



PR1: Baseline assessment

T1.4: Creation of Baseline Assessment & Benchmarking

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Abbreviations

Abbreviation	Definition
MSW	Municipal solid waste
HORECA	Hotel, restaurant, café accommodation and food service activities
SMEs	Small and medium enterprises

Executive summary

This report provides the baseline assessment and benchmarking of HoReCa businesses and municipalities in terms of food waste generation and management. The baseline assessment and benchmarking were carried out using the consolidated results of Tasks 1.2 (Implementation of surveys) and 1.3 (Assessment of existing waste management practices), as well as data found in the literature on HoReCa businesses, municipalities and food waste.

Regarding HoReCa businesses, the analysis showed that in many respects HoReCa businesses lag behind in both preventing the generation of food waste and managing it sustainably. The main issues identified have to do with:

- the lack of systematic measurement and monitoring of food waste;
- moderate customer engagement in food waste prevention (e.g., doggie bags usage);
- passive disposal of part of food suitable and unsuitable for consumption;
- low rates of in-house composting;
- the need to educate HoReCa employees about food waste.

Similar results were obtained for the municipalities. In particular, the analysis concerning the management of food waste by municipalities showed that:

- the compositional analysis is not yet standard practice for a proportion of municipalities in Serbia and Croatia;
- the development of food waste prevention initiatives is modest in these countries although there is a willingness to intensify them;
- a large proportion of European households stated that there is no organized system for separate collection of food waste;
- the European average food waste generation is estimated at 66kg per capita but there are large differences between countries;
- Differences also exist in the management of MSW between European countries - Western European countries have abandoned the practice of landfilling while Southern and Eastern countries still opt for it.

1 Introduction

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

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

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

In this direction, ADVANCE will produce the following results:

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

This report presents the results of “Task 1.4 Creation of Baseline Assessment & Benchmarking”, which aims to create a baseline assessment, including an average European benchmarking on food waste management performance, based on the results of the surveys report (Task 1.2) and the Waste Management Best Practices Assessment Report (Task 1.3).

2 Objectives and methodological approach

Food waste in EU is defined as any substance or product, whether processed, partially processed or unprocessed, intended to be, or reasonably expected to be ingested by humans which the holder discards or intends or is required to discard (LAANINEN, 2020). Due to the intensity of the problem, food waste has been identified as a major global problem that has important environmental, economic and social implications (FAO, 2014). Food waste can occur at all stages of the food supply chain, each having its own root causes.

HoReCa industry has been identified as a major contributor to food waste in the EU, as estimates show that 12% of total food waste is generated at this stage (Stenmarck et al., 2016). There are several factors that contribute to food waste in the HoReCa industry, including overproduction, large portion sizes, customer-specific reasons etc. In addition, the way HoReCa SMEs manage food waste plays a key role in the total amount that will end up in landfill. HoReCas may eliminate the amount of food wasted by better managing their food production and distribution system. Options include redirecting excess food to food banks or charities, in-house composting, separating different waste streams, customer engagement, etc.

Local authorities and municipalities are a key factor influencing the amount of food waste, both due to their responsibility for waste management and because of their ability to organize and coordinate awareness and partnering initiatives. Municipalities aiming at rational and environmentally sustainable management of food waste need to comply with the principles of the food waste management hierarchy which prioritizes the prevention of waste and keeps redistribution and recycling as a secondary option.

In the light of the above, both HoReCa and municipalities will need specific indicators that will help them understand, measure and monitor important aspects of the issue and compare their position with their counterparts. In the context of this project, quantitative indicators were developed to provide municipalities and HoReCas with the appropriate metrics in order to begin understanding and monitoring their current food waste state but also to serve as reference points (considering average European benchmarking on waste management performance) for the status of the actors under study. The baseline assessment and benchmarking were performed using data collected under the Tasks 1.2 (Implementation of surveys) and 1.3 (Current Waste Management Practices Assessment), as well as data obtained from the available literature regarding HoReCa businesses, municipalities, and food waste. The results of the analysis aim to feed into Task 3.3 (Design and Development of Roadmap) among others.

