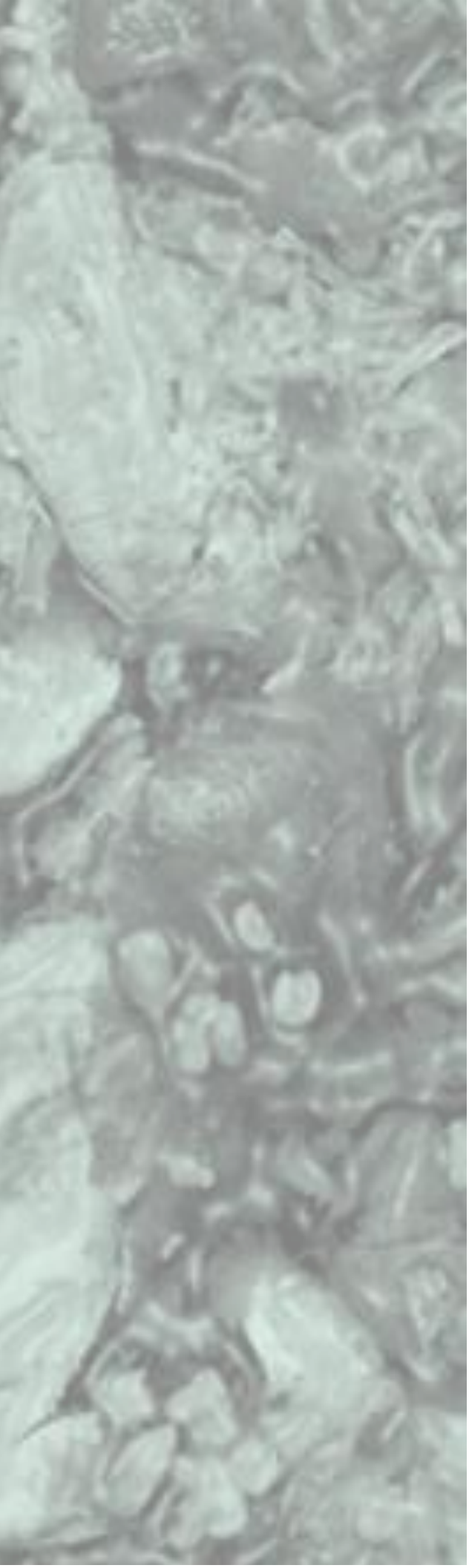

ADVANCE
ADVAncing MuNicipal Circular Economy

PR3: Development of ADVANCE Roadmap

Task 3.2: Understanding the Context of Food Supply Chain

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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
FW	Food waste
FWM	Food waste management

Executive summary

This report presents the results of the second task of PR3, namely “Task 3.2 Understanding the Context of Food Supply Chain”. Specifically, at this stage a methodological approach is provided in order to facilitate a Municipality and / or a HORECA business to assess its broader operational environment. The main objective is to understand how different factors in the food supply chain affect food waste generation and management, In particular, specific socio-political-economic factors.

In total, fourteen factors were identified and analysed in this report, as follows: 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.

For each factor a basic definition is offered and its main characteristics and their impact on food waste management are described. Moreover, the analysis aims also to define which elements of each factor and how they relate to the target groups of the Project, i.e., Municipalities and Horeca SMEs. Finally, a number of triggering questions are initiated at the end of each section to facilitate the reader understand how each factor under consideration affects food waste generation and management.

1 Introduction

The ADVANCE - "Advancing MuNicipal Circlular Economy" is an Erasmus+ Project under the KA2 - Cooperation for innovation and the exchange of good practices / KA220 - Cooperation partnerships in vocational education and training.

ADVANCE project has as main objectives to assess the current food waste management practices in selected municipalities and SMEs in the HORECA sector and to assess the gap between the baseline assessment and the requirements posed by the EU Circular Economy Action Plan using the Circularity Indicators.

The PR3 will develop a Roadmap and will design a step-by-step methodological framework for implementing the food waste targets. The project aims to catalyse synergies between municipalities and SMEs in the HORECA sector in order to achieve the food waste targets set by the European Union and the Sustainable Development Goals. However, the road to develop those synergies requires different tools, agendas and priorities on a municipal and an enterprise level. For that reason, two different Roadmaps will be developed, one for municipalities and one for the SMEs in the HORECA sector. A special part of the Roadmap will be to demonstrate how Industry 4.0 can help municipalities and SMEs to achieve better food waste management and advance food waste prevention. The Roadmap will be established on the outcomes of PR1 and PR2 and it will use the Circularity Gap Indicators as its main tool to guide the required steps.

This document provides the results of the second task of this PR3, namely "Understanding the Context of Food Supply Chain". Specifically, at this stage a methodological approach is provided in order to facilitate a Municipality and / or a HORECA business to assess its broader operational environment and identify the following factor that impact their food waste management: 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.

1.1 Scope and Purpose

The task "Understanding the Context of Food Supply Chain" is part of the overall PR3 "Development of ADVANCE Roadmap". The main objective here is to understand how different factors in the food supply chain affect food waste. In particular, specific socio-political-economic factors that influence food waste generation and management are compiled and analysed below.

For each factor a basic definition is offered and its main characteristics and their impact on food waste management are described.

A desirable objective is also to define which elements of each factor and how they relate to the target groups of the Project Result, i.e., Municipalities and Horeca SMEs.

At the end of each section, through questions, the user can reflect on how the factor under consideration affects food waste.

2 List of factors

The following table summarises the factors to be studied in relation to food waste management (Table 1):

Table 1: Distribution of factors per partner

ID	Factor	Responsible Partner
1.	City Demographics	SIGMA
2.	Spatial Information	NTUA
3.	Risks in Circular Transition	SIGMA
4.	Regulations and Legal Framework	NTUA
5.	IND 4.0 Appliances in Waste Management	D-WASTE
6.	Food Waste/ Food Loss Generation	D-WASTE
7.	Municipal Management	D-WASTE
8.	Waste Prevention	Zadar
9.	Waste Collection	EUGENE
10.	Recycling	Novi Sad
11.	Financing	NTUA
12.	Disposal	Zadar
13.	Economic	Horeca Partners
14.	Behavioural	Horeca Partners

3 Factor analysis

3.1 Factor 1: City Demographics

3.1.1 Definition

Statistics that describe populations are based on characteristics, such as age, sex, occupation, income, family status, education, attitudes, etc. Demographics are used by enterprises to detect if any social group has a certain behaviour pattern, and so use this knowledge to adjust its practices based on the target group and its characteristics.

It is not possible to know and understand every client, so the only way is to separate them into categories based on some common characteristics, observe if the groups that are created have common ground and adjust on them, rather than on everyone separately.

3.1.2 The role of the factor in food waste generation and management

Demographics are very important because, if we detect the characteristics of the people that are part of the food waste problem, we can adapt to them instead of taking blind measures. This way we save resources and have better and faster impact. The table below (Table 2),

classifies key elements of this factor that affect food waste generation and management and relate to the two main sectors of organisations-target group.

Table 2: City Demographics Factor Analysis

Factor's element	HORECA SMEs	Municipalities
Age	• Younger people, students waste more than other age groups (Alena Filipová, 2017). • Children are more likely to have more food wasting behaviour (Grasso, 2019). • Younger people are more likely to purchase suboptimal products and they are increasingly aware of the importance of recycling and the negative consequences of food waste (Heng Yan, 2022). • Adults 65 years of age or older have been found to practice food waste reducing behaviours such as planning meals in advance (Grasso, 2019).	• Households with children are more likely to have more food wasting behaviour (Laasholdt V. A., 2021). • People who were born in the 1980s and early 90s waste almost 50% more food than people who are aged over 65, due to their busy lifestyles and changing plans. (Husna Jamaludin, 2022).
Gender	• Women waste more food than men when they are responsible for grocery shopping (Heng Yan, 2022). • Being male was associated with more FW behaviours in Denmark (Grasso, 2019). • Males waste less food than females in Finland (Grasso, 2019). • Women on average in the EU appeared to be more conscious of food waste compared to men, which may make them less susceptible to generating food waste (Grasso, 2019).	• Women are found to waste lesser amount of food as compared to men, because they spend more time in the kitchen and thus are aware of the economic cost of wasting food. (Husna Jamaludin, 2022).

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Factor's element	HORECA SMEs	Municipalities
Occupation	• People working full-time (Grasso, 2019) & people with higher frequency of eating outside waste more (Heng Yan, 2022) / Part-time, unemployed or retired people waste less food (Grasso, 2019).	
Income	• Economically active people and people from higher-income households (both per household and per person) waste more / Pensioners waste much less than other groups. (Alena Filipová, 2017). • Individuals with higher education and income tend to waste more, while individuals living in rural area produce less waste (Heng Yan, 2022).	• Economically active people and people from higher-income households (both per household and per person) waste more / Pensioners waste much less than other groups (Alena Filipová, 2017). • Individuals with higher education and income tend to waste more, while individuals living in rural area produce less waste (Heng Yan, 2022).
Family status		• Larger households produce more total waste than smaller ones, but larger households waste less on a per capita basis (Heng Yan, 2022) • Households with children are more likely to have more food wasting behaviour (Videb 2021). • The higher the population density in a city or household, the lower the production of food waste (Collins and Grantham 2021).
Education	• Individuals with higher education and income tend to waste more, while individuals living in rural area produce less waste (Heng Yan, 2022).	

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3.1.3 Triggering Questions

- How educational level can influence the reduction of food waste?
- How income can (per household as well as per person) affect food waste?
- How do you think the age/modern lifestyle/nutritional habits of young people is related to food waste?
- How could a restaurant use the demographics of the area to reduce food waste and increase profit?

3.1.4 References for factor 1

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3.2 Factor 2: Spatial Information

3.2.1 Definition

Spatial information refers to the geographical connection between people and activities using geographic location data (spatial data). Spatial information consists of data that can be mapped, and any associated information such as metadata which provides context and meaning (Department of Environment and Science, 2019). Spatial information includes among other (Alberta Education, n.d.):

- understanding shape and space
- measuring time, weight, height or amounts
- determining location and direction

3.2.2 The role of the factor in food waste generation and management

Food system has a strong connection with other areas which important in spatial planning like economic development, health, land-use, transportation and natural resource quality (Sirén, 2013). Nevertheless, important parts of the food chain, including food waste, have not been addressed in planning literature yet (Holtslag-Broekhof & van der Valk, 2012; Sirén & Carsjens, 2013). The role of spatial information in food waste generation and management can be related to material aspects (e.g., bins for separate collection or composting facilities, quantity and composition of food waste, etc.), organisational aspects (e.g., food waste initiatives, food banks and other charities, etc.), and institutional instruments (e.g., waste policies, economic incentives, etc.) at three difference scale levels, i.e. macro scale (city level or higher), meso scale (district level), and micro scale (neighbourhood or household level) (Sirén & Carsjens, 2013). Also, spatial information may be related to socio-economic and socio-cultural characteristics that affect food waste generation and management provided that consumers, in particular, have been identified as the main responsible for food waste generation (Cerciello, 2021). The analysis of urban food systems involves different subsystems, conceptualized on the food cycle chain: production, transformation, processing, distribution, consumption, waste disposal (Guerrero, 2019).

