	10,739	80,564
Ireland	770,316	70,413	219,453	60,894	178,507	241,048
Greece	2,048,189	372,204	375,158	150,472	220,032	930,323
Spain	4,260,845	845,620	1,419,257	348,219	213,023	1,434,726
France	9,000,000	1,059,000	1,926,000	800,000	1,096,000	4,119,000
Croatia	286,379	40,916	9,866	4,180	15,072	216,345
Italy	8,650,456	1,270,638	510,018	343,535	193,915	6,332,349
Cyprus	354,021	43,564	169,706	50,268	27,145	63,338
Latvia	275,304	32,487	36,107	14,765	35,436	156,509
Lithuania	382,665	81,202	28,057	27,342	4,495	241,570
Luxembourg	92,580	7,384	10,692	8,525	8,739	57,240
Hungary	905,068	16,587	187,391	41,952	19,331	639,806
Malta	79,589	759	4,668	3,910	23,016	47,235
Netherlands	2,811,000	463,045	1,031,407	209,805	83,035	1,023,708
Austria	1,211,534	13,879	173,734	84,326	201,956	737,639
Poland	4,002,099	670,547	544,942	320,396	190,293	2,275,921
Portugal	1,890,712	101,384	61,719	214,233	237,486	1,275,891
Slovenia	143,570	93	10,757	15,290	42,666	74,764
Slovakia	455,587	71,889	4,113	15,825	7,110	356,650
Finland	641,258	48,011	162,278	57,555	77,914	295,500
Sweden	905,000	22,000	53,000	97,000	98,000	635,000
Norway	769,967	162,158	29,088	61,281	97,547	419,893

Source: (Eurostat, 2023b)

Table 2. Food waste by sector of activities (in kg per capita)

	Total (aggregate changing according to the context)	Primary production of food - agriculture, fishing and aquaculture	Manufacture of food products and beverages	Retail and other distribution of food	Restaurants and food services	Total activities by households
EU-27	131	14	26	9	12	70
Belgium	250	3	161	6	8	71
Bulgaria	86	33	23	2	2	26
Czechia	91	3	9	6	4	69
Denmark	221	11	102	17	11	79
Germany	131	2	19	9	22	78
Estonia	125	18	24	15	8	61
Ireland	155	14	44	12	36	48
Greece	191	35	35	14	21	87
Spain	90	18	30	7	4	30
France	133	16	29	12	16	61
Croatia	71	10	2	1	4	53
Italy	146	21	9	6	3	107
Cyprus	397	49	190	56	30	71
Latvia	145	17	19	8	19	82
Lithuania	137	29	10	10	2	86
Luxembourg	147	12	17	14	14	91
Hungary	93	2	19	4	2	66
Malta	154	1	9	8	45	92
Netherlands	161	27	59	12	5	59
Austria	136	2	19	9	23	83
Poland	106	18	14	8	5	60
Portugal	184	10	6	21	23	124
Slovenia	68	0	5	7	20	36
Slovakia	83	13	1	3	1	65
Finland	116	9	29	10	14	53
Sweden	87	2	5	9	9	61
Norway	143	30	5	11	18	78

Source: (Eurostat, 2023b)

The economic cost of food waste was estimated to be USD 1 trillion per year in 2014, according to the Food and Agricultural Organization of the United Nations (F. FAO, 2014). However, this figure does not account for the hidden costs associated with environmental damage and social impact. When these externality costs are included, the annual cost of food waste could rise to at least USD 2.6 trillion, which is equivalent to the GDP of France. Along with the negative economic impact of the FLW there are also environmental and social impacts as it entails the wastage of natural resources such as energy, water, and fuel . Food waste has significant environmental consequences, as it entails the wastage of natural resources such as energy, water, and fuel. For instance, throwing away a kilogram of beef is equivalent to throwing away 50,000 litres of water. Pouring a glass of milk down the sink is nearly 1,000 litres of water

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wasted. Food waste contributes directly and indirectly to climate change. When food decomposes in the landfill methane is produced, a gas that is far more effective in trapping heat in the earth's atmosphere (studies estimate that food wastage is responsible for around 6% of total global greenhouse gas emissions). Additionally, taking into account global food transportation, large amounts of oil, diesel and other fossil fuels are used, the combustion of which adds carbon dioxide to the atmosphere. But that is not all, since food waste contributes indirectly to the degradation of land and harms the biodiversity.

The moral dimension of food waste becomes evident when considering that many people cannot afford a quality meal every other day, while 20% of the food produced in the EU is wasted. This increases the risk of food insecurity, malnutrition, and excessive water use, particularly as world hunger continues to grow. Establishing food redistribution and donation channels is crucial to mitigate hunger in the EU. According to the Food and Agriculture Organization latest report on the state of food security and nutrition in the world (FAO, 2022), it is estimated that between 702 and 828 million people (corresponding to 8.9 and 10.5 percent of the world population, respectively) faced hunger worldwide in 2021, a figure that is higher by 150 million since 2019, prior to the COVID-19 pandemic. Countries should establish food redistribution channels to divert food from being wasted and reach the people in need. Efforts should focus on policy interventions and food supply actors' collaboration.

Through their pivotal position, HoReCa businesses can support a sustainable food system by establishing a holistic way to prevent and reduce food waste they produce, while they can promote the adoption of this food system by their several stakeholders.

2.2 The European and National Context

The broad range of areas affected by food waste is evident through the involvement of numerous **Directorates General (DGs)** within the European Commission (Eriksson et al., 2020a).

It is estimated that a minimum of seven Directorates General (DGs) within the European Commission are engaged in addressing food waste, with each DG having at least one policy area dedicated to this issue:

1. rural development and agriculture (DG AGRI),

2. maritime affairs and fisheries (DG MARE),

3. food safety and health (DG SANTE),

4. industry, entrepreneurship, internal market and SMEs (DG GROWTH),

5. energy (DG ENER),

6. environment (DG ENV) and

7. customs union and taxation (DG TAXUD).

In addition, since food waste represents one of the important causes of greenhouse gas emissions (L. and W. D. FAO, 2013), the Directorate General for Climate Action (DG CLIMA) is also directly concerned.

There are different definitions of food loss and waste across the globe, making the quantification of the problem challenging (Nicholes et al., 2019). In an effort to achieving a baseline and monitoring progress towards Target 12.3 of the UN Sustainable Development Goals, the Food Loss and Waste Accounting and Reporting Standard (FLWS) was developed (Food Loss and Waste Protocol, 2016), which divides food waste into 'wasted food', i.e. "*any substance- whether processed, semi-processed, or raw- that is intended for human consumption*", and 'associated inedible parts', i.e. "*components associated with a food that, in a particular food supply chain, are not intended to be consumed by humans*".

Food waste, which is the main focus of ADVANCE, means for the European Commission "*all food as defined in Article 2 of Regulation (EC) No 178/2002 of the European Parliament and of the Council that has become waste*" (Directive 2018/851, 2018). Hence, food waste "*can comprise items which include parts of food intended to be ingested and parts of food not intended to be ingested*" but it "*does not include losses at stages of the food supply chain where certain products have not yet become food as defined in Article 2 of Regulation (EC) No 178/2002, such as edible plants which have not been harvested. In addition, it does not include by-products from the production of food that fulfil the criteria set out in Article 5(1) of Directive 2008/98/EC, since such by-products are not waste*" (Commission Delegated Decision (EU) 2019/1597 of 3 May 2019 Supplementing Directive 2008/98/EC of the European Parliament and of the Council as Regards a Common Methodology and Minimum Quality Requirements for the Uniform Measurement of Levels of Food Waste, 2019).

In 2017, the European Parliament called on Member States to "take the measures required to achieve a Union food waste reduction target of 30% by 2025 and 50% by 2030 compared to the 2014 baseline". The European Commission has taken steps towards tackling food waste and the EU members are committed to the target of the Sustainable Development Goal 12.3 of the United Nations' 2030 Agenda. SDG Target 12.3 focuses on food and inedible parts lost or wasted and is tracked through two indicators: the Food Loss Index (Indicator 12.3.1(a)) and the Food Waste Index (Indicator 12.3.1(b)). The European Union is committed to improving its initiatives to reduce food wastage. To achieve this goal, it employs a three-tier approach within the Food Waste Index. This approach involves utilising modelling techniques to estimate food wastage, measuring food wastage on a national level, and offering supplementary data for policymaking and intervention strategies aimed at minimizing food waste. In this direction, Directive 2018/851 requires Member States to:

- Incorporate specific food waste reduction programs as part of their waste prevention initiatives, including initiatives aimed at raising consumer awareness (e.g., explaining the significance of 'use-by' and 'best-before' dates).
- Offer incentives to facilitate the collection of unsold food items at every stage of the food supply chain and promote their safe redistribution, including to charitable organizations.

- Monitor and evaluate the implementation of food waste reduction measures by measuring the levels of food waste.

The European Commission, in line with the **Farm to Fork Strategy**, intends to propose legally binding targets for reducing food waste throughout the EU by the end of 2023, using a baseline for EU food waste levels (European Commission, n.d.-b). The targets will be proposed as part of a wider initiative to revise the "Waste Framework Directive" (European Commission, n.d.-b). The Commission will implement measures to expand and advocate for sustainable and socially responsible production practices and circular business models in the food processing and retail sectors. This includes a particular focus on small and medium-sized enterprises (SMEs) and aligning with the goals and initiatives outlined in the new Circular Economy Action Plan (CEAP). The promotion of a circular and sustainable European Union (EU) Bioeconomy presents potential economic prospects, such as leveraging the utilization of food waste. By fostering circularity and sustainability, the Commission aims to create business opportunities and advance the overall efficiency and resourcefulness of the food industry.

Besides food waste reduction targets, the Commission has implemented further actions to reduce food waste. Specifically, it has established the **EU Platform on Food Losses and Food Waste**[1], has developed a common EU methodology to measure food waste (Commission Delegated Decision (EU) 2019/1597 of 3 May 2019 Supplementing Directive 2008/98/EC of the European Parliament and of the Council as Regards a Common Methodology and Minimum Quality Requirements for the Uniform Measurement of Levels of Food Waste, 2019), has adopted guidelines to facilitate food donation (Commission Notice — EU Guidelines on Food Donation, 2017) and use of food no longer intended for human consumption in animal feed (Commission Notice — Guidelines for the Feed Use of Food No Longer Intended for Human Consumption, 2018), and will propose the revision of EU rules on date marking to prevent food waste linked to misunderstanding and/or misuse of "use by" and "best before" dates (European Commission, n.d.-a). Measures such as dual-date labelling, discounted sales of close-to-expiry goods, and improved storage instructions are being considered to address the issue. The ban of sell-by and display-until indications, which create consumer confusion, could significantly reduce waste (L. and W. D. FAO, 2013).