3 Baseline assessment and benchmarking for HoReCa SMEs

1. Frequency of food waste compositional analysis

Benchmark indicator: **4/year minimum**

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

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

2. Number of installed bins for separate collection

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

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

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

3. kg of food waste generated per month

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

4. kg of food waste generated per customer per month



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

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

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

- 5. **% of food waste (avoidable and unavoidable food waste that will be donated, be composted or landfilled) to food supplies (w/w)**
 - a. Benchmark indicator: **plan & implement a monitoring framework/system**
 - b. Benchmark indicator: **progress monitoring indicator**

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

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

6. % of total food waste produced - pre-kitchen

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

7. % of total food waste produced – kitchen

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

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

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

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

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

food waste percentage appeared as service losses, i.e. leftovers in the buffet and serving bowls (62.6% and 38.21%).

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

a. Benchmark indicator: 50%

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

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

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

a. Benchmark indicator: 30%

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

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

According to survey data 55.1% of the HoReCa businesses throw away at least a fraction of leftover food. On one hand, a similar study (Sakaguchi et al., 2018) conducted in Berkeley, California, USA, found that 14% of the surveyed restaurants dispose leftover food to landfills. On the other hand, all participant restaurants in a study conducted for the city of Veszprem in

Hungary relied on passive disposal as the main approach to manage food waste (Filimonau & Sulyok, 2021).

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

- a. Benchmark indicator: **70%**

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

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

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

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

In contrast to the previous indicator, these three indicators show the amount of leftover food that is managed in a more sustainable manner than the landfilling. In particular, the first and more general indicator captures the percentage of leftover food (suitable for consumption) that is recovered through reuse, recycling or any other process. The second indicator tracks the percentage of leftover food that is donated either to feed other people or to be treated and upcycled for other purposes. Last, the third indicator monitors the amount of food that is composted by the business. Note that since the two last indicators cover all the available options of sustainable management of leftover food, the summation of them should be equal to the first indicator.

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

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

- a. Benchmark indicator: **5%**

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

- a. Benchmark indicator: **95%**

Food that is not suitable for consumption consist of food parts that cannot be consumed by humans (pits, bones, skins etc) or food that cannot be served due to the fact that it has expired. Food waste unsuitable for consumption makes up a large part of the total amount of food wasted and therefore monitoring this fraction is also important for a HoReCa business. Therefore, based on the hierarchy of food waste management, the percentage of this fraction

that ends up in landfill and the percentage that is recovered in a sustainable way should be monitored. The two indicators above serve exactly this purpose.

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

16. % of food waste collected in a separate bin

a. Benchmark indicator: 100%

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

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

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

a. Benchmark indicator: 100%

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

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

18. % of packaging waste collected in a separate bin

a. Benchmark indicator: 100%

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

and collect it in a separate bin to facilitate recycling. Their aim should be to recycle all the food packaging they use.

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

19. Internal training programs on food waste

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

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

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

4 Baseline assessment and benchmarking for the municipalities

1. Frequency of municipal waste compositional analysis

- a. Benchmark indicator: **once per year (non-touristic places) or twice per year (touristic places)**

The analysis of the composition of municipal waste is done to assess the type and quantity of waste generated by the municipality's community (residents, businesses, etc.). After the results of such an analysis, a municipality can obtain insights on the main waste streams and take action to prevent/reduce them. For example, a compositional analysis may reveal that a lot of obsolete or broken electronic equipment ends up in the waste stream and take action by promoting the recycling of such items. In addition, conducting compositional analysis in frequently is important since studies have shown that seasonal patterns may affect the quantity and composition of municipal waste (Denafas et al., 2012, 2014; Edjabou et al., 2018). It is evident that the more frequent the compositional analysis the quicker the response of the municipality to take action.

Based on the results of the survey conducted for the Croatian municipalities, less than 40% of the municipalities perform compositional analysis; however, none of them records the weight and the type of biowaste. About 86% stated that they record the overall quantity of the biowaste and 14% stated that they conduct quality analysis. As far as the frequency that

compositional analysis is carried out, 80% of the municipalities stated that it is conducted on a yearly basis and the rest stated that it is only conducted when there is a need to do so as part of a specific study. In Serbia, two out of three surveyed municipalities stated they conduct compositional analysis. The analysis is conducted on a daily basis at the Regional Centre in Subotica and once per three months in Niš, however none of them records the annual amount of food waste.