Table 3. Spatial Information Factor Analysis

Factor's element	HORECA SMEs	Municipalities
Spatial distribution of gender	• The empirical literature shows that women are generally more sensible to environmental issues (Karim Ghani et al., 2013). Hence HORECA businesses run by women usually produce less waste. However, women occupy only 6.3% of the head chef positions at prominent U.S. restaurant groups (Troitino, 2020).	• Areas with higher percent of female population produce less food waste (Cerciello, 2021). The empirical literature shows that women are generally more sensible to environmental issues (Karim Ghani et al., 2013)
Spatial distribution of unemployment rate	• Areas with higher unemployment rates may have less HORECA businesses, because unemployment rate affects the sales of restaurants (Maze, 2015).	• Areas with higher unemployment rates tend to waste less (Cerciello, 2021). In general, unemployed people are endowed with fewer resources and face a higher opportunity cost of wasting food (Hage & Söderholm, 2008).
Spatial distribution of food expenditure	• The more food is purchased by HORECA enterprises the bigger the amount of waste, according to the survey of the HORECA SMEs that was conducted by the ADVANCE project.	• Areas where data shoes that more food is purchased produce more food waste (Cerciello, 2021).
Spatial distribution of population age	• Areas with more older people may indirectly affect food waste from HORECA businesses. Older people are becoming more tech-savvy and tend to order takeout food. Also, older people are eating out more than the younger people (Hodgetts, 2019).	• Areas with elderly people tend to produce more food waste (Cerciello, 2021). The elderly are typically less waste-averse due their lower environmental awareness (Morrison & Beer, 2017).
Areas with high concentration of low-income households	• Low-income neighbourhoods offer greater access to food sources that promote unhealthy eating, e.g. fast-food outlets (Hilmers et al., 2012). The latter HORECA businesses are usually less waste-adverse.	• 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 (Porpino et al., 2015). The presence of immigrants may increase food waste due to

Factor's element	HORECA SMEs	Municipalities
(including immigrants)		difficulties in interpreting expiry dates and storing food correctly (Cerciello, 2021).
Spatial information on food waste generation		• It is an essential information for the municipal authorities to plan the collection and transport of food waste for reuse, recycling or disposal to landfills (Hidalgo-Crespo et al., 2022; Raut et al., 2015).
Spatial distribution of food waste bins	• The "out of sight, out of mind" phenomenon is triggered if collection bins for separate collection of food waste are far from the HORECA businesses.	• The results of the ADVANCE households' survey shows that separate collection of food waste is more widespread when they have bins for separately collecting the food waste and there is an organised food waste management in their municipality. Similar findings are reported from previous research efforts (e.g. González-Torre & Adenso-Díaz, 2005). • For the municipalities, identifying optimal locations for establishing food waste bins is also important in terms of cost of the waste management system, as well as in terms of efficiency. Similar to other waste streams, this is usually based on criteria like population density, waste sorting culture, road network, distance to composting/recycling facilities, landfills, land space, and land cost, etc. (Farahbakhsh & Forghani, 2019).
Spatial patterns of housing types		• Single-family houses have a greater potential for backyard composting compared to high-rise buildings and this affect the viability of decentralised and centralised composting facilities (Pai et al., 2019).

Factor's element	HORECA SMEs	Municipalities
Spatial distribution of HORECA businesses	-	• Collection from restaurants and other HORECA businesses experiences large variations in terms of food waste volumes and this makes it difficult to develop a general model on what size of container is needed and where to install the bins so as to avoid under- and over-capacity of bins and optimise the collection cost (Seadi et al., 2013).
Location of composting, anaerobic digestion and other food waste reuse/recycle facilities (including urban farmers, livestock, food banks, etc.)	According to the results of the HORECA SMEs survey that was conducted by the ADVANCE project, 44.1% state that they donate it to charity, 9.4% that they compost it, 7.1% that they collaborate with external factors. Hence, proximity to these facilities reduces the amounts of food waste that end up to landfills, for instance: • Proximity to urban farmers (including livestock), who are an important part of urban food system, helps to transform food waste into a resource for further use in agricultural production (Kasper et al., 2017). • Community food security movements (food banks, food pantries and soup kitchens, etc.) work in the benefit of vulnerable households (Guerrero, 2019) and reduce food waste that end up to landfills. Also, locating social supermarkets, food banks, etc. close to HORECA businesses secures the supply of food for vulnerable people (Lienbacher et al., 2021).	• Relevant research shows that spatial variability exists in the valorisation of food waste due to differences in tipping fees, O&M costs of the facilities, and product market prices, among others (Badgett & Milbrandt, 2021; Manson, 2017). • The management of household waste is affected by the recycling boundaries and treatment capacity. Therefore, the spatial characteristics of waste generation and consumption are important to maximise food waste treatment and minimise the average total unit cost and GHG emissions (Mabe et al., 2022; Rijal & Lin, 2021).

3.2.3 Trigger Questions

- Why spatial information is important to designing food waste management systems?
- How does the location of food waste reuse/recycle facilities and initiatives affect the municipal food waste management systems?
- Why the location of food waste reuse/recycle facilities and initiatives is important to HORECA sector in terms of food waste management?
- How does the positioning of bons affect the overall performance of food waste management systems?
- If you were responsible for designing the municipal food waste collection system, what criteria would you take into consideration from a spatial perspective?

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3.3 Factor 3: Risks in Circular Transition

3.3.1 Definition

There are numerous definitions of what a transition to a Circular Economy (CE) means (Kirchherr, 2017). The latest and most comprehensive definition in the literature is that of (Nobre, 2021): "Circular Economy is an economic system that targets zero waste and pollution throughout materials lifecycles, from environment extraction to industrial transformation, and to final consumers, applying to all involved ecosystems. Upon its lifetime end, materials return to either an industrial process or, in case of a treated organic residual, safely back to the environment as in a natural regenerating cycle. It operates creating value at the macro, meso and micro levels and exploits to the fullest the sustainability nested concept. Used energy sources are clean and renewable. Resources use and consumption are efficient. Government agencies and responsible consumers play an active role ensuring correct system long-term operation".

CE is not just a seasonal trend, but a global priority for most political agendas to reduce consumption and resource loss. For instance, Europe's new agenda for sustainable growth (Circular economy action plan-European Green Deal), describes the EU's transition to a circular economy that will reduce pressure on natural resources and will create sustainable growth and jobs. It is also a prerequisite to achieve the EU's 2050 climate neutrality target and to halt biodiversity loss (European Commision, 2020).

In conclusion, circularity can provide the necessary tools to transform the usual linear model of 'take-make-use-consume' (European Commision, 2020) into an economy where **waste and pollution are eliminated**, **products and materials are reused** and nature is regenerated (Mrówczyńska, 2022).

Regarding the definition of risk, it is useful to mention that risk can be an uncertain event or condition that, if it occurs, has an impact on at least one project or business objective. During the CE transition, many structural changes in business might occur within the company, generating thus new risks that should be identified at an early stage. Specifically, areas that should be carefully examined for generating new risks are the following: New Circular Economy Business Model, New Circular Economy re-engineered Business Processes and New Circular Economy Business Products and Services.

Below follows an aggregate but non-exhaustive list with risk categories that HORECA (Hotel, restaurant, café accommodation and food service activities) SMEs or a municipality may face by CE implementation:

Organizational Risks (e.g., new business model plan combined with new knowledge required), **Technical & Knowledge** (e.g., the need of new recycling technology and knowledge), **Financial** (e.g., implementation costs-low capital), **Social** (e.g., the perception of the consumer together with the fear of disturbing the consumer's convenience), **Supply Chain** (e.g., establishing partnerships with new suppliers and matching interests along the CE chain).

- Risk Category: **Organizational Risks** (e.g., new business model plan combined with new knowledge required)
- Risk Category: **Technical & Knowledge** (e.g., the need of new recycling technology and knowledge)
- Risk Category**: Financial** (e.g., implementation costs-low capital)
- Risk Category: **Social** (e.g., the perception of the consumer together with the fear of disturbing the consumer's convenience)
- Risk Category: **Supply Chain** (e.g., establishing partnerships with new suppliers and matching interests along the CE chain).
- Risk Category: **Environmental**

Businesses in HORECA (hospitality, restaurant, and catering) account for a significant share of total food waste and, more importantly, are characterized by a generally low sense of awareness of sustainability-oriented innovation opportunities and the challenges of minimizing food waste.

On average, a restaurant generates 25,000 to 75,000 pounds of waste annually, of which only 14.3% of food scraps are recycled, 1.4% are donated, and the remainder, 84.3% of that food, is discarded. The reduction of waste from the foodservice industry produces, in addition to increasing profits for the respective establishment and increasing sustainability indicators for the respective business, significant positive environmental impacts.

3.3.2 The role of the factor in food waste generation and management

The basic principles of the circular economy, i.e. reduction, reuse and recycling, can be applied to the food sector as follows:

1. Reduction of food waste
2. Redistribution of surplus edible food
3. Recycling. Creating new value from food waste and non-edible by-products (KPMG, 2020).

Businesses usually turn to waste reduction to reduce operating costs, gain greater efficiency and save natural resources. However, most companies still perceive circularity as something that does not directly concern them or as something too costly and risky to implement. This may be due to the high level of innovation required to implement CE strategies in a business, combined with existing regulatory, economic and cultural barriers that continue to prevent both supply and demand from fully realizing the benefits of moving to CE processes and products (Cristoni, 2018). However, cyclical businesses have proven to be resilient to many of

the above risks, and in the long run they can reap more profits than their linear counterparts (Mrówczyńska, 2022).

Regarding business executives' perception of the CE, some executives may have a positive attitude, while others may not. It is also possible that owners or managers may have a different perception of the risk. Fear of risk may discourage the implementation of CE, even after assessing the benefits associated with its implementation. Resistance to change keeps business models locked into their conventional configuration and can be a significant barrier for micro-enterprises' (Rizos et al. 2016). From the above it can be concluded that avoiding the adoption of cyclical designs due to risks is again an overall risk, i.e., perpetuating the problem of waste generation and management. This risk is particularly important for the food sector, and for HORECA SMEs and municipalities, as they are direct key actors that manage food waste. Failure to drastically minimise this major problem of our time reduces the chances of achieving the European CE targets within the set timeframes.

The table below includes key categories of risks with literature references that often prevent SMEs & municipalities from adopting circular mechanisms, possibly indirectly affecting both the maintenance of food waste production and its inefficient management:

Table 4: Risks in Circular Transition Factor Analysis

Factor's element	HORECA SMEs	Municipalities
Organizational Risks	• Managers find difficulties in integrating CE, as the perceived operational risk is high and poor disassembly (of the Linear Economy) is a key challenge (Sharma, 2021). • Compared to new product production, the remanufacturing process is time-consuming, requiring more skilled and experienced labour (Mei Jiang, 2016).	
Financial	• There are many significant barriers to the adoption of CE, such as huge capital requirements, higher initial costs for updating facilities, risk and uncertainty, lack of institutional and legal support (Sharma, 2021). • The adoption of circular operations is hampered by cost and risk barriers, which are exacerbated for SMEs (McDougall, 2022). • The costs of green innovation and business models have been reported extensively in literature as a major barrier to the adoption of sustainability practices by SMEs (Rizos et al. 2015).	• The vast majority of the 51 cities and regions participating in the OECD survey on the circular economy in cities and regions reported challenges related to insufficient financing (73%), as well as financial risks (69%), lack of critical scale for business and investment (59%) and lack of private sector commitment (43%) (OECD, 2020).
Social	• Brand protection in modern retailers is often a barrier to the recovery of food for	• Cultural barriers are a challenge for 67% of the cities and regions surveyed, along with a lack of awareness (63%) (OECD, 2020).