On 21st of April 2023[2], the Commission put forth a proposal to modify the current marketing standards that pertain to a variety of agri-food products, such as fruits and vegetables, fruit juices and jams, honey, poultry, and eggs. These proposed amendments are designed to empower consumers, enabling them to make more informed choices towards a healthier diet and simultaneously contributing to the reduction of food waste. Concerning food waste, these proposed changes address both food waste and packaging waste. As an example, fruits and vegetables that may have external imperfections but remain suitable for local or direct consumption would be exempt from complying with marketing standards when directly sold by producers to consumers in local markets. This exemption aims to promote the utilization of

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[1]   https://food.ec.europa.eu/safety/food-waste/eu-actions-against-food-waste/eu-platform-food-losses-and-food-waste_en

[2] https://ec.europa.eu/commission/presscorner/detail/en/ip_23_2366

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these products in their fresh state and provide consumers with more affordable options to purchase fresh produce. Additionally, certain products affected by natural disasters or exceptional circumstances may also be allowed to be sold, provided they are safe for consumption.

Moreover, aligned with the Circular Economy Action Plan and in collaboration with **the EU Platform on Food Losses and Food Waste (PFLW)**, the European Commission has embraced guidelines for food donation within the European Union. These guidelines aim to streamline the process of recovering and redistributing surplus food that meets the required standards of edibility to individuals in need. The primary objectives of these food donation guidelines, as outlined by (Deloitte et al., 2020), are twofold:

1. Facilitate the adherence of surplus food providers and recipients to the pertinent regulations set forth in the EU regulatory framework.
2. Foster a consistent understanding and interpretation of EU rules pertaining to the redistribution of surplus food among regulatory authorities in EU Member States.

By establishing these guidelines, the European Commission seeks to enhance compliance with regulations, promote efficient redistribution practices, and encourage a harmonized approach across EU Member States when it comes to the redistribution of surplus food.

At the national level, the majority of Member States have either formulated or are currently in the process of creating national plans or strategies aimed at reducing food waste. These strategies encompass a range of approaches, including both regulatory and non-regulatory measures, along with specific targets for reducing food waste. Many of these strategies and action plans incorporate the food use hierarchy, and some have introduced regulatory measures to encourage food donation and prevent the unnecessary disposal of edible food. Typically, these strategies and plans are integrated into broader initiatives related to circular economy principles and sustainable food systems, and they often intersect with various policy areas such as agriculture, nutrition, and more (European Commission & Directorate-General for Health and Food Safety, 2021). In an effort to reduce food waste, most Member States have structured processes to engage stakeholders, conduct consumer information and awareness campaigns to clarify the difference between "use by" and "best before" dates, use fiscal instruments to provide incentives for food waste prevention (e.g. tax credits and deductions and reduced VAT for donated food), and offer financial support, for example, to programmes managed by local or regional authorities, SMEs, etc. (European Commission & Directorate-General for Health and Food Safety, 2021).

A descriptive analysis of how Member States implement EU rules to facilitate food donation in practice is provided in the "*Redistribution of surplus food: examples of practices in the Member States*" report (EU Platform on Food Losses and Food Waste, 2019). Further, a detailed analysis of existing measures impacting food redistribution from all Member States based on a literature review, scoping interviews and input provided by the members of the EU Platform on Food Losses and Food Waste, is provided in the "Food redistribution in the EU: Mapping and analysis of existing regulatory and policy measures impacting food redistribution from EU Member States" report (European Commission & Directorate-General for Health and Food Safety, 2020).

2.3   Evolving the Waste Management System in your business

The separate collection of organic waste is important for the recovery of nutrients and energy (Jain et al., 2018). So far, different food waste management systems exist in terms of collection (e.g. some systems have made food waste collection mandatory, while others have used waste management taxes to incentivise the separate collection) or food waste treatment (e.g. some systems treat waste via anaerobic digestion and others compost it) (Jain et al., 2018).

The characteristics of the waste management system (e.g. collection frequency, treatment processes, etc.), depend on the specific goals and factors in each municipality, e.g. existing infrastructure, demographics, type of housing, behavioural factors, climate conditions, available funding, etc. (Jain et al., 2018), affecting all its stakeholders (households, retailers, businesses etc).

A HoReCa business is an entity that produces large quantities of food. Therefore, it has to handle its food waste even a municipality does not provide all the appropriate means. The best food waste management is the one which promotes firstly the prevention. This requires a general re-design of the whole process receiving, cooking and serving the food and a tighter management of this process. More specifically, this re-design requires:

- Yield management: by maximizing the output derived from a product;

- Stock management: by ensuring the right flow of goods in and out of the kitchen to prevent spoilage;

- Waste management: By minimizing waste whenever possible and composting before recycling or disposal to landfill.

The combination of these techniques forms a comprehensive approach that enables each company to minimize and eliminate wastage. Implementing these methods, which consist the "lean management", will result in a simplified, adaptable, and responsive company, as wastes are reduced (*ILO Cataloguing in Publication Data Lean Manufacturing Techniques for Food Industry*, n.d.). For example, the implementation of lean management in meal development has the potential to impact several aspects, including ingredient selection, menu size (number of meals offered), portion sizes, and the amount of leftovers consumed by customers (Gładysz et al., 2020).

2.4   Drivers and Barriers

As mentioned in ADVANCE's deliverable D3.2 (ADVANCE project, 2022c), the main factors that can act as drivers or barriers in relation to food waste management are the following:

- City Demographics
- Spatial Information
- Risks in Circular Transition

- Regulations and Legal Framework
- IND 4.0 Appliances in Waste Management
- Food Waste/ Food Loss Generation
- Municipal Management
- Waste Prevention
- Waste Collection
- Recycling
- Financing
- Disposal
- Economic
- Behavioural

These factors that contribute to food waste, as follows:

1. Overproduction and overconsumption: Overproduction of food leads to excess food that is not consumed and ultimately becomes waste. Overconsumption also contributes to food waste, as consumers may purchase more food than they need or throw away food that is still edible. Consumer food waste is to a large part driven by planning (e.g. checking inventory, making shopping lists, planning meals ahead) and shopping (e.g. buying too much food, buying unintended products) routines (Farr-Wharton et al., 2014; Stefan et al., 2013).

2. Inadequate storage and handling: Inadequate storage and handling can lead to food spoilage and waste. This can include issues with temperature control, poor packaging, and improper storage (FAO, 2011). In the same direction, low-income households follow strategies like impulse buying, monthly shopping trips and preference for large packages, etc. to save money and end up generating more food waste due to inappropriate storage and handling (Porpino et al., 2015).

3. Confusing expiration dates: Confusing expiration dates can lead to consumers throwing away food that is still edible. Expiration dates can be unclear or misleading, leading consumers to discard food that is still safe to eat (Van Boxstael et al., 2014; Waarts et al., 2015). A confused consumer can be a confused working person regarding the expiration dates in labels, affecting directly a HoReCa business as well.

4. Cosmetic standards: Cosmetic standards, which dictate that food must meet certain appearance and size requirements, can lead to perfectly edible food being discarded because it does not meet these standards. For example, HoReCa personnel may not use ingredients that do not conform to their internal aesthetic standards (Papargyropoulou et al., 2019).

5. Retail practices: Retail practices, such as promotional sales, buy-one-get-one-free offers, and imperfect produce discounting, can lead to consumers buying more food than they need or throwing away perfectly good food because it was not sold at a discount. For instance, flawed sales forecasting by retailers, particularly as far as

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seasonal products are concerned, may result in an increase in food waste (Eriksson, 2012).

6. Food service industry practices: The food service industry can contribute to food waste through practices such as oversized portions, buffet-style service, and food left on customers' plates. However, the food industry's contribution to the problem is affected by other parameters, as well. For instance, HoReCa businesses run by women usually produce less waste (Troitino, 2020). Also, low-income neighbourhoods offer greater access to food sources that promote unhealthy eating, e.g. fast-food outlets (Hilmers et al., 2012).

7. Socioeconomic factors, such as:

- Consumer behaviour: Consumer behaviour can contribute to food waste. Food waste tends to be higher among higher income consumers, which may have more disposable income to purchase more food that they actually need. Moreover, societal norms and expectations around dining out can also influence waste generation. In certain cultures, leaving food on the plate may be considered polite. This can discourage individuals from taking leftovers home or practicing portion control, leading to increased waste. Moreover, the utilization of the doggy bag is a practice that exhibits significant cultural variation, affecting the food waste generation as well.

- Food packaging and marketing: Food packaging and marketing can contribute to food waste by promoting large portion sizes or encouraging consumers to purchase more than they need. For example, portion sizes of ready to eat food products are not always adjusted to the actual needs of customers (Segrè et al., 2014).

- Supply chain inefficiencies: Inefficient supply chains can contribute to food waste, such as overproduction, mismanagement, and losses during transportation or storage (Parfitt et al., 2010).

- Retail practices: Retail practices, such as promotions, discounts, and price wars, can contribute to food waste by encouraging consumers to over-purchase or by causing retailers to overstock shelves (Quested et al., 2013).

There are also several barriers to reducing food waste, such as:

- Lack of awareness and understanding: Many people are not aware of the issue of food waste or do not fully understand the extent of the problem. This can make it difficult to motivate individuals to change their behaviour. For instance, lack of awareness about the effect of food waste is leading young adults, ages 18 to 24, to waste more food than any other age group (Boyle, 2018; Goodwin, 2023), despite the fact that this age group shows more interest in environmental issues.

- Infrastructure and technology: Inadequate infrastructure, such as poor transportation systems or lack of refrigeration, can lead to food waste in the supply chain. Similarly,

outdated or inefficient technology can contribute to waste. The results of the ADVANCE households' survey (ADVANCE project, 2022a) shows that separate collection of food waste is more widespread when there are the needed space and bins for separately collecting the food waste.

- Economic incentives: Economic incentives, such as low food prices or tax incentives for disposing of food waste, can discourage individuals and businesses from taking action to reduce waste. For instance, the rise in incomes has lowered the relative importance of food in household budgets, thus leading to a less careful attitude and more food waste (FAO, 2011), a fact that indirectly affects the HoReCa businesses as well.

- Regulatory environment: Regulations that discourage food donation or encourage waste, such as expiration date labelling requirements, can also act as barriers to food waste reduction. If, for example, waste disposal is cheap, HoReCa businesses will not look for other ways of reusing their residual flows (Waarts et al., 2015).

- Lack of coordination and collaboration: Food waste is a complex issue that requires collaboration between multiple stakeholders, including consumers, producers, retailers, and government. A lack of coordination and collaboration between these groups can make it difficult to develop effective solutions (de Moraes et al., 2020; Mohamadi et al., 2021; Surucu-Balci & Tuna, 2022).

2.5 Beyond Roadmap

It is now commonly acknowledged that businesses can act in a holistic way to prevent food waste and motivate a wind of change in their current status-quo.