2. Number of food waste prevention programs and/or initiatives, platforms, organisations, etc.

- a. Benchmark indicator: **at least 1 program per category, e.g. prevention, donation, etc., at least one active platform/organisation and the number of influenced people**

Municipalities have a key role in food waste management as they can bring together different actors (businesses, residents, NGO etc) to tackle the problem of food waste. For example, they can install community fridges so that HoReCa businesses can distribute excess food to those in need. In addition, municipalities can organise food donation schemes through partnering with other organizations such as food banks. The literature shows that different types of intervention campaigns have different impacts on the final quantities of food waste prevented (Sharp et al., 2010). It is therefore important to keep track of the number of these initiatives in order to monitor their current status, evaluate their impact and assess any gaps that may exist.

The percentage of Croatian municipalities that had implemented a food waste prevention programme/initiative was less than 40%. These initiatives were mainly related educational campaigns and programmes for different target groups, sorting, distribution of composters for free. According to the responses of the survey, the development of such programs will intensify since three out of four municipalities aim to launch such programmes in the future. Only one out of three surveyed Serbian municipalities has a food waste prevention program in place. This involved promotional activities encouraging composting in households and thematic competitions aimed at citizens' associations.

3. kg of food waste generated per capita per year

- a. Benchmark indicator: **progress monitoring indicator**
- b. Benchmark indicator: **50% reduction of the produced food waste by 2030 (baseline = 2019)**

The per capita amount of food waste generated in a municipality each year is a very useful metric both because the monitoring of it gives a clear picture of how the total amount of food waste varies over a fixed period of time (e.g. each year) and because it can be used to compare municipalities with similar demographic characteristics. Thus, a municipality can easily quantify and assess the extent of food waste generated and take the necessary prevention and reduction measures in a timely manner.

The literature (United Nations Environment Programme, 2021) shows that there are variations in the amount of food waste (for households) per capita for different European countries. Specifically, on an annual basis, in Greece this indicator is 142kg per capita, in Croatia 84kg per capita, in Belgium 50kg per capita, in Cyprus 95kg per capita and in Serbia 83kg per capita. In Europe, this indicator is 66kg per capita.

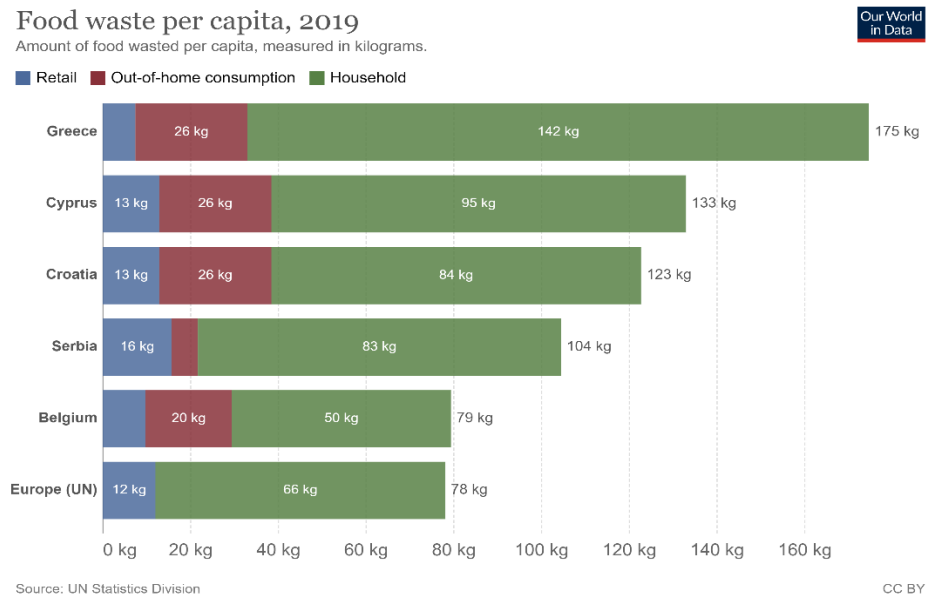


Figure 1. Food waste per capita for selected countries (source: ourworldindata.com)