Factor's element	HORECA SMEs	Municipalities
	redistribution (Niken Kusumowardani, 2022) • Consumers' behaviour is an important factor for CE implementation in companies. They can also influence organizations, while reuse strategies are often driven by market conditions and users' acceptance (Marit Moe Bjørnbet, 2021).	
Technical & Knowledge	• Risks related to Human Resources caused by low level of knowledge and unfamiliarity with CE and high-risk perception in the supply chain (Kazancoglu, 2021). • Prevention can be achieved via various pathways at the source either through better logistics and management tools (production, processing and retail level), or targeting consumer's education, behaviour, and consumption habits. (Papargyropoulou, 2014)	• The lack of human resources is a challenge for 61% of surveyed cities and regions participating in the OECD survey. Technical capacities should not just aim for optimizing linear systems but strive towards changing relations across value chains and preventing resource waste (OECD, 2020) • Inventory related barriers for stocking waste for recycling and a large amount of waste sending to landfills (Municipal waste recycling) (Sharma, 2021). • Cultural barriers are a challenge for 67% of the cities and regions surveyed, along with a lack of awareness (63%) (OECD, 2020).
Supply Chain	• Supplier related risks caused by lack of environmental awareness of the suppliers (Kazancoglu, 2021). • Supply chain integration risk caused by suppliers' reluctance to engage in integration, co-creation, and partnership within the supply chain and during the life cycle of the product in the context of the circular transition (Kazancoglu, 2021).	

Factor's element	HORECA SMEs	Municipalities
Environmental	• Lack of environmental awareness of the suppliers. (Masi, 2018)	

3.3.3 Trigger Questions

- Which individuals-factors along the food supply chain pose a risk of non-implementation of circular plans and non-integration of the chain and why?
- What is the current state of knowledge about the risks of transitioning to a circular economy?
- How can lack of environmental awareness prevent the implementation of a circular economy?
- How do costs relate to the implementation of the circular economy?

3.3.4 References for factor 3

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3.4 Factor 4: Regulations and Legal Framework

3.4.1 Definition

Legislation is defined as the preparing and enacting of laws by local, state, or national legislatures. In other contexts, it is sometimes used to apply to municipal ordinances and to the rules and regulations of administrative agencies passed in the exercise of delegated legislative functions (Britannica, 2018).

Legislature, which is one of the branches of the separation of government's powers (the other two being the executive and the judiciary) is an authorized assembly that makes laws for a political entity such as a country or a city.

3.4.2 The role of the factor in food waste generation and management

Food waste has many origins, one of which is food legislation. Research (Bremmers & van der Meulen, 2016) has shown that Western countries overemphasize the quest for food safety and food risk avoidance and that such a behaviour has several implications on the legal framework that is implemented across EU especially at the early stages of food supply chains (production, processing). This zero-tolerance policy also leads business operators to take precautionary measures in their processing activities and follow or even surpass publicly set standards resulting in exaggerated food waste and loss.

On the other hand, legislation can be a lever for the transition to a circular food supply chain. Recognising that addressing food waste can be beneficial for people, the economy and the environment, the European Commission has adopted a number of policies based on the food waste management hierarchy that aim to prevent food waste or manage it in environmentally friendly manner.

Table 5. Regulation and Legal framework analysis

Factor's element	HORECA SMEs	Municipalities
Internal standards	• HoReCa personnel may not use ingredients that do not conform to their internal aesthetic standards (Papargyropoulou et al., 2019)	
Labelling regulation	• Misconception of date labelling can lead to food waste (Waarts et al. 2015) • Products may not be used after "best-before" dates	
Financial incentives	• VAT exemptions to incentivize food donors	• If waste disposal is cheap, companies will not look for other ways of reusing their residual flows (Waarts et al. 2015) • Pay as you throw scheme (Bilitewski, 2008) • VAT exemptions to incentivize food donors
EU Waste directives		• 55% of municipal waste to be recycled and prepared for reuse by 2025, 60% by 2030 and 65% by 2035. The most critical waste fraction is exactly the biowaste, representing, on average, more than 45% in mass of produced municipal waste (VALUEWASTE, 2019) • Separate collection of bio-waste by 31/12/2023 and of textiles and hazardous waste from households by 1/1/2025 • Recycling of packaging waste to at least 65% by 31 December 2025 and 70% by 31/12/2030 • Reducing landfill to a maximum of 10% of generated municipal waste by 2035 and ban on landfilling of waste suitable for recycling effective from 2030.

Factor's element	HORECA SMEs	Municipalities
Farm to Fork strategy	• EU Commission will propose legally binding targets to reduce food waste across the EU, by end 2023	• EU Commission will propose legally binding targets to reduce food waste across the EU, by end 2023
Sustainable development goal 12.3		• Halve per capita food waste at the retail and consumer level by 2030
EU Food donation guidelines	• Guidelines to facilitate the recovery and redistribution of safe, edible food to those in need (Commission Notice — EU Guidelines on Food Donation, 2017)	• Guidelines to facilitate the recovery and redistribution of safe, edible food to those in need (Commission Notice — EU Guidelines on Food Donation, 2017)

3.4.3 Trigger Questions

- What will be the impact of the legally binding targets set by the EU on food waste?
- What will be the impact on food waste if employees working in the HoReCa sector are not familiar with the differences between 'use by' and 'best before'?
- Would a HoReCa company be less likely to waste food if it would lead to additional municipal fees?
- How can municipal authorities facilitate food waste repurposing?

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3.5 Factor 5: IND 4.0 Appliances in Waste Management

3.5.1 Definition

Worldwide sustainable manufacturing is facing various challenges as there is still in place a constant increasing global demand for capital and consumer goods, this has as a result the ongoing relevant research towards the development of new technologies (Stock and Seliger, 2016). Industry 4.0 refers to the fourth industrial revolution and is characterised by the employment of smart machines, that collect real-time data, which increases automatization within the manufacturing industry (Bongomin et al., 2020) in order to increase the efficient production of goods through the interaction of the virtual world with the physical one (Alcácer and Cruz-Machado, 2019).

In accordance to this, the industrial activities and productivity levels within the European Union are aimed to be increased as the European Commission is supporting the development of Industry 4.0 (European Commission, 2019a). Additionally, the European Technology Platforms (ETPs) are initiatives which are offered to the industry, at national and EU levels, recognized by the European Commission, are formed to support the development of innovation agendas and technology roadmaps for several sectors, (European Commission, 2020). Currently, the industrial FSC attempts to be upgraded through the application of innovative technologies and digitisation, leading to the reduction of FLW while maximising profitability (Kayikci et al., 2020).

3.5.2 The role of the factor in food waste generation and management

A study on the scope for Industry 4.0 in agri-food supply chain indicated that the supply chain is oriented towards the utilization of digital technologies, predictive analytics and artificial intelligence, in order to reduce food loss and waste, costs and other inefficiencies found in the food supply chain (Soosay and Kannusamy, 2018). Relevant studies, have considered the positive potential impact of Industry 4.0 on the sustainability of the food industry, suggesting that the use of innovative and advanced technology could have a positive impact on both the processing and the production of food with caution in the sustainability's three main pillars, the environment, the economy and the society (Kayikci et al., 2020; Ojo et al., 2018; Režek Jambrak et al., 2021). However, the development of all the areas of the food supply chain are in need of many improvements (Jagtap et al., 2020).

The primary production of crops and animals consists the first stage of the FSC ("From Agriculture to the Global Food Chain/System", 2020). The current conventional food production is less environmentally friendly and efficient while rising concerns regarding the extensive use of resources (such as water and energy), including also land degradation, air and soil pollution and negative impact on the biodiversity (Smith et al., 2019; Sonesson, Berlin, and Hospido, 2010). EU2020 strategy spurs innovation, through the adoption of new technologies by the EU farmers which are focused in adopting a sustainable agricultural development (European Commission, 2019b). Nowadays, new technologic revolution has been involved with the primary food production, utilizing robotics and some forms of AI (Zambon et al., 2019). Farms are adapting autonomously in real-time changes as they are becoming smarter, more efficient and more sustainable, as they as incorporating innovative technological devices, information and communication systems and data networks (Talaviya et al., 2020).

Storage and handling methods come after the harvesting, and they are equally crucial as they affect food losses. Physiological factors such as moisture and storage conditions are critical in order to reduce food losses (Angelovič et al., 2018). Specifically, high moisture content leads to storage problems as it increases fungal and insect development. In addition to this, the storage conditions such as the temperature can also affect spoilage (Angelovič et al., 2018). Thus, in order to prevent germination and fungal development reduced temperature conditions are preferred during the storage stage so that the storage life of the food could be extended. However, high levels of moisture and heat are responsible for encouraging bacterial and

inspects development, which can spoil food and consequently lead to food loss. Therefore, is made clear that is necessary to maintain a high food quality, that would also lead to lower operational costs and food prevention, just through the development of an effective and efficient storage management system.

Food processing is a complicated business, which involves numerous activities including sorting, processing, heating, grading, milling and packaging. Therefore, the food industry which prioritizes the food safety engage modern innovations for novel food production and technical processing methods. AI and machine learning solutions are combined with the current food industry system in order to optimize and automate processes, reduce operational costs and eliminate human error in the food industry.

Following the manufacturing stage, food is transported and distributed to retailers. Transportation and distribution conditions are critical as they could negatively impact food safety and quality ("Chapter 1 - Introduction to Transporter Container Sanitation, Traceability, and Temperature Controls," n.d.). Thus, food businesses and companies track and monitor the ambient conditions, at which products are kept, utilizing attached sensors (which provide data such as temperature and humidity). Current innovative monitoring approaches have verified to be capable of resolving problems related to food safety and quality during the transportation stage ("Chapter 2 - Current and Emerging Transportation Food Safety Models," n.d.). Additionally, intelligent routing can calculate efficient paths for food trucks while tracking each vehicle as it moves.

An innovative digitalized supply chain network which is updated with real-time data in order to provide information such as current inventories, demand forecasting, storage space required, location tracking of food trucks and product perishability, in now getting available for retailers. According to this, blockchain is one of the most promising technological advancements, which provide a robust and efficient mechanism for enhancing food traceability and safety and ensuring sustainability and efficiency in the food industry. Therefore, is getting a lot of attention. Specifically, blockchain technology is being used in food industry aiming to connect different contributors in the FSC, including farmers, exporters, shippers, importers, retailers, distributors and consumers (Xu et al., 2020).

The generation of food waste in the HoReCa (Hotel-Restaurant-Catering/Café) sector and households constitutes a large amount, with various studies examining the drivers and the behaviours causing this waste (Ishangulyyev, Kim, and Lee 2019; Schanes, Dobernig, and Gözet, 2018). It cannot be defined through a single behaviour but rather through a combination of multiple behaviours, which could influence the probability of food being wasted (Aktas et al., 2018). Currently, various kinds of approaches are investigated in order to sustainably manage food and prevent its wastage.

3.5.3 Trigger Questions (3 to 5 questions per factor)

- What role does IND 4.0 play in reducing food waste?

- Can IND 4.0 prevent the kind of behaviours that have led to food waste?
- How can the technological advantages transform the food industry?
- Which are the drivers and outcomes of the adoption of Industry 4.0 technologies in the case of a food waste?
- How can IND 4.0 ensure food safety?