This holistic approach involves a diversity of stakeholders from business owners, decision-makers, society and customers towards promoting several preventing and managerial actions. These actions should be targeted to different groups and/or to different geospatial level (international, national, interregional, regional and local) (Buczacki et al., 2021).

The holistic approach is necessary due to the high levels of food are lost pre-retail in the EU (De Laurentiis et al., 2020). For this reason, in 2017, the 67 European organisations who called for a legally binding EU food loss and waste mentioned that "this means that it should include not just retailer and consumer food waste, but also food wasted at the primary production, manufacturing, and distribution levels" (De Laurentiis et al., 2020). Hence, food waste reduction plans should cover pre-retail sectors to be efficient and effective.

However, the proposed roadmap does not consider food waste along the whole supply chain. It is designed to complement the transformational changes needed to achieve the EU food waste reduction target in consideration of HoReCa businesses' capacity for change and aims to give a concrete pathway on what they can do to reduce food waste to the stage of pre-kitchen, kitchen and post-kitchen, using financial incentives, capacity building, awareness campaigns, food donations, etc.

3   Roadmap development process

The development of the Roadmap involves several steps, as follows:

- Conducting food waste survey to understand the scale and scope of food waste in the business and to identify where, how, and why food waste occurs.
- Developing a food waste reduction plan that will include the vision, targets, and priorities of the plan, the strategies and actions for reducing food waste across the business operation, the roles and responsibilities of various stakeholders, the identification of funding and resources required to implement the plan, as well as the potential risks.
- Raising awareness to educate all the stakeholders involved in the business about the importance of reducing food waste and how they can contribute to this target through campaigns, workshops, and events.
- Implementing the food waste reduction practices and defining a timeline.
- Monitoring the progress towards food waste reduction targets regularly and adjust strategies as necessary.

The following sub-sections discuss the main points of the development process of the Roadmap.

3.1   Food Waste Survey

Conducting a food waste audit constitutes a crucial initial step in comprehending the volume and categories of food waste generated by municipalities, businesses, or households. Accurate data regarding the quantity and composition of food waste are indispensable to prevent misguided waste reduction measures and formulate effective intervention strategies (Adelodun et al., 2021; De Laurentiis et al., 2020). For example, a comprehensive understanding of food waste composition is vital in identifying opportunities for its utilization, either as an energy source or a material resource (Corrado et al., 2019). However, a review study by (Xue et al., 2017) which examined data from 84 countries spanning 52 years from 1933 to 2014, revealed that the majority of studies relied on secondary data sources. Similar findings were reported by (Corrado & Sala, 2018) who analysed selected studies and their underlying quantification methodologies at the global and European scales.

The methods used to measure food waste generated by food business operators or households can be divided into direct and indirect (Caldeira et al., 2017; Commission Delegated Decision (EU) 2019/1597 of 3 May 2019 Supplementing Directive 2008/98/EC of the European Parliament and of the Council as Regards a Common Methodology and Minimum Quality Requirements for the Uniform Measurement of Levels of Food Waste, 2019; Corrado et al., 2019; Xue et al., 2017). More specifically, the direct methods are based on direct measurement/direct access to food waste and include the following approaches:

- Conducting direct weighing or volumetric assessment of separately collected FW by means of a measuring device.
- Scanning/counting the individual items constituting FW, which is subsequently used to calculate the total mass of FW.
- Conducting waste composition analysis, involving the physical separation of FW from other waste fractions to ascertain the mass of the separated fractions.
- Maintaining FW diaries, where individuals or groups regularly record information about FW.
- Implementing garbage collection procedures that segregate FW from other categories of residual waste containers.
- Conducting surveys based on information collected through questionnaires from individuals or entities.

The indirect measurement methods include (Caldeira et al., 2017; Commission Delegated Decision (EU) 2019/1597 of 3 May 2019 Supplementing Directive 2008/98/EC of the European Parliament and of the Council as Regards a Common Methodology and Minimum Quality Requirements for the Uniform Measurement of Levels of Food Waste, 2019; Corrado et al., 2019; Xue et al., 2017):

- Mass balance calculations that determine the quantity of FW by comparing the mass of inputs and outputs of food within a measured system, considering factors such as food processing and consumption.
- FW coefficients or percentages estimated through various means, including sampling, data provided by food business operators, or other methods specific to certain food industry sectors or businesses.
- Mathematical models relying on factors related to food waste generation to estimate the amount of FW.
- Literature data or calculations based on information reported in other publications.
- Proxy data based on the latest available data from companies, statistical agencies, or socioeconomic data relevant to different stages of the food supply chain.

The choice of method depends on factors like the study's purpose, desired depth, accuracy, reliability, and available resources (time, budget) (Caldeira et al., 2017). Moreover, the choice of the method depends on legislative requirements. For instance, in the Annex III of the Commission Delegated Decision (EU) 2019/1597, in-depth measurement of food waste generated by restaurants and food services must be conducted using methods such as waste composition analysis, counting/scanning, diaries, or a combination of these approaches, or any other method that is equivalent in terms of relevance, representativeness, and reliability. If an in-depth measurement in accordance with Annex III is not used, then a methodology based on the latest available data or indicators as defined in Annex IV of the Commission Delegated Decision (EU) 2019/1597 can be implemented.

3.2 Food Waste Reduction Plan

3.2.1 Visions, targets and priorities

A food waste reduction plan should clearly outline the business' vision, goals and targets. The vision might refer, for example, to establish a zero-waste framework is to avoid valuable resources from ever becoming waste, lower the environmental impacts of food waste, capture energy and recycle essential nutrients, increase economic benefits by using material resources more efficiently, corporate communication etc.

The primary objective of a business food waste reduction plan is to reduce food waste at each stage of its operation. The plan should clearly define specific goals and targets that align with the business' overall sustainability objectives.

These goals and targets can include a reduction in the amount of food waste produced, an increase in the amount of food donated to charitable organizations, a reduction in the amount of food waste generated per month, etc. For example, the business could aim to achieve 0% growth in food waste generation over the next three years, reduce the overall amount of food waste generated in each stage (pre-kitchen, kitchen, post-kitchen) by 50% over the next five years, increase food donations to local food banks by 25% etc.

The list of targets can be long and demanding in terms of financial and human resources. Some objectives and targets may conflict with others. Hence, the targets must be prioritised (using, for example, ranking in the form of high, medium or low priority). It is noted that priorities can be set at various stages of food waste management plan, e.g., setting priority for the targets, the actions, etc.

3.2.2 Food Waste reduction strategies and practices

FWM encompasses strategies and practices employed to either reduce food waste or effectively manage it once it arises along the supply chain. To aid the prioritisation of different methods for handling surplus food, the European Commission (EC) has developed the Food Waste Management Hierarchy (Figure 1). This hierarchy accounts for three sustainability factors (environmental, economic, and social) and promotes a comprehensive approach to addressing the food waste problem (Papargyropoulou et al., 2014). Practices at the top of this hierarchy receive higher priority and offer more significant socioeconomic benefits, whereas those at the bottom are less preferable. Numerous studies (Bajzelj et al., 2019; Benetto et al., 2018; Eriksson et al., 2020b; Garske et al., 2020; Ingrao et al., 2018; Morganti & Chen, 2017; Ojha et al., 2020; Slorach et al., 2020; Torres De Matos et al., 2016) have put forth various solutions to address food waste at each stage of the food supply chain, spanning from primary production to final disposal (Aramyan et al., 2020; Kolk & Ciulli, 2020; Närvänen et al., 2020).
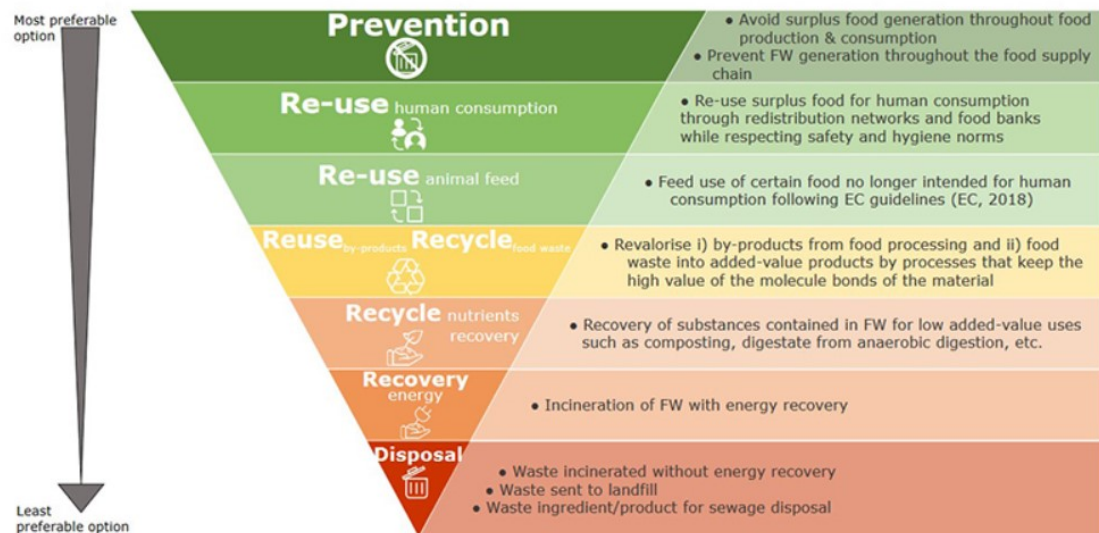
Figure 1. Food waste management hierarchy (source: https://food.ec.europa.eu/safety/food-waste/eu-actions-against-food-waste/food-waste-measurement_en)

Waste prevention is the first step and the cornerstone of sustainable waste management, and it is the highest ranked option in the European waste (Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on Waste and Repealing Certain Directives (Text with EEA Relevance), 2008). Waste prevention implies measures taken before the product has become waste and involve 3 key steps - reduce, reuse, and donate or exchange (*EU Actions against Food Waste*, n.d.).

Re-use food for human consumption through donation is the best way for avoiding food waste, and as most important, it simultaneously includes a social component. Also, preparation of creative meals from excess food and using ugly fruit and vegetables for marmalades, smoothies, juices, desserts, and similar products, makes a very effective way for waste reduction. When excess food no longer complies with human consumption standards it can be re-purposed for animal feed. Recycling and valorisation of food that is not usable in the basic process, as a by-product or raw material for another product is the next preferable option. Food waste is transformed into a new material that services another purpose and retains its value or its nutrients are recovered through composting, anaerobic digestion etc. The least preferable options include incineration of food to recover its chemical energy and disposal to landfill.