4. kg of food waste collected separately from the source to total kg of food waste collected by the MSW management system
 - a. Benchmark indicator: **target 65%**
5. kg of biowaste collected separately from the source to total kg of biowaste collected by the MSW management system (in case that no separate collection for food waste exists – second-best option)
 - a. Benchmark indicator: **target 75%**
6. % of the population covered by a separate food waste collection system
 - a. Benchmark indicator: **progress monitoring indicator**
 - b. Benchmark indicator **100% by 2030**
7. % of the population covered by a separate biowaste collection system (in case that no separate collection for food waste exists – second-best option)
 - a. Benchmark indicator: **progress monitoring indicator**

b. Benchmark indicator: 100% by 2030

Separate collection of organic material (biowaste and food waste) is an essential step towards its sustainable management. This is because separate collection simplifies downstream valorization processes such as upcycling or composting. The four indicators above are intended to facilitate the monitoring of separate collection systems established by the municipalities. In particular, the first two indicators show the percentage of food waste/bio-waste collected from the source in relation to the total amount of food waste/biowaste collected by the municipal solid waste management system (w/w), and the last two track the proportion of population covered by a separate food waste/biowaste collection system.

Data for calculating the indicators regarding food waste are not available from the municipal survey analysis since none of the municipalities specifically monitors food waste, let alone its separate collection. In Croatia, survey data suggest that 45% of the municipalities implement separate collection of mixed biowaste and 50% of the municipalities intend to establish a separate collection scheme for food waste.

As far as household survey is concerned, 11.4% of the participants stated that they collect their leftover food (suitable for consumption) in separate bins provided by the municipality. In addition, 16.8% of them use a separate collection system for the management of their unavoidable food waste. Lastly, 66.7% expressed their willingness to separate food waste/biowaste but stated that there is no organised waste management in the municipality to handle this stream.

8. % of food waste being landfilled (to total amount of collected food waste)

- a. Benchmark indicator: **progress monitoring indicator**
- b. Benchmark indicator: **5% of food waste ended up in landfills by 2030**

9. % of food waste recycled, reused and treated (to total amount of collected food waste)

- a. Benchmark indicator: **progress monitoring indicator**
- b. Benchmark indicator: **95% of food waste recycled/reused/treated by 2030**

Landfilling organic materials, such as food waste, has a negative impact on the environment. The decomposition of food waste in landfills not only contributes to climate change through the release of methane gas into the atmosphere, but can potentially contaminate soil and groundwater. On the other hand, sustainable treatment of food waste avoids these risks and reintroduces materials back into a system that needs them. Municipalities need to divert food waste from landfills to more sustainable management options that promote circular economy. Thus, two indicators that help monitor this goal are the percentage of food waste sent to landfill (to the total amount of food waste collected) and the percentage of food waste that is recycled, reused and processed (to the total amount of food waste collected). These two indicators are in a sense identical since they consider the only two management options, i.e. landfill or sustainable treatment, and their sum should be 100%.

According to municipal survey data, in Croatia 66.7% of municipalities choose landfilling for the management of mixed biowaste while less than 30% of municipalities choose composting. In addition, 5.5% of municipalities use them for energy recovery through anaerobic digestion. In Serbia, all three municipalities surveyed use composting to manage food waste, but one of them disposes part of it in the landfill.

Data obtained from Eurostat (Eurostat, 2022a) indicates that municipal solid waste (MSW) management is not harmonized across Europe. In particular, as shown in Figure 2. **Municipal solid waste management per country** (source: (Eurostat, 2022a))

, in eastern and southern European countries (Romania, Cyprus, Greece, Malta, Bulgaria and Serbia) landfilling is the main option for the management of municipal solid waste. In contrast, countries in Western and Northern Europe have largely abandoned this practice and are now using more sustainable methods such as composting and recycling.