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3.6 Factor 6: Food Waste/ Food Loss Generation

3.6.1 Definition

The definition of food loss includes the reduction in the quantity or quality of food which results from decisions and actions taken by food suppliers in the Food Supply Chain (FSC), focusing mainly on the losses that occur from production stage up to retail level (excluding retailers, food service providers and consumers). On the other hand, food waste refers to the reduction in the quantity and quality of food resulting from decisions and actions taken by retailers, food service providers and consumers.

Currently, public, academic and political attention has been given to both Food Loss (FL) and Waste (FW) which has intensified relevant research (Gruber et al., 2016; Aschemann-Witzel et al., 2015; H. Charles J. Godfray et al., n.d.). Almost one third of the food produced is lost and wasted, while also including significant resource, energy, environmental and socio-economic negative impacts (Eshel et al., 2014). Regarding the HoReCa sector, food waste constitutes a significant challenge, as this sector generates excessively large amounts of waste (von Massow and McAdams, 2015). Therefore, the exact amount and accurate causes of food wastage are

to be understood in order to explore and develop innovative strategies, under governmental supervision and legislative guidance, which could lead to food waste reduction. Currently, the United Nations (UN) has set a target of halving per capita global food waste at the retail and consumer levels and reducing food losses along production and supply chains by 2030, in the Sustainable Development Goals (SDG) Target 12.3.

Based on the Food and Agriculture Organization (FAO) of the United Nations is reported that approximately 1/3 (one third) of the food produced globally, which is intended, for human consumption is both lost and wasted.(FAO 2013) Additionally, it should be noted that apart from the food loss and waste, various resources (water, energy, etc.) are lost along the FSC, from the agricultural production to the end of life of the food (Table 6) (European Environment Agency, 2014).

Table 6: Causes of food loss and waste along the food supply chain

Food loss	
Production and harvest	Limitations on agricultural techniques Production surpluses Compliance with regulations and standards Climate and environmental factors
Storage and transportation	Limitations on storage infrastructure and transportation Compliance with regulations and standards
Food waste	
Industrial processing	Inadequate processing Technical limits on processing, production and infrastructure Overstocking Inadequate packaging
Distribution	Limits on the distribution system Errors in order forecasting and management of reserves Package failure Multiple handling of fresh production Marketing and sales strategies
HoReCa sector and domestic consumption	Excess purchases Excess portions prepared Confusion to understand the labelling Errors in food storage Inadequate food storage

Source: IND 4.0 against food wastage (https://d-waste.com/ind-4-0-against-food-wastage/)

3.6.2 The role of the factor in food waste generation and management

The first step needed to reduce food loss and waste is to identify where this wastage occurs along the FSC (Jenny Gustavsson et al., 2011). Overall, about 56% of total food loss and waste

occurs in the developed world (such as North America, Oceania, Europe, and the industrialized Asian nations of China, Japan, and South Korea). While, the developing world accounts for 44% of the loss. Yet on a per capita basis North America and Oceania stand out from other regions, with approximately 1,500 kcal/person/day lost or wasted from production to consumption. Regarding the various stages of the food value chain, 24% of global food loss and waste occurs at the production level, another 24% during handling and storage procedures and 35% during consumption. The above stages account for more than 80% of global food loss and waste. Regarding the distribution of this food loss and food waste it should be noted that varies significantly between developed and developing regions. With developed countries wasting more food at consumption level and developing countries losing more food during production and handling and storage (as presented in Figure 1).

Figure 1 shows that more than 50% of the food loss and waste in North America, Oceania, and Europe occurs at the consumption stage. In contrast, the stages during the production of food -farm and storage - account for 2/3 (two-thirds) to ¾ (three-quarters) of food loss and waste in South and Southeast Asia and in Sub-Saharan Africa, respectively. Based on the above is evident that that efforts to reduce food loss and waste should focus mainly on stages close to the primary production (farm) for the most developing countries and focus on stages close to the consumption for the developed countries. Yet, it should be noted that the majority of urban areas experience substantial levels of food waste, unrelatedly of whether they are in developed or developing countries. These levels of waste may even be higher in cities located in developing countries, which lack the infrastructure needed to address this issue. The percentage of food lost or wasted varies from 15 to 25% across most regions. The one exception is North America and Oceania, where loss and waste is approximately 42% of all available food, suggesting the need for concentrated efforts to reduce the waste levels in those regions.

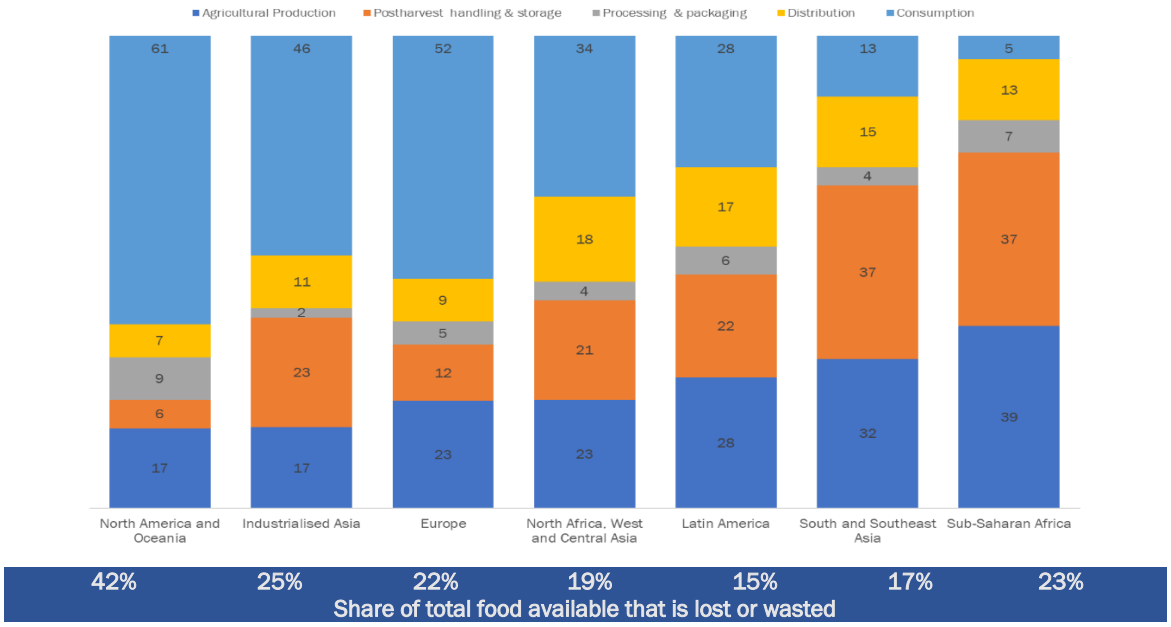

Figure 1. Food Lost or Wasted by Region and Stage in Value Chain, 2009 (% of kcal lost and wasted) (Gustavsson et al. 2011)

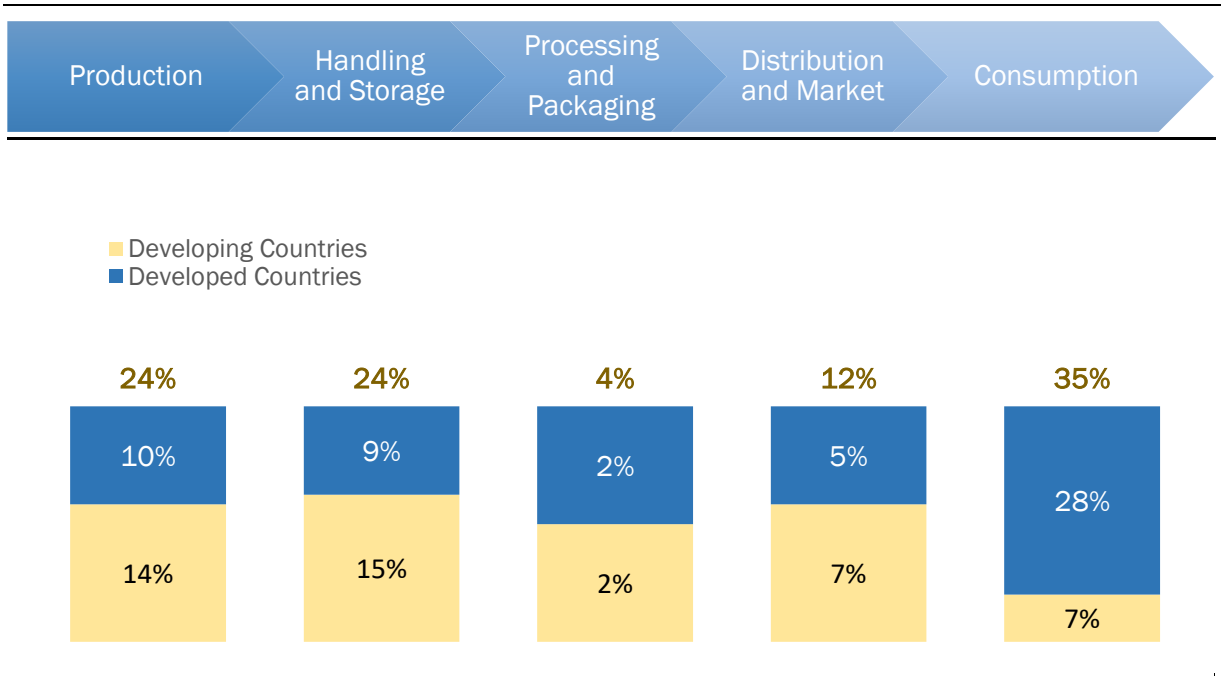

Figure 2. Share of Total Food Loss and Waste by Stage in the Value Chain, 2009 (100% = 1.5 quadrillion kcal)
Note: Numbers may not sum to 100 due to rounding (Gustavsson et al. 2011)

Data on food waste shows a high variation according to the source. Specifically, one of the main reason for this is the different definition of what food waste actually is (i.e., the lack of an agreed definition) and the different methodologies used for measuring and assessing it. Different studies present conflicting data for each of the sectors and stages of the food supply chain (Stenmarck et al. 2016; Jenny Gustavsson et al. 2011; University of Applied Sciences and iSuN - Institute of Sustainable Nutrition, n.d.). Table 7Table 7 presents the results of a selection of some studies which shows that food waste occurs along the entire food chain, though care should be taken when comparing the results as the methodology and definition of food waste used are not homogeneous.

Table 7. Share of food waste at the different stages of the food supply chain (in %) according to different studies

	FAO (Europe)	Foodspill (Finland)	FH Münster (Germany)	Bio Intelligence Service (EU)	Fusions (EU)1*
Production sector	23	19-23	22	34.2	11
Processing sector	17	17-20	36	19.5	19
Retail sector	9	30-32	3	5.1	17
Consumers	52	28-31	40	41.2	53

* The study recognises that 'there is moderately high uncertainty around this estimate' (page 27). In particular, for the data related to the production sector, estimates are based on data from six countries only and 'the estimated uncertainties of ±17 % is probably underestimated' (page 21).

3.6.3 Trigger Questions

- What happens to the food waste?
- Why should we recycle food waste?
- What are the challenges of treating food waste?

3.6.4 References for factor 6

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3.7 Factor 7: Municipal Waste Management

3.7.1 Definition

Municipal Waste Management could be defined as the discipline associated with the control of generation, collection, storage, transfer and transport, processing and disposal of solid wastes

in a manner that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics and other environmental considerations. The most commonly recognized methods for the final disposal of solid wastes are: dumping on land, dumping in water, ploughing into the soil and incineration (Aung, Yi, and Hkyeng 2020).