In this direction, the food waste reduction plan should include a range of strategies, as follows:

a. Food Waste Prevention Programs: HoReCa businesses can establish food waste prevention programs to help staff, customers, and suppliers prevent food waste at the source. These programs can include education and awareness campaigns, workshops, and training on meal planning, food storage, and portion control. For example, a business can provide staff with tips on how to reduce food waste. This can include information on proper food storage, meal planning, and portion control.

b. Food Recovery and Donation Programs: The business can work with local food banks, charities, and non-profit organisations to develop food recovery and donation programs. These programs can facilitate the collection and distribution of surplus food from local businesses and institutions to those in need.

> Food donation is an important strategy not only to reduce food waste but also to provide assistance to those who are struggling with food insecurity. HoReCa businesses can establish food recovery programs to collect unused food from businesses by taking identifying local food donation organisations, such as food banks, shelters, and community kitchens, and partnering with them to promote food donation. This can include providing information on how to donate food, promoting food donation drives, and facilitating food donation events and/or providing training on safe food handling and storage.

c. Food waste valorisation: If the municipality establishes composting programs for households, businesses, and institutions by developing anaerobic digestion facilities and turning food waste into animal feed, a HoReCa business can reduce the amount of organic waste sent to the landfill.

d. Education and Outreach: a HoReCa business can use various methods to educate and engage its customers in reducing food waste. These can include workshops during meal, presentations, and social media campaigns to raise awareness about the environmental and social impacts of food waste.

HoReCa businesses, as well as municipalities, can explore alternative food waste management (FWM) scenarios using available FWM calculators. For example, the European Commission Joint Research Centre has developed an evaluation framework for food waste prevention actions to support the EU Platform on Food Losses and Food Waste. In this context, a food waste prevention calculator[3] has been created based on life cycle thinking that provides a consistent assessment of the environmental and economic benefits of such initiatives, and the identification of potential trade-offs at early design stages (De Laurentiis et al., 2020). Also, Quantis as part of the FReSH program of World Business Council for Sustainable Development (WBCSD) and with input from World Resources Institute, has created a calculator[4] that can be used to compare the environmental and nutritional impact of various actions to reduce food loss and waste. The calculator complements the Food Loss and Waste Accounting and Reporting Standard as it enables users to describe and convey the scale and relevance of food loss and waste in terms that may be more meaningful for some audiences than weight (Food Loss and Waste Protocol, n.d.). Finally, US EPA has created the Food Waste Management Calculator[5] that estimates the cost of alternatives to food waste disposal, including source reduction, donation, composting, and recycling of yellow grease (Further with Food, 2016).

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[3] https://eplca.jrc.ec.europa.eu/permalink/valeria/prevention_action_calculator.xlsm
[4] https://www.flwprotocol.org/why-measure/food-loss-and-waste-value-calculator/
[5] https://www.epa.gov/sites/default/files/2017-01/foodcost3.xls

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It should be mentioned that no businesses or households are responsible for the food waste management. If the municipal authorities provide the appropriate means of collection and treatment, the food waste derived from a HoReCa business it is easier to be handled. If not, any business that wants to innovate and evolve its food waste management is free to act and implement the best solution.

3.2.3   The role of partners and stakeholders

Stakeholders are persons, groups, institutions or organisations that have a stake in an activity or project and may be directly or indirectly affected by the project or to have the ability to influence it either positively or negatively (D-WASTE, 2012). The stakeholders can play a very important role in FWM planning process and, thus, their identification is of great importance (Pimentel et al., 2022).

The FWM plan should clearly outline the roles and responsibilities of various stakeholders in implementing the food waste reduction plan. There are several stakeholders involved in food waste prevention and reduction at the business level, such as:

- Consumers: Consumers also play a role in food waste reduction efforts, because they generate a significant portion of food waste. The unconsumed food that remains in plates can be taken to home via doggy bags. Yet, In numerous countries, prevailing societal customs and the presence of shame often deter individuals from utilizing doggy bags to take leftover food home (van Herpen et al., 2021).

- Employees: Employees are the ones who take care of the appropriate storage, handling and cooking of food. Any observation, misfunction during the storage and/or the cooking occurs in a business operation, employees have to handle it. Moreover, the staff can play a vital role in consumers' awareness and education. For example, they can brief the consumers regarding food waste generated in buffet service, in which there are the unlimited plate refilling and food waste is mostly observed.

- Suppliers: Suppliers provide to HoReCa businesses the appropriate raw materials for their operation. Food suppliers however have to take care the storage during transportation, the preservation of their safety and hygiene. Any accident or omission affects the transported food, which consequently becomes food waste. Suppliers can be educated and provide extended collaboration with a business to implement its vision.

- Municipal authorities: Municipal authorities are responsible for implementing policies and programs that support food waste reduction and prevention. In this context, they can provide funding for food waste reduction initiatives, implement local regulations around food waste, and coordinate with local businesses and organizations to reduce food waste.

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- Non-profit organisations: Non-profit organisations can provide food recovery services, such as collection and distribution of surplus food to those in need. They can also provide education and outreach to the community on the importance of food waste reduction.

- Food banks and pantries: Food banks can accept surplus food and provide it to food pantries that directly serve people who suffer from hunger and food insecurity within a specified area. They can also work with local businesses and non-profit organisations.

- Government Departments/ Agencies: HoReCa businesses must collaborate with governmental authorities, especially those responsible for bio-waste and food waste streams, as they coordinate national efforts to reduce FW.

3.2.4   Funding Schemes and Mechanisms

The economic instruments needed for the implementation of a FWM plan ensure that the costs of providing FWM services are recovered, and secondly influence the behaviour of waste generators to reduce FW, and to follow the preferred direction of the waste stream (D-WASTE, 2012). There are several funding schemes and mechanisms available to support food waste prevention and reduction initiatives, e.g., taxes subsidies but other schemes, as well. Some common mechanisms used to promote FWM are, as follows:

1. <u>Grants and subsidies:</u> Governments and foundations often provide grants and subsidies to organisations and businesses working on food waste reduction initiatives. These grants can cover a wide range of activities, from food waste audits to the development of new technologies for reducing waste. For example, the European Union is providing several funding programmes to support the transition to a circular economy, including FW prevention and reduction, such as the Horizon Europe, the LIFE programme, the European Structural and Investment Funds, and the Single Market Programme (European Union, 2020). Moreover, the European Investment Bank (EIB) is providing finance and advice for circular economy projects through the InvestEU Advisory Hub[6] (European Union, 2020).

2. <u>Tax incentives:</u> Tax incentives can encourage businesses to reduce food waste by providing financial benefits for adopting waste reduction practices or donating surplus food to charity. These can include, among others, VAT exemptions or zero-rate VAT on food donations, tax credits or tax deductions (European Commission & Directorate-General for Health and Food Safety, 2020). For example, In Belgium, VAT is not imposed when food is donated to the nine food banks registered by the Belgian Food Bank Federation. In France and Spain, 60% and 35% respectively of the net book value of donated food can be claimed as a corporate tax credit (EU Platform on Food Losses and Food Waste, 2019). In Greece, there is tax exemption for the donation of food products close to their expiration date, according to the article no.21 of the National Law 4819/2021.

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[6] https://advisory.eib.org/

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3. Impact investment: "Impact investment" is defined as the quest to "invest for impact" beyond the financial bottom line (Food Trails, 2022). Impact investors provide funding to businesses and organisations that are working on social or environmental issues, including food waste reduction. Impact investments can take the form of equity investment or debt financing. For example, Capital One Ventures has invested in Goodr, a sustainable waste management platform that leverages technology to reduce food waste and combat hunger (Wolf, 2020).

4. Crowdfunding: Crowdfunding platforms can provide a way for individuals and organizations to raise funds for food waste reduction initiatives. This can include funding for research, development of new technologies, or community-based projects. For instance, Tesco launched the BackIt crowdfunding platform for projects that eliminate food waste across the supply chain (Goulding, 2016).

5. Collaborative funding models: Collaborative funding models, such as public-private partnerships, can also provide a way for local governments, businesses, and NGOs to work together to fund food waste reduction initiatives. For example, in Greece there is a funding program, namely, "Investment Plan of the Law 4887/2022 for Entrepreneurship" in which recycling actions are included. Applicants can be from a SME to public companies. Table 3 presents a summary of selected economic tools and incentives identified by FUSIONS partners and experts as having the most potential in reduction and prevention of food waste (FUSION, 2016).

Table 3. Price and quantity-based instruments

Taxes, fees and charges	Subsidies, grants, tax benefits
Unit pricing policies by charging on the basis of the volume or weight of trash discarded (e.g. "PAYT themes) instead of a flat tax or monthly fee	Subsidies/regulations to stimulate private companies to invest in food waste reduction technologies
	Subsidies for free redistribution and new processes
	Subsidies to farmers to stimulate food waste reduction by X%
	VAT exemptions on food donations, fiscal incentives for food donation such as tax breaks (e.g. France)
	Matching funds-private public partnership
	Venture capital funds to develop new business models or invest in novel technology
	Local community and authorities can stimulating gleaning for products with imperfect sizes by supporting entrepreneurs (e.g. involving local communities and providing financial and non-financial support
	Food service establishments can receive tax benefits from donating wholesome, edible food to food banks or food rescue organizations.
	Provide tax credit as an incentive for taxpayers to engage in food waste reduction

Source: (FUSION, 2016)

3.2.5   Risk Management

Risk management aims to identify risks related to the FWM plan and suggest appropriate measures to keep those risks to an acceptable minimum. The risk management methodology consists of the following main elements:

- **Identify**: identify a risk (threats or opportunities) and document the risks.

- **Assess**: to document the net effect of all identified threats, by assessing:

    o   Likelihood of threats (risks);

    o   Impact of each risk;

    o   Prioritisation based on scales.

- **Response**: preparation and implementation of management responses to mitigate threats and maximise opportunities.

- **Monitor and review**: monitor and review the performance of the risk management actions.

Indicative risks may be:

- Design issues (e.g., inaccurate assumptions on FW generation in planning stage, incomplete number of collection bins, etc.).

- External factors (e.g., geopolitical issues, high expectations from stakeholders, political factors that affect FW policies, changes in permits required, FW donation regulations changes, lack of administration and management capacity from the relevant authorities involved, low involvement or performance of critical stakeholders, etc.).

- Environmental risks (e.g., unanticipated environmental impacts, etc.).

- Organisational risks (e.g., lack of specialised staff, inconsistent cost, time, inconsistent scope and quality objectives, lack of understanding of complex internal funding procedures, etc.).

- Financial risks (e.g., budget deviations, unavailable funds, funding changes, inefficient funding mechanisms, etc.).

- FWM plan risks (e.g., FWM plan overall goal and need is not well-defined, no control over staff priorities, lack of coordination/communication, unresolved FWM planning conflicts, added workload or time requirements because of new direction, policy, or statute, unforeseen agreements required, etc.).