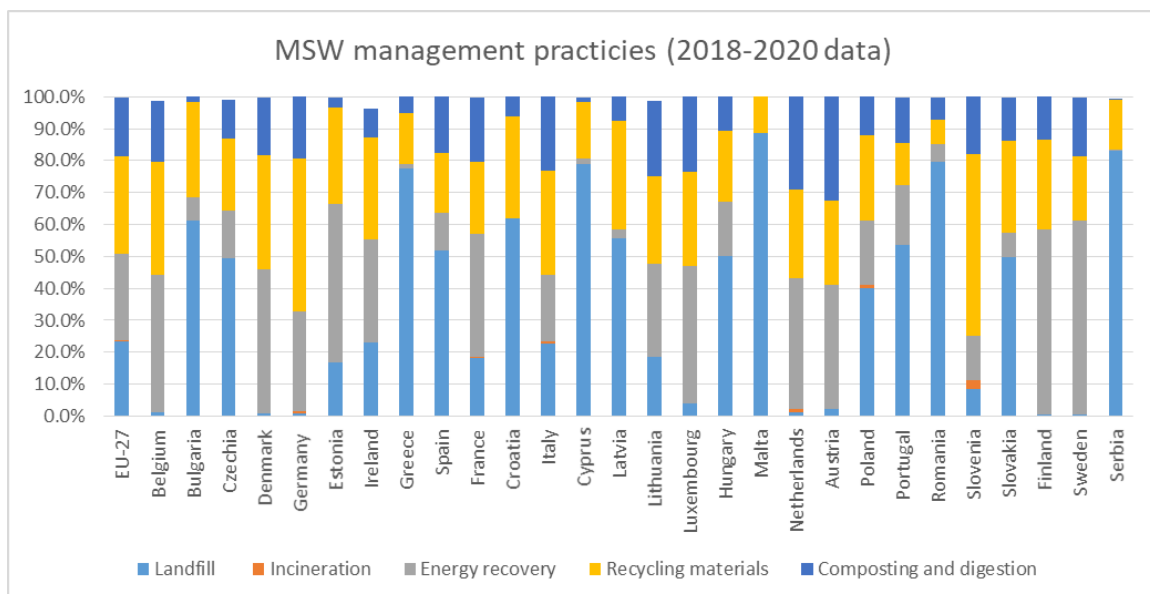


Figure 2. Municipal solid waste management per country (source: (Eurostat, 2022a))

10. % of food waste recycled into animal feed (to total amount of collected food waste)

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

11. % of food waste recycled via composting (to total amount of collected food waste)

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

12. % of food waste treated for energy recovery (via anaerobic digestion/and or incineration) (to total amount of collected food waste)

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

13. % of food waste bio-dried (for the production of SRF) (to total amount of collected food waste)

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

Municipalities should also monitor the amount of food waste repurposed for different processing methods, because some of them are preferable according to the food waste management hierarchy. For example, it is preferable to use food waste to feed animals, or to valorise it through composting, rather than incinerating it for energy recovery. The first indicator aims to monitor the percentage of food waste recycled into feed (to the total amount of food waste collected). The second indicator shows the percentage of food that is recovered through composting, the third indicator shows the percentage of food waste treated for energy recovery (via anaerobic digestion/and or incineration) and the fourth indicator shows the percentage of food waste bio-dried to be used for soil recovered fuel (SRF). Note that since these indicators cover the whole spectrum of the food waste management hierarchy, the sum of the individual indicators should equal the percentage of food waste recycled, reused and treated (9th indicator).

None of the Croatian municipalities surveyed repurposes food waste for animal feed. In addition, less than 30% compost food waste and 5.5% of the municipalities use it for energy recovery through anaerobic digestion. Yet, 50% of them expresses their willingness to launch a municipal compost system. In Serbia, all the municipalities that participated in the survey stated that they compost at least a fraction of food waste collected but no detailed data were given.

14. Number of communication and educational actions /campaigns per year (e.g. numbers of articles published about food waste, leaflets mailed to households, visits organised to households, schools, etc.)

- a. Benchmark indicator: **at least one campaign per target group (e.g. households, HORECA businesses, schools, etc.)** including
- i. the number/ percentage of people/pupils that were informed
 - ii. the working hours and staff that participated in the campaign strategy
 - iii. duration of the actions/campaigns (e.g. 1 semester, 4 months etc)
 - iv. money spent per action/ campaign

European municipalities should conduct communication and educational campaigns to raise the awareness of the community on food waste and to promote food waste prevention and reduction. There are numerous methods that can be employed in this direction such as social media campaigns, school workshops regarding food waste, billboards, leaflets etc. It is important that all actors in the municipality take part in the educational campaigns to amplify the dissemination of information regarding food waste to as many people as possible. Municipalities should keep track of the number of campaigns that have been conducted and ensure that diverse audiences have participated.