Different activities include collection, monitoring, regulation, and disposal. Waste collection services are often provided for free by the local government. The collected wastes are disposed of by various methods, e.g. by landfill compaction and incineration. Solid wastes, most especially, are incinerated to reduce their volume by 80 to 95%, and to convert them into gas, steam, ash, and heat. However, air pollution is a concern when disposing of wastes by means of incineration (Kaza and Bhada-Tata 2018).

Thus, other means are encouraged, such as recycling, reprocessing, and re-use (Morseletto 2020). Organic wastes, especially those that are biodegradable, are allowed to be decomposed so that they can be used as mulch or compost in agriculture and the methane gas from the biological degradation be collected and used for generating electricity and heat. Liquid wastes, such as wastewater, undergo treatment producing sewage sludge that can be disposed of by incineration, composting, and landfill.

Table 8 presents the different phases of waste management and their descriptions are presented.

Table 8: Waste Management Phases

Waste Management Phases	Description
Onsite handling, storage and processing	After waste generation, there are activities to facilitate easier collection of the waste, such as the use of dust bins and putting them at places where most waste is being generated.
Collection of waste	This phase includes the placement of waste collection bins, collecting the waste by vehicles and making sure the vehicles get to the right location where they are emptied.
Waste transfer and transport	Waste transfer and transport is the part of waste management where the focus is on all the activities involved in getting waste from the smaller waste collection locations to the bigger regional waste disposal stations. Crucial for transportation is the availability of waste transport vehicles.
Waste processing and recovery	This part involves the facilities, techniques and equipment that are needed to recover and recycle materials from the waste process. This part is also to improve the effectiveness of the other elements and activities in waste management.
Waste disposal	Waste disposal is the final step in waste management and involves all the activities that are needed for systematic disposal.

3.7.2 The role of the factor in food waste generation and management

Municipal Solid Waste (MSW) is generated from households, HORECA sector, manufacturing sector, etc. It generally refers to all waste streams produced from various human activities. (Sondh et al. 2022). Food waste is part of the bio-waste stream which most of the times is treated with the rest streams (Figure 3). This means that food waste management is under the umbrella of solid waste management. Generally, it can be said the food waste management is directly affected by the solid waste management system, unless there is a separate collection system followed by some kind of treatment facility. Food waste is a significant waste material that local authorities collect, and robust food waste data can guide both prevention and circular food strategies, alleviating pressure on local waste management systems (Q. Zhang, Dhir, and Kaur, 2022). Yet, it should be mentioned that with the existing management system (Business as Usual) it is impossible to measure the food waste produced. That's the reason why more and more cities introduce a separate collection and management system only for biowaste (including food waste).

A considerable amount of waste is generated in the food supply chains. Food waste are responsible for the 8% of anthropogenic GHG emissions (Cattaneo, Federighi, and Vaz, 2021). Therefore, the development and implementation of improved, targeted management practices are necessary (Ali et al., 2019). In an increasingly resource constrained world, it is imperative to reduce the high environmental, social and economic impacts associated with this type of waste.

Food waste is mainly consists of materials intended for human consumption that are eventually discharged, lost, degraded or contaminated (Girotto, Alibardi, and Cossu, 2015). The issue connected with the production of food waste is currently enlarged, involving all sectors of waste management from collection to disposal; the identifying of sustainable solutions extends to all contributors to the food supply chains, agricultural and industrial sectors, as well as retailers and final consumers (Gómez-Luciano et al., 2018). A series of various solutions may be applied in the suitable and appropriate management of food waste, and prioritised in a similar way to waste management hierarchy. The most sought-after solutions are represented by avoidance and donation of edible fractions to social services. Food waste is also employed in industrial processes for the production of biofuels or biopolymers (Z. Zhang et al., 2016). Further steps foresee the recovery of nutrients and fixation of carbon by composting. Final and less desirable options are incineration and landfilling.

Food waste management is the process through which food and other agricultural products are recovered or redirected for human consumption, animal feed, industrial uses, or environmental benefits (Despoudi et al., 2021). The food waste management process includes the collection of edible food scraps and other food-related wastes from homes, restaurants, institutions, and businesses. Food waste can be diverted into a variety of uses including composting materials for agriculture and gardening purposes.

Regardless of the scale, food waste is an international issue that has financial, environmental, legal, and health consequences (Baig et al., 2019). In the case of the hospitality industry,

managing large amounts of food waste requires a solution that's effective enough to solve the problem of food wastage (Munir, 2022). When it comes to food waste management in commercial kitchens, there are many aspects involved as most organic and inorganic waste finds its point of origin during food preparation and in warewashing areas of commercial kitchens. With proper commercial food waste management in place, hygiene can be improved, the environment protected, and legal, and health risks can be minimized.

Food waste reduction offers a win-win situation for the people and the planet, improving food security, addressing climate change, saving money and reducing pressures on land, water, biodiversity and waste management systems. Yet, this potential has until now been woefully under-exploited. This potential may have been overlooked because the true scale of food waste and its impacts have not been well understood. Global estimates of food waste have relied on extrapolation of data from a small number of countries, often using old data. Few governments have robust data on food waste to make the case to act and prioritize their efforts.

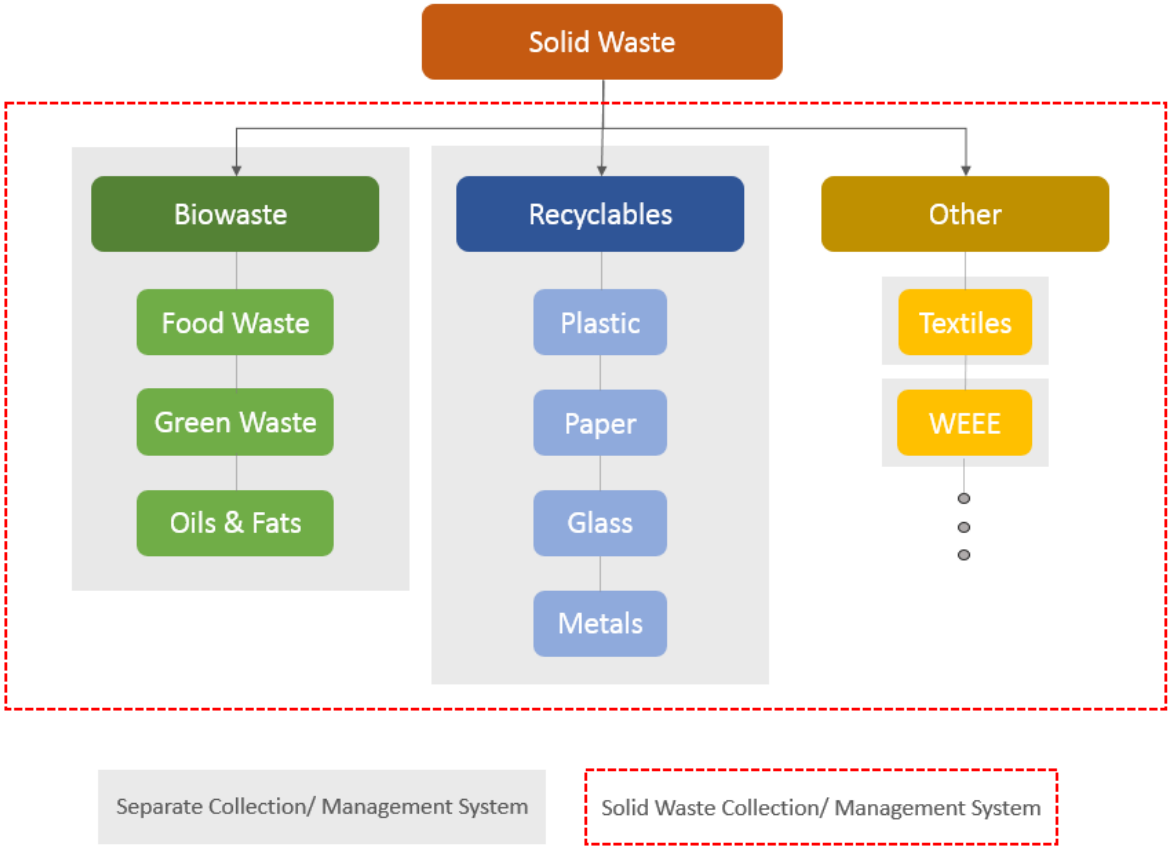

Figure 3: Solid Waste Management Vs Management of Separately Collected Streams

3.7.3 Trigger Questions

- How can a household eliminate the waste that is producing?

- How can a household collect separately its food waste?
- How and why can a restaurant implement management system only for its food waste?
- How can a restaurant or a municipality benefit from its own food waste?

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3.8 Factor 8: Waste Prevention

3.8.1 Definition

Waste prevention relates to reducing the amount of waste generated, thus reducing the impact of that waste on the environment ("A European Green Deal" 2021). Preventing products and materials from becoming waste for as long as possible and turning waste that cannot be avoided into a resource, are key steps to achieve a greener and more circular economy ("Press Release: Eurostat Data for 2014 Confirms Need for European Residual Waste Target" n.d.). This can boost growth, create jobs, help reduce greenhouse gas emissions and reduce dependency on imported raw materials (Deselnicu et al. 2018).

3.8.2 The role of the factor in food waste generation and management

Waste prevention is the first step and has the most important role in the entire waste management system in the cycle of circular waste management. Waste management regulations have clearly defined order of priority in waste management, whereby waste prevention is determined as a priority in the waste hierarchy. Prevention is the cornerstone of sustainable waste management policies, 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.).

Reduction is the first step in food waste prevention. Reducing consumption is a global challenge for today's consumerist lifestyle. The reduction involves a change in lifestyle and a change of approach to food procurement and consumption.

Reuse includes practices of using food that is not usable in the basic process, as a by-product or raw material for another product. 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. Composting can also be observed as a method of reuse because it creates a new useful raw material - humus, which will be used for the purpose of producing new food.

Donation - Food surpluses exist along the entire food chain and donation is the best way for avoiding food waste, and as most important, it simultaneously includes a social component. The most common obstacles to donating food are identified as: responsibility for donated food, food regulations, not knowing whether certain food can be donated, lack of infrastructure

(storage and transportation of food), insufficient knowledge about how to start, and the inability to identify non-profit organizations to which food can be donated.

According to research carried out as part of the Commission's project – FUSIONS, about 88 million tons of food are thrown away annually in the EU member states ("EU FUSIONS" n.d.).

Nowadays, food waste has become a habit: buying more food than is needed, letting fruits and vegetables spoil or taking larger portions than we can eat. These habits put extra strain on our natural resources and damage our environment. When we waste food, we waste the labour, effort, investment, and precious resources (like water, seeds, feed, etc.) that go into producing it, not to mention the resources that go into transporting and processing it.

It is necessary to undertake great efforts by all participants in the food chain to achieve awareness of urgent action to prevent food waste. And the actions need to be done immediately.

All stakeholders in food chain must build an emphasized responsibility, starting with:

- farmers - who at the very beginning of the food chain can significantly contribute to reducing food waste by: proper organization of the harvest - adapt it to the species and varieties, taking into account the ripening time and weather conditions; careful handling during harvesting, packaging, storage and transportation to minimize mechanical damage; adequate and timely fertilization to prevent loss of food in the field even before harvest; ensuring appropriate storage conditions (temperature and humidity), avoiding an additional stage in distribution to prevent food spoilage, etc.
- producers - by using food that is not usable in the basic process, as a by-product or raw material for another product; smart selling organization; storage, transportation, etc.
- traders - ensuring a safe and sustainable supply system; ensuring fair trade practices; selling inferior products at a lower price; proper storage and transportation, etc.
- HORECA sector - maximum utilisation of food; preparation of creative meals from excess food; device correctness; keeping track of terms of use; motivation and sensitization of employees and guests; providing guests with doggy bags (packages containing leftovers); application of Follow the First In, First Out (FIFO) method; proper storage, proper procurement planning; good employee communication; determining the ideal portion size, donation; sharing etc.
- households – smart purchase according to needs, planning meals, making a shopping list and avoiding impulse buys, using ugly products for smoothies, juices and desserts; device correctness; keeping track of terms of use; wisely storing; understanding of food labelling; starting meal with smaller portions; using leftovers; donating; sharing etc.