All risks should be registered, thoroughly analysed and evaluated. The risk assessment must include methods for prioritising the identified risks for further action, as follows (Table 4 and Table 5):

Table 4. Likelihood evaluation matrix

Likelihood Evaluation Matrix				
(5) Almost Certain	**(4) Likely**	**(3) Moderate**	**(2) Unlikely**	**(1) Remote**
-Expected to occur frequently i.e. more likely to occur than not -More than 90% chance of happening	-Strong possibility of occurrence and could occur several times -61% to 90% chances of occurrence	-Fairly likely to occur -31% to 60% chances of occurrence	-Not expected to happen but potential exists – unlikely to occur -Less than 30% chance of occurrence	-May occur only in exceptional circumstances or virtually impossible -Less than 10% chance of occurrence

Table 5. Impact evaluation matrix

Impact Evaluation Matrix				
(5) Catastrophic	**(4) Major**	**(3) Moderate**	**(2) Minor**	**(1) Insignificant**
A risk event that, if it occurs, will have a severe impact on achieving the desired results, to the extent that one or more of the outcomes will not be achieved.	A risk event that, if it occurs, will have a critical impact on achieving the desired results, to the extent that one or more of the outcomes will fall below acceptable levels.	A risk event that, if it occurs, will have a moderate impact on achieving the desired results, to the extent that one or more of the outcomes will fall below goals but above minimum acceptable levels.	A risk event that, if it occurs, will have a minor impact on achieving the desired results, to the extent that one or more of the outcomes will fall below goals but well above minimum acceptable levels.	A risk event that, if it occurs, will have little or no impact on achieving outcome objectives.

According to the above risk criteria, the risk heat map can be generated (Table 6).

Table 6. The Risk Heat Map

Risk Heat Map	Likelihood				
Impact	**(1) Remote**	**(2) Unlikely**	**(3) Moderate**	**(4) Likely**	**(5) Almost Certain**
(5) Catastrophic	5	10	15	20	25
(4) Major	4	8	12	16	20
(3) Moderate	3	6	9	12	15
(2) Minor	2	4	6	8	10
(1) Insignificant	1	2	3	4	5

For each identified risk, a response must be identified. It is the responsibility of the project committee to select a risk response for each risk. The possible risk responses are:

- **Avoid,** eliminate the threat by eliminating the cause.

- **Mitigate,** identify ways to reduce the probability or the impact of the risk.

- **Transfer**, make another party responsible for the risk.

- **Accept**, nothing will be done.

3.3   Awareness Campaigns

Raising awareness and educating businesses' stakeholders about the importance of reducing FW is a critical step in promoting behaviour change (Caldeira et al., 2019; FUSION, 2016). The food waste behaviours of consumers are greatly influenced by their level of awareness and education (Lang et al., 2020). Awareness campaigns should start at an early stage and need to be intensified based on the desired outcomes. These campaigns should be a) systematic and b) targeted.

a) Changing customers daily behaviour requires ongoing communication and adaptation to the specific requirements. Additionally, it should be noted that the content should reach all stakeholders through multiple channels that collectively achieve the desired outcome.

b) Moreover, the communication cannot be "one size fits all"; it needs to be tailored to specific target groups and prioritize those groups that can lead in raising awareness among the population. Furthermore, different communication is needed for increased participation in food waste prevention and recycling. HoReCa SMEs should pay more attention to its local customers than seasonal visitors, modifying their communication content differently to each one.

Some actions to raise awareness and educate a stakeholder about the importance of reducing food waste are the following:

- Outreach programs: Outreach programs can help raise awareness and educate all stakeholders about the importance of reducing FW. These programs can include events in collaboration with the local community, workshops, and educational sessions. They can be organised by the businesses in the context of Corporate Social Responsibility (CSR), local government agencies, or non-profit organizations.

- Use of social media: Social media platforms can be a powerful tool to reach a broader audience. A HoReCa business can use its social media accounts to share information on FW reduction, including tips for reducing FW at home, food donation opportunities, and local initiatives. Social media attract more young people than the old – fashioned techniques do. This group of customers tend to follow and adopt new trends more easily if these campaigns are displayed in social media.

- Partnerships with local schools: HoReCa businesses can partner with local schools to educate children on the importance of the problems. This can include incorporating FW reduction lessons into the class, hosting educational events, and encouraging children to participate in food donation and cooking programs.

- Support of food recovery programs: HoReCa businesses can support food recovery programs, which collects unused food from its operation or/and households and redistribute it to those in need.

- Collaboration with local authorities: HoReCa businesses can collaborate with local authorities, such municipalities, waste management authorities. This can include promoting the use of composting and food donation programs, providing training on proper food storage and handling etc.

- Provision of education resources: HoReCa businesses can provide educational resources, such as brochures, posters, and online guides, to educate their stakeholders on the importance of reducing FW. These resources can include tips for reducing FW in the whole food supply chain, information on the environmental impact of FW, and strategies for reducing FW in commercial settings, as well as digital tools (apps) that the businesses use in order to measure their food waste generation. For instance:

  o SavingFood's Food waste calculator[7] is a self-assessment tool for businesses like supermarkets, restaurants, bakeries etc. in order to help them understand the financial and environmental impact of their food waste activities.

  o The food waste calculator by The Less Food Waste Project[8] is based on an extensive food waste diary study by Natural Resource Institute Finland. The calculator is addressed to households and the questions that includes were selected by statistical methods to generate a FW prediction of highest possible precision with a limited set of questions.

  o The Food Waste Impact Calculator[9] developed by ReFED, a national non-profit organisation dedicated to ending food loss and waste by advancing data-driven solutions, quantifies the environmental, economic, and social impacts of FW on the climate, natural resources, lost meals, and the economy for several sectors in food supply chain.

  o The IGA Food Waste Calculator[10] helps consumers understand the true cost of wasting food. The calculator provides an estimate of the total impact of a

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[7] https://savingfood.eu/food-waste-calculator/
[8] https://www.lessfoodwaste.fi/paulig/en/Home
[9]https://insights-engine.refed.org/impact-calculator?inputs=%7B%22sector%22%3Anull%2C%22type%22%3A%22standard-mix%22%2C%22unit%22%3A%22tons%22%2C%22alternative%22%3Afalse%2C%22destinations%22%3A%5B%5D%7D
[10] https://www.iga.com.au/food-smart/

product across the metrics of cost, energy and water consumption, calculated using a 'Farm to Gate' Life Cycle Assessment approach.

3.4 Proposed actions and timeline

3.4.1 Actions

The following table describes the main actions of the FW prevention and reduction Roadmap (Action Plan), along with rationale and indicative methods/means. Each action must be monitored to estimate its effectiveness and enable continuous improvement. More details on the performance framework are provided in Section 4 of this document. By following these steps and continually refining and expanding efforts, a HoReCa SME can make significant progress in reducing FW. However, every business has some unique characteristics. Thus, the Action Plan should be customised to address these specific needs.

Table 7. Proposed Action Plan

Actions	Rationale	Means/methods
Action 1: Baseline identification and analysis	Identify key stakeholders, including customers, employees, suppliers, municipal authorities, government departments, etc. to understand their contribution to FW production and management. Determine the amount and causes of FW within the business through accurate and reliable measurements. Use the information gathered to provide feedback to stakeholders.	Stakeholder analysis Direct methods (e.g., waste composition analysis, direct weighing, surveys, etc.) (see section 3.1) Indirect methods (e.g., mass balance calculations, proxy data, etc.) (see section 3.1)
Action 2: Goals and targets	Outline the business' goals and targets that align with its overall sustainability objectives	Internal procedures (e.g., participatory decision-making, techno- economical analysis)
Action 3: Awareness and Education	Raise awareness about the impacts of FW on the environment, economy and society. Provide customers and staff with practical tips on reducing FW. Provide feedback to them on their progress in reducing FW. Share success stories and best practices.	Educational programs, use social media -vlogs, seminars, and community events (see section 3.3) Collaborate with NGOs to reach different audiences

Actions	Rationale	Means/methods
Action 4: Establish partnerships	Collaborate with other local businesses, charitable organisations, and food banks to redistribute surplus food. Partner with suppliers and local authorities to promote sustainable food practices and implement strategies for reducing FW in their businesses.	Targeted communication channels (e.g., emails, phone calls, in-person meetings, etc.). Participation in local events related to FW Provision of training and resources to educate staff and customers
Action 5: Implement FW prevention programs	Optimise recipes and purchases to minimise FW. Better match the demand and supply, minimising FW through demand prediction. Design out avoidable FW by using AI and smart hardware. Design out avoidable FW during storage by using automated inspections and sorting processes. Create an online platform to connect the business with food banks.	Systematic inventory management (e.g., FIFO - First In First Out). Use of technological innovations and software. Menu planning (e.g., use of seasonal and local products & ingredients, portion adjustments). Pro-active work with customers and the staff, create an effective approach towards FW.
Action 6: Implement food recovery programs	Set up a food recovery program that involves collecting, storing surplus food and/ or redistributing it to local food banks, shelters, and community centres. Introduce new concepts for promoting and selling any leftover food in lower prices. Collaborate with national agencies in order to establish guidelines to ensure the safe handling and transportation of recovered food.	Platforms (e.g., and apps (e.g., "Too Good To Go", "Food Rescue Hero", "Waste No Food", "Boroume", etc.) Assist in the logistics of collecting and distributing surplus food to ensure safe handling and transportation Collaborate with local NGOs involved in food donation
Action 7: Implement source reduction measures for unavoidable FW	Encourage on-site composting in the business.	Provision of composting bins Educational materials on composting techniques
Action 8: Participate in separate collection systems	Participate in municipal bio-waste separate collection and management systems, if any available. Train staff to separate inedible FW to increase recycling and valorisation of food that is not usable in the basic process and diverted it from landfills.	Information leaflets/ emails for staff on FW separate collection. Provision of training and resources to educate food professionals. Supply of bins/special bags for separate collection of FW/biowaste

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Actions	Rationale	Means/methods
Action 9: Support FW tracking and measurement	Assess food waste generation in different stages of HoReCa businesses (e.g., pre-kitchen, kitchen and post-kitchen stage). Analyse the data collected on FW to identify patterns, trends, and areas of focus.	Internet of Things (IoT) sensors Artificial intelligence, machine learning and data analytics (hardware and software).
Action 10: Promote any local policy measures	Promote local policies that support FW reduction, such as composting programs, incentives that minimise FW and restrictions on excessive food portion sizes.	Participatory Decision-Making Collaboration with government agencies
Action 11: Promote innovation	Encourage innovation in FW reduction by supporting pilot projects and initiatives that test new technologies or approaches. Explore partnerships with research institutions to develop and evaluate innovative tools, such as FW tracking apps, FW donation platforms, smart bins, etc.	FW Hubs Pilot projects Research grants
Action 12: Create a HoReCa cluster	Collaborate with neighbouring HoReCa businesses creating a cluster in order to share best practices, FW infrastructure and facilities (e.g., on-site composting facilities or shared food recovery networks), coordinate efforts, and develop strategies for reducing FW.	Joint agreements EU and national funded programmes Conceptual and marketing promotion
Action 13: Monitor, evaluate and share the progress	Monitor, evaluate and share the progress of food waste reduction initiatives. Collect feedback from staff, customers and suppliers to identify challenges and refine strategies accordingly. Regularly review and evaluate the impact of FW prevention, reduction, and management actions.	Key performance indicators (KPIs) Progress reports Workshops, seminars and surveys

3.4.2 Timeline

The plan should provide a timeline for the implementation of strategies and actions, as well as identify key milestones and checkpoints for monitoring progress. The timeline should be realistic, feasible, and aligned with the business' overall sustainability objectives.

