



Article Urban Food Waste: A Framework to Analyse Policies and Initiatives

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Abstract: Food waste policy analysis has traditionally concentrated on supranational or national policies and paid little attention to the role of cities in tackling this phenomenon. Nevertheless, cities have proved to be crucial actors in tackling food waste, launching effective policies and initiatives to address it. By looking at 40 cities across 16 European countries, this study aims to present a new framework for assessing urban food waste policies and initiatives. The framework proposed identifies and sheds light on the links between the different types of policies launched, the main areas of interventions addressed, as well as the different actors intervening in urban food waste management. Finally, it identifies direct and indirect links with the Sustainable Development Goals, showing the role that cities can play in achieving the targets of the UN 2030 Agenda.

Keywords: food waste; food policies; urban food policies; urban food waste; urban food governance; sustainable development; food security; urban food security

1. Introduction

Food waste is one of the most important issues of current food systems: the Food and Agriculture Organization (FAO) has estimated that more than one third of food is either lost or wasted along the entire food supply chain [1–3], causing significant economic, social and environmental impacts. Estimates of the overall cost of global food loss and waste amount to 2.6 trillion US dollars, close to the GDP of France [4], including 1 trillion dollars of economic costs, 700 billion dollars of environmental costs and 900 billion dollars of social costs [5]. From an environmental point of view, food waste represents between 8 and 10 percent of global greenhouse gas emissions (3.3 billion tons per year) [6]; and the annual (blue) water footprint of the agricultural phase of food waste is about 250 km³, five times the volume of Lake Garda and higher than any national (blue) food consumption water footprint [7]. Others have found that food loss and waste embeds 23–24% of the total global use of cropland, freshwater resource and fertilisers for food production [8]. In the European Union (EU), 88 million tonnes of food waste are generated each year (i.e., 173 kg per capita) with significant economic, environmental and social impacts [5,9–12]. It has been estimated that 15–16% of the total environmental impact of the food supply chain in Europe can be attributed to food waste [13]. These figures underline the crucial role of reducing and preventing food waste in tackling climate change (with a mitigation potential of between 0.8-4.5 Gt CO₂ equivalent per year), reducing the pressure on water resources [6,14] and achieving the pledge of the UN 2030 Agenda, which calls for halving food losses and waste at the retail and consumer level by 2030 (Target 12.3). In this sense, the recently

adopted "Farm to Fork" Strategy [15], pursues the European Commission's goal to halving per capita food waste at retail and consumer levels by 2030, part of the broader objective of making the EU food system the global standard for sustainability.

Cities have emerged as crucial actors in the global food security geography [16–20] as they are experiencing several food security-related challenges [21–23], among which the management of food waste is central [24,25]. Urban contexts are in fact the biggest source of post-consumption food waste, with organic waste accounting for more than half of total urban waste [26], and cities like Los Angeles producing up to 800,000 tons of edible food waste every year [27,28]. Current and estimated urbanisation rates will exacerbate this issue in the coming decades, with 2.5 billion people estimated to move towards urban settlements [29,30].

However, several cities around the world have also proved to be able to develop very effective food waste policies, becoming the best geopolitical unit to address goal 12.3 of the 2030 Agenda [31–33]. In particular, European cities have worked closely to share best practices and lessons learned to counter the phenomenon, creating important networks such as the EUROCITIES Working Group on food waste, and implementing initiatives and mechanisms to tackle these issues, such as market incentives, food donations, awareness raising campaigns, and integrated actions that also contribute to generating renewable energy, bio-fertilisers used in urban agriculture, and new jobs [34]. Recent studies have confirmed the need for a local approach to fully implement the Agenda, as almost two thirds of the 169 Sustainable Development Goals (SDG) targets require the proper engagement of, and coordination with, local and regional governments [35–37]. However, food waste management is an intrinsically complex challenge, since it requires diversified but integrated actions that involve many public local authorities (e.g., cities, regions, metropolitan areas and provinces, all the way up to central government) and other actors including retailers [38,39], school canteens [40], hospitals, food markets [41], citizens [42] and Non-Governmental Organizations [28,43]. All these actors and levels of governance need to work in a synergic way to ensure effective urban food waste policies.

Integrated urban food policies and initiatives can alleviate the paradoxes of the current food system, addressing all those sectors that affect urban and peri-urban food systems directly or indirectly, such as school meals, food markets, farmers' markets, retail sector, food donation, food waste [17,18]. Cities are also promoting new models of governance, for instance launching new institutional settings like the Food Policy Councils [44], creating regional and global networks of mayors advocating for more sustainable food systems [16,17,45], and coordinating initiatives to address food waste-related challenges in an integrated manner, from food production to food distribution (i.e., logistics), from education to food waste management itself [46–48].