Actions undertaken at each level will significantly results in a reduction of the total amount of food waste generated ("CROATIA" n.d.).

The Commission has already carried out important steps to prevent food losses and waste, in line with the actions put forward under the first Circular Economy Action Plan, adopted in 2015.

The Revised EU Waste Legislation adopted in 2018 by co-legislators calls the EU countries to take action to reduce food waste at each stage of the food supply chain, monitor food waste levels and report back regarding progress made.

Benefits of waste prevention includes:

- decreasing the demand of landfill space,
- conserving energy and resources,
- reducing pollution and harmful effect on the environment and human health,
- decrease of greenhouse gas emissions and contribute to climate change
- save money spent on recycling or disposal
- making production processes more efficient.

Sustainable Development Goal (SDG) 12 of Agenda 2030, seeks to "ensure sustainable consumption and production patterns." Target 12.3 of that goal aims to "by 2030, halve the per capita global food waste at the retail and consumer level, and reduce food losses along production and supply chains including post-harvest losses." Efforts by FAO and the UN Environment Program are underway to measure the progress made towards achieving SDG 12.3 using two separate indices – the Food Loss Index (FLI), led by FAO; and the Food Waste Index (FWI), led by UN Environment.

The European Green Deal as a strategic document defines a fair and healthy food system that is acceptable for the environment. Farm to fork Strategy, as one of the strategies of the European Green Plan, gives a new comprehensive approach to assessing food sustainability in Europe through assurance of sustainable food production and transition to a sustainable food system, whereby the reduction food waste is one of the priority goals.

3.8.3 Trigger Questions

- What are the key steps to reduce food waste in your hotel/restaurant?
- How familiar is the person who conducts food procurement, with the processes in the kitchen and storage?
- In awareness raising education, do people with different income need a different approach to food waste prevention?
- How much the social sensitivity and social responsibility impact the awareness for food waste prevention?
- What would encourage stakeholders in the food chain to donate more food?

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3.9 Factor 9: Waste Collection

3.9.1 Definition

Although attempts have been made to quantify global food waste in regards of global malnutrition and the reasons why there is no expected consumption, none has come to a conclusion. At least, the base is considered to be the thought that half of the food is lost or

wasted before it reaches the table of the consumer (Lundqvist et al. 2008). But in any case, it has, so therefore we need to scale the competence of the system to metric the waste so it can be recycled.

Waste collection has become an efficient business but an inefficient operation because of the lack of measurement connected to the real waste bins' fill-levels (Rovetta et al., 2009). Waste collection is described as the waste management after it left the household/enterprise, picked up by the allocated company or municipality to be directed to point of treatment or landfill (Wikipedia).

3.9.2 The role of the factor in food waste generation and management

Evidence has shown that prior to this system of collection, the ancient world had already made plans of gathering their food waste and with rituals or not, depending on their culture, made a plan of disposing their household debris. For example, Mayas gathered once in a month to burn their debris performing a ritual just for that cause (Halperin and Foias, 2016).

Nowadays, as the industrialization has evolved and there are a lot of enterprises polluting with their mainly food debris, functional elements of solid waste management system comprise of 6 basic elements (Fig. 4), including:

- Generation of solid waste.
- On-site handling & storage.
- Collection.
- Transfer & transport.
- Material and resource recovery and.
- Disposal.

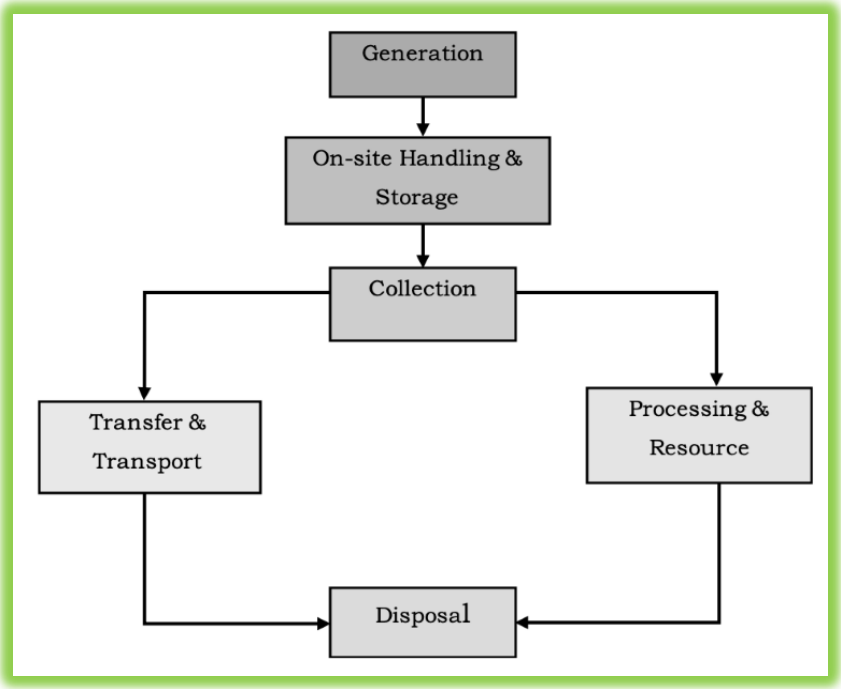

Figure 4: Six basics elements

Those apply to both municipalities and HORECA enterprises, meaning that after the solid waste has been generated, must be disposed as well. Generation has two controls: a) quality of solid waste and b) quantity of solid waste.

Quality includes the root of its origins, the different types and composition of solid waste along with its properties, and the quantity includes the generation rates and total quantities and volumes of waste generated. The handling, storage and separation of solid waste at the residence, before they are collected by the allocated trucks, is generating a crucial step in the management of solid waste.

Handling alongside to actions related to managing solid wastes before their placement in the containers to be stored before they are collected or returned to drop-off and to the recycling centres. These procedures connected with handling waste materials in the place of generation will alter, laying on the different ways of waste materials which are separated as decided to be reused and recycled and the procedure to which all materials are separated from the waste stream. All these depend of course on the type of collection service because handling may also be requested to move the bins/containers to the collection point and then resend the same container to storage.

Our houses and the HORECA enterprises are the first step to manage waste as it must be stored and note to be let in the premises. The responsibility both of the citizens and the owners of small enterprises consists of onsite storage of waste. For premises, such as industries, cafes and other small business, on-site storage of waste is the rising of the best practicing disposal, as

unkept waste and dumps of any kind could be hazardous to public health and an optical nuisance.

That leads to proper collection by gathering and picking up the waste either from households or from cafés for instance and includes also the hauling process of these debris to the disposal site – transferring station -unloading dock.

Transporting means that specific appurtenances are used to impose the transfer of wastes from one place to another within a local area. The procedure is as this, the small vehicles are transferred to larger vehicles and then transported to distant locations to abandon the debris.

The next step before final disposal is the resource recovery being both a waste disposal step and reclamation opportunity. It can lower the landfill volume requirements mainly as the resource recovery is the process of the future, as it has to consider the environmental benefits before landfilling.

Finally, the disposal occurs after segregation may be subjected to bacterial decomposition with humus or compost. The all step by step procedure involves separation and bacterial conversion known as "Composting" accomplished aerobically or anaerobically.

3.9.3 Trigger Questions

- What of the 6 Components of waste collection could be eliminated and if so, why?
- Could the archaeological behavioural findings help implement debris burning attitude?
- How could overloading of landfilling be forecasted?

3.9.4 References for factor 9

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3.10 Factor 10: Recycling

3.10.1 Definition

Recycling is the process of converting waste materials into new materials and objects. The recovery of energy from waste materials is often included in this concept. The recyclability of a material depends on its ability to reacquire the properties it had in its original state. It is an alternative to "conventional" waste disposal that can save material and help lower greenhouse gas emissions. It can also prevent the waste of potentially useful materials and reduce the consumption of fresh raw materials, reducing energy use, air pollution and water pollution.

Recycling is a key component of modern waste reduction and is the third component of the "Reduce, Reuse, and Recycle" waste hierarchy. It promotes environmental sustainability by removing raw material input and redirecting waste output in the economic system.

There is no strict definition for food waste recycling but essentially it is the process of turning discarded food produce into a useful product such as fertiliser or biofuel.

There are two main ways food waste is recycled: Anaerobic Digestion and In-vessel Composting.

Anaerobic Digestion is the natural process where bacteria is used to decompose the food waste (organic matter) in an environment or chamber absent of oxygen. This produces biogas and a residual sludge.

In-vessel Composting - Food waste is mixed with garden waste, shredded and fed into a big container such as a drum, silo, or concrete-lined trench where the environmental conditions can be monitored and controlled. Such conditions include moisture, aeration, and temperature. It is then held in this container for around 2-4 weeks in conditions where any harmful microbes are killed off (this is usually achieved at 70C). Then after it is left to rest and occasionally mixed for 1-3 months it is ready to be used as soil conditioner for parks, farms and other areas needing such products.

The current Food Supply Chain (FSC) system based on the linear supply chain operating model is unquestionably unsustainable. In the linear FSC, raw materials are extracted from the land and subsequently processed into final products, which are consumed by people or discarded as waste.

Waste food is often disposed of to landfills, mostly with little or no recovery of the products and/or embedded materials.