For example, the plan can be implemented over a five-year period, with specific actions and strategies identified for each year. Key milestones and checkpoints can be established to track progress towards the goals and targets outlined in the plan.

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Table 8. Actions Timeline

Action		Starting Month											
		1	2	3	4	5	6	7	8	9	10	11	12
A1	Baseline identification and analysis	S	S	I										
A2	Goals and targets			S	I									
A3	Awareness and Education				S		I	I	I	I	I	I	I
A4	Establish partnerships						S	S	S	S		I	I
A5	Implement FW prevention programs								S		I		
A6	Implement food recovery programs								S		I		
A7	Implement source reduction measures for unavoidable FW									S	I		
A8	Participate in separate collection systems									S	I		
A9	Support FW tracking and measurement						S				I		
A10	Promote any local policy measures								I		S		
A11	Promote innovation										S		
A12	Create a HoReCa cluster										S		
A13	Monitor, evaluate and share the progress			S	S	I	I	I	I	I	I	I	I

Starting month
Implementation month

Each action has a period (starting months) in which every preparatory procedure is started. After this period, the implementation period starts without any limitation regarding its completion time. Ideally, as long as the action is implemented, it should not be ended in the next years, in order HoReCa SMEs to maintain its circular concept that has launched.

3.5 Monitoring the progress

The Roadmap should outline a system for monitoring and reporting progress towards the business FW reduction goals and targets. This can include regular reporting to the public, tracking and analysing data, and conducting periodic evaluations of the effectiveness of the plan.

In this direction, the business can establish a FW dashboard that tracks the amount of food waste generated, the amount diverted for donation or composting, etc. that must relate to specific Key Performance Indicators (KPIs). The dashboard can be publicly available and updated regularly to provide transparency and accountability, and motivate its staff and consumers to continue their efforts.

3.5.1 Performance Measurement

FW generation varies with respect to consumer behaviour (which is affected by demographic characteristics, cultural aspects, awareness, etc.), economic conditions (e.g., consumers' income, public and private funds directed to FWM, etc.), and market characteristics (e.g., product availability, size of product packages, supply chain characteristics, etc.). Therefore, a

more comprehensive approach should be established to investigate the role of the above-mentioned factors on business' effort to reduce FW.

As far as the progress towards FW reduction is concerned, changes in the quantity of FW generated per month, the percentage of FW diverted from landfills to donations and treatment facilities and other figures should be measured.

The performance measurement framework aims to create the basis for evaluating the business' activities the implementation of the Roadmap. Achievements, aligned to the FW reduction, are connected to key performance indicators (KPIs) and timeline targets that contribute to the business's vision statement.

The next section presents the suggested KPIs that were developed by the ADVANCE project's baseline assessment and benchmarking and can be used to monitor the Roadmap's progress (ADVANCE project, 2022b).

3.5.2   Outcomes, Key Performance Indicators and each Year Targets

During the baseline assessment and benchmarking on FW management performance that was conducted by the ADVANCE project (ADVANCE project, 2022b), a number of specific KPIs were developed. These KPIs can be used to monitor the progress of the FW reduction Roadmap as they demonstrate how effectively a HoReCa business is achieving its goals towards FW prevention and reduction in a quantitative manner.

It is important to note that KPIs are only worth of the data that is used to calculate them. Although data limitations may exist at the beginning of the process with respect to the suggested KPIs, businesses can gather data to monitor the achievement of the targets against the timeline and the baseline conditions as the Roadmap progresses. The establishment of baseline conditions is also of crucial importance, because it determines the starting point of and can be used to assess the distance travelled during the implementation of the Roadmap. Finally, the following KPIs and the relevant benchmark indicators should be seen as a proposed framework, which is flexible and open to change to respond to any particular needs of each business that adopts it.

The proposed KPIS and benchmarking indicators are the following:

1. **Frequency of food waste compositional analysis**

Benchmark indicator: **4/year minimum**

Food waste compositional analysis refers to the examination and characterization of the different waste streams that make up food waste that is produced from the operations of a HoReCa business. Compositional analysis can help HoReCa businesses identify the main contributing sources of food waste, understand waste-intense processes and assess repurposing options. Therefore, the frequency that a HoReCa business performs a compositional analysis can determine the responsiveness of the business to take measures against food waste. It is recommended that the compositional analysis is conducted at regular time intervals in order to capture seasonal effects that may occur (minimum 4 times/year).

Based on the responses of the HoReCa survey and the "Current Waste Management Practices Assessment" report, compositional analysis remains an important challenge and is being conducted on a pilot basis so far.

2. Number of installed bins for separate collection

    a. Benchmark indicator: **plan & implement a separate collection system**

    b. Benchmark indicator: **upgrade your system including bins for the separate collection of various streams (depending on the available space)**

Separate collection bins are a crucial aspect of the waste management of HoReCa businesses. This is because separate collection enables the separation of the different waste streams and facilitates the reusage and repurposing. HoReCa businesses may typically use separate bins for frying/cooking oil, bio-waste, packaging as well as storage for food that has not been served. In this direction, the higher the degree of outflow separation the more effective the management that can be achieved.

Based on the responses of the HoReCa survey, only 34.6% of the businesses use a separate bin for organic waste collection in the EU, 35.4% for unserved food, and 14.2% for packaging. However, the majority of the European HoReCa businesses implement separate collection of frying/cooking oil (74%). In addition, the survey revealed that there is a high interest in installing separate bins for organic/biowaste and unserved food (36.2% and 46.5% respectively). Nevertheless, they are concerned with the availability of space.

3. kg of food waste generated per month

    a. Benchmark indicator: **plan & implement a monitoring framework/system**

    b. Benchmark indicator: **progress monitoring indicator**

4. kg of food waste generated per customer per month

    a. Benchmark indicator: **plan & implement a monitoring framework/system**

    b. Benchmark indicator: **progress monitoring indicator**

The total amount of food waste generated per month in HoReCa industry is a key indicator that needs to be measured, monitored and reported to the management and the employees, since deviations from the average can indicate change in the way food is processed, supplies inefficiencies, modification of the way the employees prepare the food, special events etc. However, due to the fact that the total amount of food waste generated can be affected by the number of customers served, the type of food offered and other reasons, a relative indicator proposed is the amount of food waste generated per customer per month. This indicator takes into account special events (e.g., holidays, touristic periods) that can have an effect on the first indicator. It can be a more robust indicator, which does not depend on the number of customers served and can capture regime shifts of both the production process and the supply

chain. Both of these indicators can be used not only to monitor food waste but also to compare between the same type of businesses.

Survey data suggest that European HoReCa businesses generate 180 kg of food waste per month (~ 45 kg each week). The average number of customers that they reported they had was 940 per month (235 per week). This means that each month ~0.19 kg of food is wasted per customer. The food waste rate found through the survey data analysis is in accordance with the figures reported in the literature. In particular, using a similar metric namely food waste per meal (Cordingley et al., 2011) estimated 159–191 g per meal in a study on food waste in secondary schools in the UK, Baier & Reinhard (2007) estimated 124g/meal and Andrini & Baune (2005) found 50g/meal. Papargyropoulou et al. (2019) reported an average food waste rate of 0.53kg/customer for Malaysian restaurants, though they mention there are significant differences between the restaurants under study.

5. **% of food waste (avoidable and unavoidable food waste that will be donated, be composted or landfilled) to food supplies (w/w)**
   a. Benchmark indicator: **30% by 2035.**
   b. Benchmark indicator: **progress monitoring indicator**

The percentage of food waste to the food supplies (w/w) is another indicator that is menu specific for the HoReCa businesses. It captures what percentage of the original stocked food did not serve its original purpose, i.e., being consumed by the customer. This indicator does not separate the different management options of the unserved food; it only measures the efficiency of the operations regarding food recovery. It is possible that a HoReCa business that exhibits higher % of food waste to food supplies (w/w) compared to a similar HoReCa business to face efficiency issues that can be attributed to either the food production or the supply and storage processes.

According to the survey data, 13.34% of the food supplied is wasted. This includes avoidable and unavoidable food waste that was either landfilled or repurposed. A similar study conducted by Betz et al. (2015) that examined the food waste to food supplies for two food service businesses in Switzerland found that the corresponding percentage for the two companies was 10.73% and 7.69%. Engström & Carlsson-Kanyama (2004) found that a fifth of the food delivered in four food service institutions in Sweden was lost.

6. **% of total food waste produced - pre-kitchen**
   a. Benchmark indicator: **plan & implement a monitoring framework/system**
   b. Benchmark indicator: **progress monitoring indicator**

7. **% of total food waste produced – kitchen**
   a. Benchmark indicator: **plan & implement a monitoring framework/system**
   b. Benchmark indicator: **progress monitoring indicator**

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8. % of total food waste produced – post-kitchen

   a. Benchmark indicator: **plan & implement a monitoring framework/system**

   b. Benchmark indicator: **progress monitoring indicator**

Companies operating in the HoReCa sector must measure and monitor the percentage of food waste generated at each stage of the production process, because each corresponding percentage is likely to reveal waste intense points at the various operational stages. For example, if a HoReCa business exhibits high post-kitchen wastage rate then it should evaluate if the food portions are excessive and in fact many of the customers get full before the amount of food on their plate is finished. Additionally, if a high amount of food is wasted in the pre-kitchen stage, then this can be an indicator of improper storage of the food or inaccurate demand forecast. Finally, if a high percentage of wastage occurs during the preparation of food, then it may be necessary to assess the way the food is prepared by the employees (e.g., excessive trimming, human errors, etc.).