Some authors have argued that current food policies are still very fragmented, and that research in the field has remained somewhat abstract rather than transformative [45,49,50]. This is even more apparent in food waste research, with existing frameworks [51] still poorly able to grasp the multiple actors and areas of interventions characterising food waste management in urban contexts. In recent years, indeed, research and policy on food waste have mainly focused on the national or supranational level [51–53], while less attention has been paid to the decentralisation and devolution of food waste governance to local governments, such as municipalities [28,31,54]. In addition, the few studies attempting to measure the alignment of cities' policies with SDG12 of the UN 2030 Agenda have suffered from a lack of data on urban food waste levels [36,37], thus providing limited analyses of urban food waste policies.

Given the key role of urban food policies in tackling food waste and the identified gap in the literature, the aim of this study is to develop a framework for the analysis and characterisation of urban food waste policies and initiatives, in order to deepen understanding of the complexities linked to effective food waste management. To develop such a framework, a review of the scientific and grey literature and of the leading practices has been undertaken to identify key issues and criteria to be considered when analysing urban food waste policies and to be integrated into the most recent assessment frameworks of food waste policies [51]. The application of the framework is tested on

a sample of leading practices regarding initiatives and policies launched at the urban level across European countries.

The article is structured as follows: the next section presents the materials and methods, and the subsequent one outlines the results of the review of literature and leading practices and presents the framework for the analysis of urban food waste policies and initiatives.

2. Materials and Methods

The assessment framework for food waste policies and initiatives at the urban level was developed through a deductive approach. Drawing on consolidated food waste assessment frameworks existing in the literature, so far applied only at supranational or national levels, the criteria and categories which emerged from the review were integrated to capture the specificities of urban contexts.

The authors started from the review research on food waste policies conducted by Principato [51]. This was the basis for a review of the most recent literature on food waste policy assessment frameworks and on urban food waste initiatives intended to achieve two aims: (i) to analyse the most recent developments in the food waste policy-related literature and (ii) to identify criteria and policy categories suitable to the urban scale.

A first step of the research focused on scientific literature and considered the following search engines and databases: EBSCO, Science Direct, Google Scholar, Scopus, Emerald. Combinations of the following keywords were used: "food waste", "policies", "cities", and "urban". This search was carried out between October 2019 and April 2020, and only scientific articles (both research and review articles) and books published in English during the last fifteen years were considered. A screening of the titles and abstracts was performed to identify those publications that included either (i) assessment of food waste policies or initiatives and/or (ii) their application to urban contexts. Studies not meeting these criteria were excluded from the review. Publications cited in the selected papers have been also reviewed.

Since the scientific review revealed a lack of sources on urban food waste policies, the authors performed a second review focused on grey literature. This allowed the scientific literature to be complemented and urban food waste policy leading practices to be identified. This search included reports, best practices and initiatives issued by the most relevant actors working on food waste policies at the urban level. The following websites were been consulted: FAO, the European Commission, cities' networks such as the Milan Urban Food Policy Pact (MUFPP), C40 and EUROCITIES, Foundations (Està, Ellen MacArthur Foundation, Global Alliance for Improved Nutrition, Barilla Center for Food and Nutrition) global partnerships (RUAF) and individual municipalities. Documents published in English, French, Italian and Spanish (based on the authors' knowledge of these languages) were considered. The selection criteria and timeline applied to sort out the grey sources were the same as those considered for the scientific literature. Finally, the selection of the leading practices focused on European cities for two main reasons: on the one hand, the dramatic food waste figures in the region [5,9–13] and, on the other, the leadership of European cities in tackling this issue, as described in the introduction.

Overall, the final selection from the two-step review included 84 publications, including 37 from the scientific literature and 47 from the grey literature, among which 16 illustrate leading practices (see Table S1 for a complete list). All the studies were published between 2008 and 2020, with almost half (45%) presenting analyses characterised by global coverage, more than one third (35%) focusing on the local scale and the remaining 20% on the regional or national one. With regard to the central topic of the reviewed studies, almost two thirds (63%) focus on the food waste issue, more than one quarter (26%) on urban food governance, and the remaining 11% on other topics, such as sustainable diets, food policy and SDGs.

As a final step, a mapping exercise between urban food waste policies initiatives and SDGs was carried out considering the 40 European leading practices identified in the literature, in order to shed light on the links between such initiatives within the Agenda 2030. In particular, the sources used for

identifying potential links between the urban food waste initiatives with the SDGs included the 16 grey sources providing the 40 leading practices. A twin-track approach was taken. Firstly, all the SDGs targets were preliminarily analysed to identify possible direct or indirect relations between the goals set in the Agenda 2030 and the urban food waste issue. Indeed, apart from the explicit link between urban food waste policies and initiatives and SDG12 (target 12.3 mentions the reduction in food loss and waste as a key priority, although it does not refer to cities but rather to the national level), other sustainability targets, such as environmental conservation, food security and social protection, and partnership for the goals, can be impacted by urban food waste initiatives. Secondly, the urban food waste leading practices identified in the literature review were analysed to explore their contribution to the subset SDG targets identified in the first step.