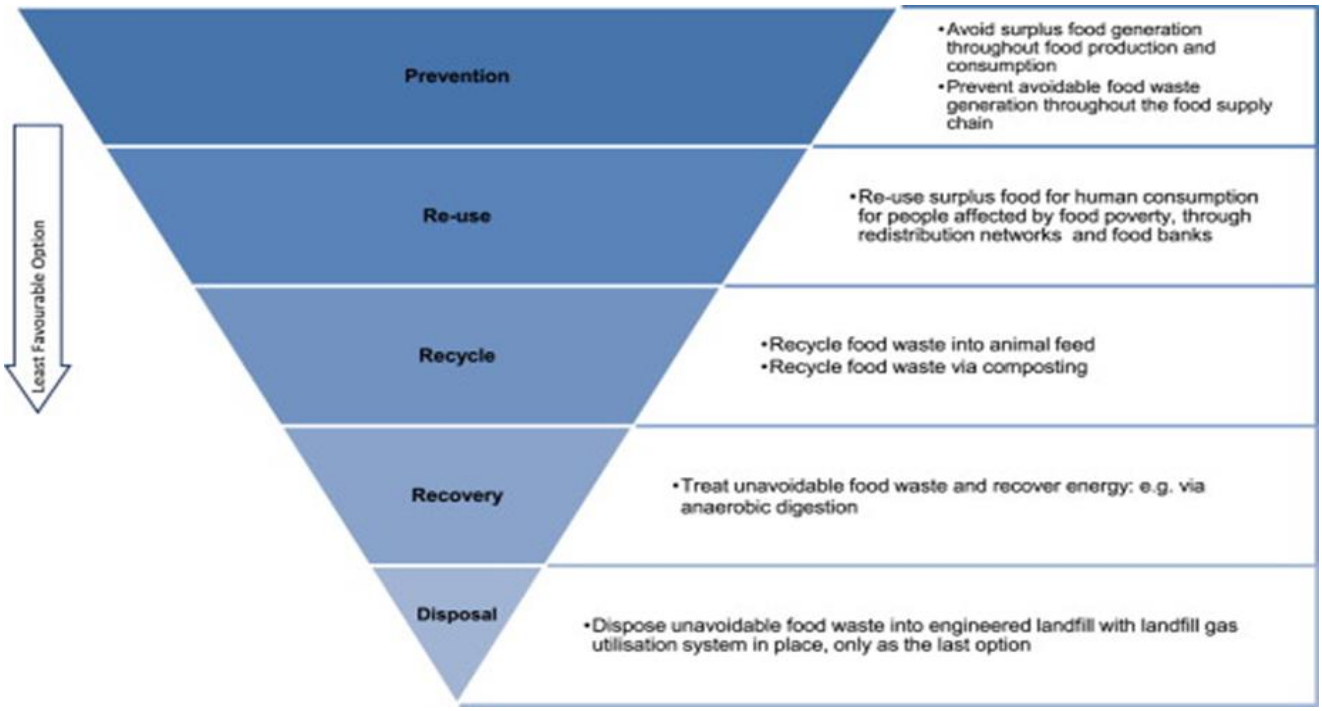

Figure 5: Comparison between Linear Economy and Circular Economy (Papargyropoulou et al., 2014)

3.10.2 The role of the factor in food waste generation and management

It is very important to recycle your food waste so that it doesn't end up in landfill. If it goes to landfill it will decompose and produce Methane gas. This is an extremely harmful gas for the environment. In fact, it is 25x more potent than Carbon Dioxide.

Food waste recycling not only prevents landfill pileups and lessens the amount of methane gas harming the ozone layer, but it also produces very useful products such as fertiliser and biofuel.

Plus, for small businesses, it is also of financial benefit since it will reduce how much landfill tax you have to pay since you will be sending less there each bin collection.

Recycling of unused food products and/or food packaging materials as far as possible through reprocessing wastes can allow them to be redistributed or converted into useful resources. Recycling and processing waste to form new products or packaging identical to the original is known as primary recycling, while secondary recycling uses waste as raw materials for other products with different properties. CE is crucial as it enables the FSC cycle to start again by re-entering waste into the production or consumption stages. Examples of the recycling principle in the FSC are food by-products that can be converted to new materials or bioenergy, used as inputs to agriculture, for example as animal feed, and in making new food products, for example preserves from discarded 'wonky fruits and vegetables'. Recycling of the food packaging is another example and for this companies need to ensure that the packaging is easily recyclable.

Home composting is the most practical and convenient way to manage biodegradable waste streams in individual households, especially in rural areas. By applying home composting, large amounts of organic material do not end up in landfills and are turned into a useful product.

Home composting reduces waste transportation costs and is considered one of the most important ways to prevent waste generation, given that the amount reduction is done before waste collection itself.

Home composting means that households separate and compost their garden and partly food waste in their own yard. The home composting process must be controlled, with the ultimate goal being that the breakdown of organic materials such as leaves, twigs, grass and appropriate food waste results in compost that can be used for soil conditioning. In order to obtain "usable" compost, extremely important education. It is necessary to take measures for dealing with the resulting compost, precautions and education.

The valorisation of food processing waste as animal feed is one of the most traditional practices. Food residues rich in fat and protein are suitable for omnivores, while substrates with a high content of cellulose and hemicellulose are suitable for feeding ruminants. However, the possible presence of toxic materials, which have an anti-nutritive effect and unbalanced nutritional compositions, can endanger both animals and humans. Transportation costs (due to the distance between the location where the waste is generated and the location of use) often make this food source as expensive as conventional animal nutrition.

3.10.3 Trigger Questions

- Does the high economic investment that is needed at the beginning prevent from starting home composting?
- Does the lack of knowledge of citizens on this topic influences on results that can be reached by home composting?
- Does the lack of innovative material for food packaging affect the food waste management?
- Does the lack of infrastructure for food recycling present crucial point that need to be solved?
- Does the lack in sufficient and unclear government regulations to support its implementation prevent from recycling food waste?

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3.11 Factor 11: Financing

3.11.1 Definition

The process of financing is the provision of funds for business activities, purchases or investments. Institutions can provide funds to businesses or municipalities to help them achieve their goals. In general, there are two types of financing: equity financing and debt financing. Equity financing involves the purchasing of a part of the business by an investor while debt financing involves the borrowing of capital that needs to be repaid together with the interest charge.

In addition to the traditional funding mechanisms mentioned above, the EU and the European Investment Bank offer their own financial and non-financial instruments to businesses and municipalities that want to attempt sustainable changes such the mitigation of food waste.

3.11.2 The role of the factor in food waste generation and management

HoReCas and municipalities will need funds to cover investment costs related to food waste prevention and management. As far as HoReCas is concerned, funds will be need for the installation of new bins to separate different waste flows, technology to help them identify, understand and measure food waste, smart packages that enable them to track the condition of the food, self-composting facilities etc. These investments may partially be covered by own capital, however, this may not be always feasible, thus EU has developed funding instruments to enable food waste mitigation under the umbrella of circular economy.

As for the municipalities, the ambitious new EU legislation requires profound structural changes for waste management for many of the countries (COWI et al., 2019). These changes include the development of infrastructure related to the collection, handling, storage, processing, recycling etc. Again, investments of such kind may be financed by the national budgets, but EU has developed its tools to support such a plan.

Table 9. Funding Instruments on Waste Management

Factor's element	HORECA SMEs	Municipalities
Cohesion Fund		• Cohesion Fund is an investment instrument, under shared management with Member States, requiring co-financing from other sources that supports environmental projects, including waste (COWI et al., 2019).
LIFE	• LIFE program helps SMEs bring their green products, technologies, services and processes to the market (*LIFE Close-to-Market Projects*, n.d.).	• Numerous projects on solid waste management have already been funded by the program across the EU. • It supports environmental, nature conservation and climate action projects across EU. • Under the European City Facility (EUCF) it supports municipalities and local authorities to develop investment concepts to accelerate investments in sustainable energy.
Horizon Europe	• European Innovation Council's (EIC) Accelerator program focused on helping SMEs scaling up innovations of great potential.	• Funding instrument for innovation and research aiming at tackling climate change, helping to achieve the UN's Sustainable Development Goals and boosting the EU's competitiveness and growth.
European Fund for strategic investments	• European Investment Fund that supports SMEs by helping them access finance.	• Eligible for financing investments in infrastructure (transport, energy, digital, environment, urban and social sectors) for projects that have high societal and economic value contributing to EU policy objective.
Grants for stakeholders to improve measurement of	• Supports stakeholders in the hospitality and food services' sector to improve measurement of food waste and help implement food waste prevention in their operations and organization.	

Factor's element	HORECA SMEs	Municipalities
food waste and help implement food waste prevention in their operations and organizations		
InvestEU Fund – SME window	• The InvestEU SME window provides access to and availability of finance primarily for SMEs, including innovators, SMEs in cultural and creative sectors, and small mid-cap companies (*InvestEU Fund – SME Window*, n.d.).	

Co-funded by the European Union

3.11.3 Trigger Questions

- What are the traditional financing methods for an SME?
- How can municipalities benefit from the funding mechanisms developed by EU?
- What tools can a SME mobilize to access funds for projects that promote innovation and sustainability?

3.11.4 References for factor 11

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LIFE close-to-market projects. (n.d.). Retrieved December 9, 2022, from https://cinea.ec.europa.eu/programmes/life/life-close-market-projects_en

3.12 Factor 12: Disposal

3.12.1 Definition

Disposal refers to a disposition of discarded waste in landfills. Waste disposition and landfill management shall comply with regulations and specific technical standards. The main environmental threat from biowaste including food waste is the production of methane from such waste decomposing in landfills, which accounts a share of 3% in total greenhouse gas emissions ("Air Quality in Europe 2019 — European Environment Agency" n.d.). That is why food waste disposal in landfills shall be minimized to the greatest extent possible. As biowaste makes up 34% and is the largest single component of municipal waste in the EU and as about 60% of bio-waste is food waste, it is necessary to urgently move in the direction of reducing the amount of food waste that end up in landfills. Although the share of food waste composted and digested is constantly increasing — a high proportion still ends up in landfills, even in many countries with well-established separate collection systems. An estimated 134,000 tonnes of nitrogen and 44,000 tonnes of phosphate are currently lost through the bio-waste disposed of in mixed municipal waste in Europe ("Bio-Waste in Europe — Turning Challenges into Opportunities — European Environment Agency" n.d.).

3.12.2 The role of the factor in food waste generation and management

Waste disposal is the last step and should be the last choice in the entire waste management system in the cycle of circular waste management. It is the lowest ranked option in the European waste hierarchy. As a least preferable option landfilling should be limited to the necessary minimum. ("Documents Download Module" n.d.).

Currently the two most widely applied treatment techniques for reducing the amount of food waste going to landfill are composting and anaerobic digestion. Composting dominates the treatment capacity, but the use of anaerobic digestion is increasing. The most significant benefits of proper food waste management - besides avoided emissions of greenhouse gases - are production of good quality compost and biogas thus contributing to enhanced soil quality and energy self-sufficiency. In practice, however, Member States are still often inclined not to opt for composting or anaerobic digestion, and instead choose the seemingly easiest and cheapest option such as incineration or landfilling and disregarding the actual environmental benefits and costs. Unquestionably, landfilling is the worst food waste management option. In order to assist decision-makers in making the best use of biowaste in line with the waste hierarchy, the Commission has prepared a set of guidelines on how to apply Life Cycle Assessment and Life Cycle Thinking to planning the management of bio-waste.

As biowaste/food waste has a significant share in total waste, Landfill Directive states that landfill gas produced from biodegradable waste, must be treated and used. If gas thus produced cannot be used for energy purposes, it must be flared. The Landfill Directive also limits the share of municipal waste landfilled to 10% by 2035 and forces **EU countries to implement national strategies to progressively reduce the amount of biodegradable waste sent to landfills.**

These strategies should strive to achieve the targets in recycling, composting, biogas production or materials/energy recovery and shall ensure that: biodegradable municipal waste going to landfills should be reduced to 75% within five years, to 50% within eight years and to 35% within 15 years, all in relation to the quantity produced in 1995.

3.12.3 Trigger Questions

- What would stimulate HORECA sector on more composting of food waste?
- What would stimulate households on more composting of food waste?
- What would stimulate decision makers to opt for composting or anaerobic digestion?

3.12.4 References for factor 12

European Commission, Landfill Directive, (1999/31/EC)
https://eur-lex.europa.eu/legal-ontent/EN/TXT/PDF/?uri=CELEX:31999L0031&from=EN

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https://www.eea.europa.eu/publications/air-quality-in-europe-2019

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3.13 Factor 13: Economic

3.13.1 Definition

The social science that is economics is primarily concerned with studying the production, distribution, and consumption of goods and services. It pertains particularly to the (inter)actions of economic agents (e.g. consumers, companies, governments, investors, etc.) and the functioning of economies. Often a distinction is made between macroeconomics on the one hand and microeconomics on the other. The former focuses on the more aggregated level of the economic system encompassing the interaction of production, consumption, saving, and investing, whereas the latter rather analyses individual economic agents and the markets upon which they interact.