About 25% of the total food waste can be attributed to pre-kitchen activities (during maintenance) according to the survey data. Betz et al. (2015) reported lower levels of food waste occurring during storage in two Swiss buffet-style HoReCa businesses – 0.84% and 4.29%. However, this can be explained by the fact that in the survey conducted under the ADVANCE program, storage is only a subset of pre-kitchen waste and, further, was based on a larger sample of businesses. HoReCa businesses reported that on average 25.5% of food waste can be attributed to the kitchen stage. The estimated food waste in the preparation stage reported in the analysis of Betz et al. (2015) was 10.02% and 32.35% for the two businesses. Last, the food waste proportion that occurs during consumption was estimated to be 49.6% by the HoReCa personnel that took the survey, while 25.16% and 26.54% rates were reported by Betz et al. (2015). However, the categorization of the stages was done differently and thus the highest food waste percentage appeared as service losses, i.e., leftovers in the buffet and serving bowls (62.6% and 38.21%).

9. % of customers taking home their leftovers in doggy bags

   a. Benchmark indicator: **50%**

Food that is not consumed by customers can still serve its original purpose and not end up in the trash if it can be taken back home inside a doggy bag. Businesses should promote the use of doggy bags and enable their customers to take home uneaten food, thus engaging them into a holistic approach to the issue. Using this indicator, a business interested in reducing food waste can monitor the customer engagement in this endeavour.

According to survey data, less than 40% of HoReCa businesses said that at least 50% of their customers take their leftover food in a doggy bag. Giorgi (2013) in a survey on waste behaviour characteristics when eating out in UK, found that there is a stigma attached to asking for a doggy bag for leftover food even though three quarters of the responders would be in favour if they were offered a doggy bag containing their leftovers.

10. % of leftover food (suitable for consumption) that is landfilled

    a. Benchmark indicator: **10% by 2035.**

Landfilling food waste is the least sustainable option according to the food waste management hierarchy. This is because, among other things, the decomposition of organic material such as food waste produces greenhouse gases such as methane, a gas that is 28 times more effective at trapping heat compared to carbon dioxide. In addition, the value of all the resources used to produce the food is lost. HoReCa businesses need to evaluate the options they have to manage leftover food that is suitable for consumption and redirect it from the landfill. A proper indicator that helps HoReCa businesses monitor their amount of leftover food ending up in the landfill is the % of leftover food (suitable for consumption) that is landfilled.

Although the percentage of food waste going to landfill can be difficult to estimate due to the fact that the final destination is not only determined by the HoReCa business but also by the waste management body, businesses that are familiar with how municipal solid waste is managed can determine the percentage that ends up in landfills. Thus, if the leftover food ends up in the trash and ultimately cannot be managed sustainably by the waste management body, it will end up in landfill. However, even if the waste management body cannot recycle/reuse it but the leftover food is donated or composted in-house, then landfill can be avoided.

According to survey data 55.1% of the HoReCa businesses throw away at least a fraction of leftover food. On one hand, a similar study (Sakaguchi et al., 2018) conducted in Berkeley, California, USA, found that 14% of the surveyed restaurants dispose leftover food to landfills. On the other hand, all participant restaurants in a study conducted for the city of Veszprem in Hungary relied on passive disposal as the main approach to manage food waste (Filimonau & Sulyok, 2021).

11. % of leftover food (suitable for consumption) that is reused, recycled and treated in any way

    a. Benchmark indicator: **90% by 2035**

12. % of leftover food (suitable for consumption) that is donated

    a. Benchmark indicator: **progress monitoring indicator**

13. % of leftover food (suitable for consumption) that is self-composted

    a. Benchmark indicator: **progress monitoring indicator**

In contrast to the previous indicator, these three indicators show the amount of leftover food that is managed in a more sustainable manner than the landfilling. In particular, the first and more general indicator captures the percentage of leftover food (suitable for consumption) that is recovered through reuse, recycling or any other process. The second indicator tracks the percentage of leftover food that is donated either to feed other people or to be treated and upcycled for other purposes. Last, the third indicator monitors the amount of food that is

composted by the business. Note that since the two last indicators cover all the available options of sustainable management of leftover food, the summation of them should be equal to the first indicator.

Survey data suggest that 44.1% of the HoReCa businesses donate some fraction of the leftover food to charity. In addition, 7.1% of them collaborate with external actors in order to manage unconsumed food that is suitable for consumption. Last, 9.4% of the businesses stated that they compost it in-house. Sakaguchi et al. (2018) in their study conducted in Berkeley, California, USA reported that 79% of the surveyed restaurants did not collaborate with external actors to redistribute excess food.

14. **% of food waste (unsuitable for consumption) that is landfilled**

    a. Benchmark indicator: **30% by 2035**

15. **% of food waste (unsuitable for consumption) that is reused, recycled and treated in any way**

    a. Benchmark indicator**: 70% by 2035**

Food that is not suitable for consumption consist of food parts that cannot be consumed by humans (pits, bones, skins etc) or food that cannot be served due to the fact that it has expired. Food waste unsuitable for consumption makes up a large part of the total amount of food wasted and therefore monitoring this fraction is also important for a HoReCa business. Therefore, based on the hierarchy of food waste management, the percentage of this fraction that ends up in landfill and the percentage that is recovered in a sustainable way should be monitored. The two indicators above serve exactly this purpose.

About 74% of the HoReCas that participated in the survey stated that at least a portion of the food waste that is unsuitable for consumption ends up in the trash. Further, 17.3% stated that they collaborate with external actors for its management and 12.6% that they self-compost it.

16. **% of food waste collected in a separate bin**

    a. Benchmark indicator: **100% by 2030.**

Separate collection is essential for the sustainable management of food waste. This is because separate bins enable better management of the food that is wasted and facilitates the treatment purposes that have been chosen to be followed (animal feed, self-composting, etc). Therefore, the more food waste is collected in a separate bin the bigger the amount that may not end up in the landfill.

Only 34.6% of the participants in the survey stated that they use a separate bin to segregate the biowaste/organic waste fraction. In addition, 35.4% stated that a separate collection bin for unserved food is in place in their businesses, 46.5% of the businesses expressed interest in installing a sperate bin to collect unserved food, and 36.2% for organics/biowaste.

17. % of waste cooking oil (including frying oil) collected in a separate bin

    a. Benchmark indicator: **85% by 2030.**

Cooking oil is one of the most common ingredients used by the HORECA sector and as a result used cooking oil is a main waste contributor. If cooking oil ends up in drains, it can cause problems in the sewage system (e.g., blockages) and if it ends up in a landfill, its decomposition will release greenhouse gases. On the other hand, the recycling of used cooking oil can convert it into animal feed, biofuel, soaps etc. The more cooking oil is collected into a separate bin the higher the recovery that can be achieved.

Almost three quarters of the participant businesses in the ADVANCE survey stated that they use a separate collection bin to collect used cooking oil.

18. % of packaging waste collected in a separate bin

    a. Benchmark indicator: **75% by 2030.**

Packaging is used to store and transport food and although its use is necessary for food safety reasons, it contributes to the total amount of waste produced by a HoReCa business. The most common packaging materials are cardboard, plastic, metal, glass and paper. While recycling processes for these materials are now in place, unfortunately large quantities of packaging still end up in landfills in the EU. HORECA businesses should separate packaging from other outflows and collect it in a separate bin to facilitate recycling. Their aim should be to recycle all the food packaging they use.

Based on the responses of the HoReCa survey participants, only 14.2% of the businesses have a separate collection bin to collect packaging material.

19. Internal training programs on food waste

    a. Benchmark indicator: **100% all personnel (permanent and seasonal) attend at least one training/awareness program per season or year**

Internal training programmes on food waste can be an effective way for HoReCa businesses to raise awareness of the food waste problem among employees. At the end of the day, employees are the ones involved in food handling and preparation. The main issues to be covered by these programs are the impact of food waste, the best practices to follow in order to prevent food waste in the operations of the business, and strategies to be followed in order to engage customers in food waste prevention and reduction.

When asked what actions should be taken in order to reduce the amount of food wasted, the majority (71.7%) agreed on the employee training. That means that the employees themselves recognise the gap of knowledge among the employees on the extend of the problem. However, the systematic training of the employees on this topic is on its infancy.

3.5.3 Progress Reporting

A progress report on the implementation of Roadmap, presenting the results for the suggested (or additional) KPIs should be published every year. Detailed measurements of actions will be carried out internally to support a summary public report.

A template form for monitoring and progress evaluation is presented in Annex I.

4 Best practices of HORECA Businesses

Towards preparing a FWM Roadmap is always useful to consider existing best practices. The following sections provide some successful examples from business FWM initiatives, as well as from applications of Industry 4.0 technologies that have been used by HoReCa businesses to achieve advance FW prevention and reduction.

4.1 FWM best practice examples

- **Kitchen Dates, Lisbon, Portugal**: The sustainable food literacy project called "Kitchen Dates" established the first zero-waste restaurant in Portugal, sharing the same name. This restaurant stood out as a pioneer in sustainable dining within the country by exclusively using local and seasonal ingredients. It actively embraced the principles of the circular economy in all aspects of its operations and daily routines. Situated in Telheiras, near the centre of Lisbon, the strategic location of the Kitchen Dates restaurant aimed to foster connections between urban residents and local farmers and their agricultural lands. To achieve their goals, Kitchen Dates committed to six fundamental values that they deemed essential in fostering a conscious, healthier, and sustainable world:

    - Circularity: Everything brought into the restaurant is either consumed, reused, or composted.

    - 100% Vegetable: Embracing a plant-based diet due to its positive impact on human, plant, and animal health.

    - Localness: Vegetables and fruits are sourced within a 50 km radius, while other Portuguese ingredients, such as almonds, come from a maximum distance of 500 km.

    - Seasonality: The restaurant's menu follows the natural cycle of nature, changing weekly to reflect local produce.

    - Organic: Partnerships are established only with farmers practicing organic and conscious farming.

    - Transparency: A commitment to total transparency with the community regarding their zero-waste goals, including honest communication about challenges faced in achieving sustainability targets.

Kitchen Dates restaurant utilized an electric composter (*Eva*) to transform inedible or unreusable food into compost within a 24-hour timeframe. The resulting compost was returned to the producers, who utilized it as a natural fertilizer for their soil.

Kitchen Dates recognized the importance of portion control in reducing food waste. They aligned with the perspective that serving smaller portions is a crucial sustainable practice. The restaurant implemented this approach by serving smaller quantities per plate, allowing customers to take home any leftovers (Figueiredo, 2021).

Figure 2. Kitchen Dates' the composting machine, "EVA"

- <u>Nolla Restaurant, Helsinki, Filand</u>: Nolla forms strong partnerships with local farmers and suppliers to provide seasonal organic food with minimal packaging. They involve designers, architects, and engineers to incorporate recycled materials for durable utensils and furniture. Utilizing inventory and waste tracking apps benefits both Nolla's management and provides feedback to the app developer.