The percentage of Croatian surveyed municipalities that implement communication and awareness campaigns was less than 40%. However, approximately 75% of them aim to launch

food waste prevention programs and initiatives in the future. In Serbia, one municipality (out of the three surveyed) has implemented food waste programmes and initiatives and two out of three plan to intensify food waste prevention and communication efforts in the future.

5 Conclusions

Based on the results obtained both from the analysis of the survey data and from data collected from the literature, European businesses in the HoReCa sector, although highly interested in the prevention and sustainable management of food waste, are still at an early stage in this direction. In particular, the main findings were:

- Steps should be taken towards the in-house identification and measurement of food waste streams through compositional analysis and the installation of waste separation systems.
- The estimated amount of food waste per customer was 190g/customer which is in line with studies found in the literature.
- The food wastage rate in relation to the goods supplied by HoReCa businesses was estimated at 13.34%.
- Data suggest that the highest percentage (49.6%) of food waste is generated during consumption, with the remaining percentages being evenly split between pre-kitchen and kitchen waste (24.9% and 25.5% respectively).
- 43.3% of businesses showed very low rates of doggy bag usage (0%-20%) for collecting leftover meals. Also, less than 40% of businesses report that more than 50% of their customers take doggy bags.
- Passive disposal of food that is suitable for consumption seems to remain a common practice for a large proportion of food service businesses as 55.1% of businesses dispose of at least a fraction of it in the trash with all that this entails for its subsequent management.
- About 44.1% of businesses donate food suitable for consumption to charities and only 9.4% of businesses compost this in-house.
- The picture is relatively similar for the management of food unsuitable for consumption with 74% of interviewees reporting that at least a proportion of this waste stream ends up in the trash.
- Around one in three businesses use separate bins for biowaste collection, the corresponding percentages are much lower for separate collection of packaging materials (14.2%), but higher for separate collection of cooking oil (74%). However, in all cases these figures are far from the targets.

- The knowledge gap that exists among foodservice workers regarding food waste is illustrated by the high percentage (71.7%) of those who agreed that internal employee training would help combat the problem.

Interesting findings emerge from the results of the interviews and the literature review on the management of food waste by municipalities. The main findings were:

- Compositional analysis is not conducted in most (>60%) of the Croatian surveyed municipalities. Of the municipalities that carry out compositional analysis 80% conduct it once per year and the rest conduct it whenever there is need as part of a relevant study. In Serbia, two out of three municipalities conduct a compositional analysis, one every day and one every quarter.
- In the two countries studied, similar percentages of municipalities have implemented food waste prevention initiatives. In particular, for Croatian municipalities this percentage was less than 40% and for Serbian municipalities it was one in three.
- Household food waste was estimated to be 66kg per capita for each year in Europe. Greece scores highest (142kg per capita), followed by Cyprus (95kg per capita), Croatia (84kg per capita), Serbia (83kg per capita) and Belgium (50kg per capita).
- None of the municipalities in both countries implements separate collection of food waste. As far as household survey is concerned, 11.4% of the participants stated that they collect their leftover food (suitable for consumption) in separate bins provided by the municipality and 16.8% of them use a separate collection system for the management of their unavoidable food waste.
- About 67% of the household were willing to separate food waste/biowaste but stated that there is no organised waste management in the municipality to handle this stream.
- Municipal waste management is not yet harmonized across EU. Many Eastern and southern European countries are still landfilling the vast majority of the MSW while their Western counterparts have switched to recycling and composting.
- None of the Croatian municipalities surveyed repurposes food waste for animal feed. In addition, less than 30% compost food waste and 5.5% of the municipalities use it for energy recovery through anaerobic digestion. In Serbia, all three participating municipalities compost at least a fraction of food waste.
- The percentage of municipalities that implements food waste communication and awareness campaigns was less than 40% and one in three for Croatia and Serbia respectively. Most of them stated that they plan to intensify communication efforts in the future.

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