3.13.2 The role of the factor in food waste generation and management

The economic factor plays a role in food waste generation and management at both the macro and micro level. As such, the economic system in its entirety as well as the (inter)actions of individual economic agents throughout the food supply chain can have an impact on food

waste. Furthermore, food waste itself has considerable economic implications. Consequently, in order to identify the required conditions for food waste reduction and to determine suitable policy implications to that end, establishment of the relevant economic framework is vital. In the table below, some of the most important economic factors relating to food waste generation and management are coupled with the two core target groups of the project.

Table 10: Economic Factor Analysis

Factor's element	HORECA SMEs	Municipalities
Industrialization	• As the likelihood of food being wasted is lower when people prepare it themselves, the industrialization-linked increase in eating restaurant or takeout food has impacted wastage (Sobal, 1999).	• The industrialization of food systems has led to a shift of producing and preparing food at home to purchasing it, thus (amongst other things) reducing the value that individual consumers attach to food and increasing the probability of it being thrown away (Strasser, 1999).
Economic growth		• Higher incomes have been associated with diet diversification, which in turn has been linked to more food waste (Drewnowski, 1999; Rathje et al., 2001; Pingali et al., 2004). • 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 (Gustavsson et al., 2011; Pearson et al., 2013) • Contrary to what positive economic theory predicts, consumers in developed countries may find it hard to identify the marginal utility of a specific product due to the fact that food choices offered to them tend to be very large and varied (Segrè et al., 2014).
Urbanization		• In an urbanized society food supply systems need to be extended, which entails diet diversification and a mental disconnection from food sources, ultimately leading to more food waste (Parfitt et al., 2010). • People living in rural areas tend to produce less food waste (Secondi et al., 2015).

Factor's element	HORECA SMEs	Municipalities
Market/bargaining power	• Economic agents with more bargaining power within the food value chain tend to transfer the risks of unsold products to their counterparties (suppliers and/or customers), thus causing an aggravated impact of inaccurate stock management/sales forecasts (Bio Intelligence Service, 2010).	
Imperfect information / information asymmetry		• Consumers might buy food products with undesired characteristics if communication is not optimal (Segrè et al., 2014).
Consumer purchasing power		• Rises in inflation and/or unemployment, particularly when unexpected, can lead to imbalances between the supply and demand of food, thus inducing waste (Segrè et al., 2014).
Food service and retail business management inefficiencies	• Inaccurate storage and incorrect stock turnover can lead to more food waste (Gustavsson et al., 2011). • Flawed sales forecasting by retailers, particularly as far as seasonal products are concerned, may result in an increase in food waste (Eriksson, 2012). • Incorrect forecasting of servings constitutes a major challenge in the food service context (Silvennoinen et al., 2015). • Higher variation in menus causes difficulties in terms of both making accurate forecasts and preparing meals, thus potentially leading to more food waste (Engström et al., 2004; Sonnino et al., 2011).	

Factor's element	HORECA SMEs	Municipalities
	• Lack of flexibility in portion sizes and assortment tends to induce plate waste by customers (Betz et al., 2015; Ofei et al., 2015). • Food service providers are not particularly stimulated to take actions with a view to reducing food waste due to the mere fact that customers pay for everything that is served to them (Cordingley et al., 2011). • Trolley waste in hospitals may be reduced by improving meal ordering and menu choices (Williams et al., 2011; Ofei et al., 2014). • Portion sizes of ready to eat food products are not always adjusted to the actual needs of customers (Segrè et al., 2014). • Absence of quality assurance standards in restaurants may seriously impact food waste generation and management (McAdams et al., 2019). • The use of whole instead of pre-prepared food products tends to lead to more food waste (McAdams et al., 2019). • Employee skill levels may have an influence on food waste generation in a food service context (Filimonau et al., 2019; Kasavan et al., 2019).	

Factor's element	HORECA SMEs	Municipalities
	• In general, casual dining restaurants have more plate waste volume than fine dining restaurants, but the latter tend to have greater food waste per customer (McAdams et al., 2019). • Restaurant managers' attitudes towards food waste can have a major impact on food waste generation, particularly when they fail to perceive the inherent cost-reduction opportunities (Principato et al., 2018). • Restaurants with meat-based menus tend to waste more (Principato et al., 2018). • The amount of food waste generated is generally lower in restaurants, bars or cafés that only open at lunch or dinner instead of serving food at both lunch and dinner (Principato et al., 2018).	

3.13.3 Trigger Questions

- How can consumer connection with food products and food production be increased?
- Which initiatives can be taken to raise the value that consumers attach to food even though its relative importance in the household budget is possibly quite limited?
- How can technological advancements improve the accuracy of sales forecasting in retail and hospitality contexts?
- How can restaurants reduce various inefficiencies leading to additional and unnecessary food waste generation?

3.13.4 References for factor 13

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3.14 Factor 14: Behavioural

3.14.1 Definition

The broad area of behavioural science can be defined as the study of human behaviour. The latter is of such complexity that often theories, concepts, and methodologies of various disciplines (e.g. psychology, anthropology, economics, sociology, etc.) are combined when examining if and how factors such as thoughts, motivations, social influences, contextual

effects, habits, etc. impact individuals and/or groups of people. In terms of methodology, mainly observation, systematic experimentation, and modelling are used in efforts to increase our understanding of human behaviour and in the design of related policy interventions.

3.14.2 The role of the factor in food waste generation and management

Basically, it can be stated that human behaviour is one of the most important factors when it comes to understanding and explaining the generation and management of food waste. This is particularly the case as the *actual* behaviour of individuals regularly diverges from their knowledge or intentions. Having a thorough understanding of what drives and impacts individuals' food-related practices, whether it be cognitive factors, (lack of) knowledge, motivations, social influences, culture or contextual effects, is therefore absolutely crucial in order to be able to tackle the food waste challenge in a focused and effective manner. Below, some major behavioural factors affecting food waste generation and management are related to the two main target groups of the project.

Table 11: Behavioural Factor Analysis

Factor's element	HORECA SMEs	Municipalities
Food provisioning	• The willingness-to-pay is lower for foods exhibiting visual imperfections compared to optimal foods, with the effect being even stronger for organic foods than for conventional foods (Yue et al., 2009). • At least for certain food categories (e.g. bread), customers tend to demonstrate a high willingness to substitute when items are out of stock (Van Woensel et al., 2007).	• The impact of "status consciousness" (i.e. the apparent need to demonstrate status through products, for example by displaying a large offer to guests) on purchasing behaviour with respect to fresh produce is higher for low income/education consumers (Marx-Pienaar et al., 2014). • 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) • Consumer willingness to buy near-expired food can be increased by using explicit messages about avoiding food waste (Zhang et al., 2022).
Date labelling		• Throughout a perishable product's shelf life, consumers' willingness-to-pay declines, although it tends to remain higher in cases where the consumers are planning to stop the aging process, e.g. by immediately cooking or freezing the product (Tsiros et al., 2005). • Consumers' willingness-to-pay is higher if they regard the dates mentioned on foods as indicators of freshness rather than as healthiness or safety indicators (Wansink et al., 2006). • The extent to which expiration dates are checked by consumers is dependent on the food category, with more frequent checks for

Factor's element	HORECA SMEs	Municipalities
		products in which a risk of quality decrease is perceived (Tsiros et al., 2005). • Consumers fail to sufficiently understand the meaning of "use by" and "best before" dates (Van Boxstael et al., 2014).
Consumer behaviour in food service environments	• Changes in menu composition, e.g. the introduction of vegetarian meals, can induce (temporary) rises in food waste (Lombardini et al., 2013). • Changing the mode of delivery from ordering on the spot to pre-ordering tends to lead to overall healthier orders being made, but also to more food being wasted (Hanks et al., 2012). • A tray-less system leads to less food waste compared to a system in which consumers are provided with trays (Thiagarajah et al., 2013). • Food waste can be reduced by using smaller plate sizes (Kallbekken et al., 2013). • Explicitly pointing out to guests that repeated helpings are welcomed leads to a reduction in food waste (Kallbekken et al., 2013). • Consumers tend to waste less food when a restaurant communicates explicitly its intention to reduce food waste (Whitehair et al., 2013).	

Factor's element	HORECA SMEs	Municipalities
Household storage		• A lot of consumers have a stock of items that were bought for a special recipe or occasion but are very rarely used and often disposed of at some point (Wansink et al., 2000). • Consumers tend to deal with meat and dairy products in a relatively hygienic manner, but products in other categories are often stored in a suboptimal manner (e.g. setting too high a refrigerator temperature, keeping leftovers for too long and wrongly using date labelling to assess whether food should be thrown out even if the labels do not apply anymore after opening) (Terpstra et al., 2005). • Consumers do not always have sufficient knowledge about whether food can still be used or not (Farr-Wharton et al., 2014).
Food packaging		• Aspects related to packaging, such as too large packages and packages being difficult to empty, contribute significantly to the generation of household food waste (Williams et al., 2012). • Consumers are not fully aware of the ways in which packaging can extend a product's lifetime and consequently fail to make optimal use of packaging functions and the information provided upon it (WRAP, 2013).
Food disposal		• Personal consumer attitudes have a major impact on the intention to recycle food waste and those attitudes can be influenced by the institutional context (Ghani et al., 2013; Refsgaard, 2009). • Both the source-separation ratio of food waste and the ratio of incorrectly-sorted material can be favorably influenced by a door-to-door information campaign (Bernstad et al., 2013).

Factor's element	HORECA SMEs	Municipalities
		• The installation of sorting equipment can function as a signal or visual nudge as far as the separation of food waste is concerned (Bernstad, 2014). • Awareness and self-reflection can be stimulated by installing bin cams in households and sharing photos of waste in social networks (Comber et al., 2013). • Household food disposal is mainly caused by not being able to use food in time, preparing or serving too much food, and personal preferences, e.g. taste (WRAP, 2012).
Food waste behaviour and practices		• Consumers do not waste food negligently, but their food wastage is rather a consequence of the manners in which domestic food practices are socially organized (Evans, 2011). • While seldom mentioning environmental concerns, consumers' aversion to food wastage appears to be primarily driven by a willingness to be thrifty (Watson et al., 2012). • Consumer behavior is also driven by certain motives which counteract food waste avoidance, such as the desire to be a good food provider for the family, for example by trying to cater to everyone's wishes (Graham-Rowe et al., 2014). • A certain family culture of accepting being served remains is required for a structural usage of leftovers (Cappellini et al., 2012) • For consumers, trade-offs exist between different kinds of motivations, in particular concerns about food safety at the individual level versus considerations regarding food waste at the societal level (Kriflik et al., 2005; Watson et al., 2012).

Factor's element	HORECA SMEs	Municipalities
Culture-based behaviour		• The amount of food wasted by a society depends on its overall appreciation of food and the value it attaches to food (Rozin, 2005; Pollan, 2007; Bloom, 2010; Gatley et al., 2014). • Culture-based cross-national differences in food shopping patterns have an impact on food wastage (Pearson et al., 2013; Neff et al., 2015; Nabi et al., 2021; Heng et al., 2022).

3.14.3 Trigger Questions (3 to 5 questions per factor)

- Which cognition-based measures can a restaurant take with a view to reducing food waste?
- What is the trade-off between avoiding out-of-stock items and generating food waste?
- Which measures can a municipality take to optimize household planning, shopping and storage routines with regard to food?
- Which types of local government campaign approaches would be most effective to reduce food waste?

3.14.4 References for factor 14

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