Nolla's core zero-waste practice revolves around an in-house composting machine. This machine, obtained from Oklin, efficiently converts bio-waste into compost within their kitchen space. Oklin's composting machine uses microbial technology and heat to transform food waste into dry compost within 24 hours. The compost is returned to Nolla's suppliers, closing the loop of bio-production and supporting sustainable growth. The machine's operation does not interfere with food production as the resulting compost is dry, odourless, and deters pests.

Figure 3: Oklin's composting machine at Nolla Restaurant

Transforming food waste into sustainable products not only benefits the environment but also reduces waste management costs significantly. Embracing a zero-waste approach eliminates monthly fees to waste handling companies and taxation. Investing in an in-house composter saves money and positions the business as forward-thinking and future-oriented. Nolla invites customers to take home their in-house compost for free, engaging them in their sustainable practices and involving them in their environmental initiatives. By offering this service, Nolla extends the customers' benefits beyond meal service, fostering a shared commitment to the environment (Nguyen, 2019).

- IKEA Restaurants, globally: IKEA understands the importance of sustainable practices, including reducing food waste. Their "Food is Precious" initiative aimed to achieve a 50% reduction in food waste by August 2020 and had been successful on a global scale. To accomplish this goal, IKEA implemented three key actions:

  1. Measurement: Pilot programs were conducted in four IKEA stores using smart scale systems provided by LeanPath and Winnow Solutions. These scales accurately measured and tracked food waste, resulting in significant decreases ranging from 23% to 54% over six (6) months. Concrete results from the pilot program played a crucial role in gaining support from IKEA employees at all levels.

  2. Engaging staff: Recognizing the vital role of the "human factor," IKEA appointed Food Waste Champions in each store. These champions were responsible for implementing the program and motivating their colleagues to reduce food waste. Additionally, a Country Implementation Responsible (CIR) was designated

in each market to lead and support implementation efforts. Surveys revealed that 50% of the employees involved in the initiative were inspired by IKEA's leadership and took steps to reduce food waste in their personal lives.

3. Continual improvement: After observing a 20% reduction in food waste within 12 weeks, with a payback period of 20 weeks, IKEA expanded its "Food is Precious" initiative. The company worked closely with partners to align technical tools and overcome implementation challenges. IKEA's plan is to address food waste across its entire value chain by collaborating with suppliers and inspiring consumers to reduce waste at home (Clowes et al., 2019).

- **Sofitel Bangkok Sukhumvit, Bangkok, Thailand:** The prestigious 5-star hotel successfully reduced its food waste by 50% in just 15 weeks, leading to estimated annual savings of $60,000. This impressive accomplishment was made possible through several key actions:

  1. Measurement: The hotel's restaurant implemented a smart scale system to track and categorize kitchen waste, allowing staff to identify areas with high food waste, such as the buffet and perishable items.

  2. Reduction of overproduction: Instead of eliminating popular buffet options, the hotel focused on controlling the quantities of each dish, ensuring guest satisfaction while minimizing waste.

  3. Engagement with suppliers: The hotel collaborated with suppliers, renegotiating contracts for more flexible ordering to align perishable items with actual needs.

  4. Staff engagement: Daily chef's meetings provided a platform for staff to discuss waste reduction strategies, prioritize high-value items, and find creative solutions.

By implementing these actions and fostering a collaborative work environment, Sofitel Bangkok Sukhumvit achieved significant food waste reduction, highlighting its commitment to sustainability and operational efficiency in the hospitality industry (Clowes et al., 2017).

- **The Ship Inn, Cumbria, United Kingdom:** This traditional pub located near Barrow in Furness, with a focus on home cooking, aimed to enhance its financial margins by reducing food waste resulting from routine plate waste. The achievement of this goal involved implementing the following key actions:

  1. Measurement: The pub initially used manual measurements to categorize waste into different bins, providing a general overview of waste patterns. More detailed insights can be obtained using digital tools that analyse waste by meal, ingredient, or dish type.

  2. Gradual implementation: The Ship Inn adopted a step-by-step approach, making changes to their operations gradually. This allowed staff to assess the

effectiveness of each change individually and build momentum for further improvements.

3. Demonstrating results: During a four-week trial period, the pub achieved impressive reductions in spoilage (84%) and plate waste (67%) through increased waste awareness and improved working practices. By offering portion size options and removing garnishes, the pub received positive customer feedback. Overall, total waste decreased by 72% between week one and week four. Conducting a trial period helped stakeholders better understand the initiative, enhancing the effectiveness of long-term waste reduction efforts.

By implementing waste measurement, gradually introducing changes, and showcasing tangible results, the Ship Inn successfully reduced food waste, leading to improved financial margins (Clowes et al., 2019).

4.2 Industry 4.0 technologies

Industry 4.0 technologies can help HoReCa SMEs to achieve better FW management and advance FW prevention and reduction. Hereinafter, the main technologies are described, accompanied with relevant examples where available.

- Internet of Things (IoT) sensors: IoT sensors can be used to monitor FW levels in bins in real-time. This data can be used to optimise waste collection routes, reduce FW generation, and improve operational efficiency. For example, LeanPath is a technology company that specializes in food waste prevention. They work with various restaurants, including Aramark, Sodexo, and Google Cafes, to implement IoT-based food waste tracking systems. These systems utilize smart scales and software to measure and analyse food waste data, helping restaurants identify waste sources, track progress, and make informed decisions to minimize waste (Haugan, 2017).

- Artificial intelligence (AI), machine learning (ML) and big data analytics (BDA): AI and ML can be used to analyse big data from IoT sensors and other sources to identify patterns and trends in FW generation. For example, Lior's teams in Italy have launched a pilot project in a Milan restaurant, testing Winnow Vision's artificial intelligence solution to reduce food waste. The system uses cameras above trash bins to capture images of discarded food, which are processed by AI. The technology automatically weighs, identifies, and categorizes the waste, providing detailed data for chefs to analyse. By optimizing raw materials, adjusting shopping lists, educating consumers, and recycling waste, the pilot restaurant has achieved a remarkable 60% reduction in waste since implementing Winnow (Food for Good, 2021).

- Blockchain: Blockchain technology can be used to create a transparent and secure system for tracking FW throughout the supply chain (Dey et al., 2022). This can help to identify areas where waste is being generated and develop more effective prevention and reduction strategies. For example, in the hospitality industry Blockchain can be used to track food problems from the first stages of their production to the final stage

(consumption) and prevent FW, fraud, and any other unethical practice or action, and to make food supply chains more transparent (Stroumpoulis et al., 2022).

- Predictive analytics: Predictive analytics can be used to forecast FW levels, allowing municipalities to plan and allocate resources more effectively (e.g. to ensure that waste is collected and processed efficiently, reduce the risk of overfilling bins, etc.). A hosptech company, Tenzo, aspires to save the food industry around 75,000 tonnes of waste globally by 2027 using an AI-powered predictive analytics platform (Taylor, 2023).

- Cloud computing: Cloud computing can be used to store and manage large volumes of data from multiple sources, making it easier for municipalities to access and analyse data on food waste generation and management. Cloud Computing, for example, can promote the real-time information exchange along the farm to fork value chain, to enable the integration of smart applications and assets along the chain, and, consequently, to reduce FW (Funchal et al., 2022).

- Smart packaging: Smart packaging can be used to monitor food freshness and quality, reducing the risk of food wastage globally (Chen et al., 2020). The technology is still in its infancy but many companies are already using like the Sealed Air's automated packaging solutions systems (Feed & Nutrition, 2022).This practice will help suppliers and HoReCa SMEs to arrange and organise their stock.

- Robotics and automation: Robotics and automation can be used to sort and process FW, reducing the need for manual labour and improving efficiency. This can reduce processing costs and increase the amount of waste that can be recycled or repurposed.

- Augmented reality (AR) and virtual reality (VR): AR and VR can be used to educate and engage consumers on the importance of food waste prevention and reduction and to raise awareness and encourage more sustainable behaviour. FW and AR is still in its infancy but some applications have been developed, where models of food are projected onto real-world environments to provide scale on FW waste and help consumers understand the level of waste (Honee et al., 2022).

- Mobile apps and online platforms: Mobile apps and online platforms can be used to facilitate communication and collaboration between municipalities, businesses, food banks, organisations, and consumers to share information and resources on FW prevention, reduction, and donation. For instance:
  - "Too Good To Go" app has established a platform where surplus food from restaurants, hotels, supermarkets, and bakeries, which would have otherwise been discarded, can be sold. This enables businesses to generate income from food that would otherwise go to waste, all while attracting new customers (Creative Denmark, n.d.). These customers purchase a "magic bag" of food at a small cost, which is valued at three times what they pay. Remarkably, four years after its inception in Copenhagen, "Too Good To Go" has rescued 43 million meals from being wasted and has mitigated the release of over 108,000 tonnes of greenhouse gas emissions. This is equivalent to the emissions produced by 22,500 vehicles driven for one year (FoodDrinkEurope, 2020).

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- o "Fridgely" informs the user when food is going to expire and prevents FW. It works by scanning the barcodes of the food items. The app itemises them and estimates the expiration date (Fridgely, n.d.).
- o "Food Rescue Hero" is an app that mobilises volunteers to transport surplus food to those who can use it. Volunteer drivers are alerted when surplus food is available to be picked up near them. Since its launch in 2016, the app has redirected more than 77 million pounds of perfectly good food from landfills to the people who need it (Food Rescue Hero, n.d.).
- o "Imperfect Foods" app helps reducing FW by offering farm fresh produce, pantry staples, animal and plant-based proteins, dairy and alternatives, beverages and that are imperfect (e.g. have irregular sizes, or a unique cosmetic feature) at reduced prices (Imperfect foods, n.d.).

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Annex I: Template form for monitoring and progress evaluation

Monthly Monitoring/ Evaluation Form

1)	**Do you implement compositional analysis?**	Yes/No	

If, yes:

Provide the number of the compositional analysis

Provide the products and their weight

Products	kg

2)	**Number of installed bins for separate collection**		
3)	**kg of Food waste generated**		
4)	**kg of food waste generated per customer**		
5)	**kg of total food waste produced - pre-kitchen**		
6)	**kg of total food waste produced – kitchen**		
7)	**kg of total food waste produced – post-kitchen**		
8)	**Do the customers take their food leftovers for home?**	Yes/No	
9)	**kg of food landfilled**		
10)	**kg leftover food (suitable for consumption) that is reused, recycled and treated**		
11)	**kg of leftover food (suitable for consumption) that is donated**		
12)	**kg of leftover food (suitable for consumption) that is self-composted**		
13)	**kg of food waste (unsuitable for consumption) that is landfilled**		
14)	**kg of food waste (unsuitable for consumption) that is reused, recycled and treated**		
15)	**kg of food waste collected in a separate bin**		
16)	**kg of waste cooking oil (including frying oil) collected in a separate bin**		
17)	**kg of packaging waste collected in a separate bin**		
18)	**Indicate other actions that implemented during this month and should be referred in the annual report**		

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