3. Results

3.1. Assessing Food Waste Policies: The Main Categorisations and Themes

The literature review confirmed that some international and regional organisations, such as the United Nations [55] or the EU institutions [56] have started to acknowledge the role of cities as laboratories for sustainable development. In addition, recent literature focused on the role of cities in tackling food waste [28,30,33,43,57]. Nevertheless, the majority of studies on food waste policies focused on the national and supranational level [51,52,58–64]. Against this backdrop, five crucial themes that need to be addressed when conducting an analysis of urban food waste policies emerged from the review.

Firstly, the most updated assessment frameworks for food waste policies and initiatives categorised existing policies into five main groups [51,59,65,66]: (i) information-based policies are aimed at raising awareness at multiple levels through social campaigns; (ii) market-based policies are market-based instruments (e.g., fiscal incentives for those organisations that donate surplus food to people in need), as well as monitoring programs to ensure that voluntary agreements are followed; (iii) regulatory policies include a general development of well-defined anti-food waste targets, such as reducing food waste; (iv) nudging tools are indirect suggestions that positively influence individuals to achieve a non-forced compliance, (e.g., putting the healthiest food at consumer sight level in public canteens); (v) voluntary agreements are agreements involving the commitment of the food industry to sign a pact with the institutions to reduce food waste. Against this backdrop, emerging literature addresses food sharing practices aimed at reducing food waste [38,67–69], particularly through food donations or by harnessing the potential of digital solutions.

Secondly, urban food waste policies and initiatives involve a vast number of actors as key enablers. Hence, the plethora of actors operating in urban ecosystems [28,43,70,71] make urban food waste policies more suited, as well as more complex than national or supranational ones. All these actors involve different levels of governance that often cannot be entirely managed by city managers, but rather require a system of multi-level governance [72] and partnerships to design, implement and effectively monitor food waste policies. The main actors emerged from the literature and their role in addressing food waste at the urban scale are listed here. Schools with school feeding programs can be a strong driver for food waste reduction at the urban level [31], while contributing to the overall socio-economic development of shorter food supply chains [71,73] and educating younger generations. Charities (e.g., food banks, NGOs, Civil Society Organizations) are crucial actors in promoting a more circular approach to food, although they have limited capacity to address the root causes of food waste [28,38]. Waste management companies are essential enablers for both designing and implementing urban food waste policies [43] and fostering significant waste-to-energy transformation programs often involving public transport or electricity generation [33,34,74], by fully unlocking the potential of the bioeconomy [75,76]. Food markets [77,78] and producers [79] ensure that food is produced according to circular principles at the beginning of the value chain [14,31]. Furthermore, restaurants and supermarkets are crucial players in the reduction in food waste, and have already been targeted by several pieces of food waste legislation through the creation of fiscal incentives to reduce food waste [31,34,52] or through social campaigns aimed at distributing food to needy citizens [80]. Finally, hospitals can play a crucial role in tackling food waste [34], not only in terms of awareness-raising among staff and patients, but also as organisers of greener public procurement through their canteens [81]. Such a variety underlines that cross-actor, cross-sectoral and interdepartmental coordination and cooperation are a *conditio sine qua non* for effective urban food waste policies [17,20,31,33,47].

Thirdly, adopting multi-layered policies is crucial [33,34,44]. Cities are the place where it is possible to concretely foster sustainable food consumption, overcoming the traditional trend to decouple food production from nutritional behaviour, economic aspects from social aspects, health aspects from environmental ones [59]. Therefore, it is crucial to launch coordinated and integrated food policies, for instance through ad hoc Food Policy offices and coordinators like those created in several cities worldwide. Therefore, analysing urban food waste policies implies looking at several and sometimes multiple areas of interventions [33,34].

Fourthly, SDGs still struggle to become a relevant key policy framework for guiding cities-led food waste policies or initiatives. Although some authors have tried to assess the alignment of municipal policies with SDG target 12.3 [36,37], only a limited picture of the phenomenon has been provided. These studies, overall, lacked data on food waste performance at the urban level, hence they focused on annual urban waste per capita production [37] or on Body Mass Index [36]. Other publications have tried to analyse the broader impact of urban food systems on sustainability [33,82,83], without providing explicit analyses on the food waste issue.

Finally, the reviewed literature highlighted that the lack of a commonly agreed definition of food waste and the related accounting [1,9,58,62,84] still represents a limitation for tackling food waste in cities [85]. The proliferation of definitions and methodologies complicates the design and implementation of effective policies, especially at municipal level [86]. Throughout the years, there have been several attempts to provide a commonly shared definition [1,9,58,60,62,87–89], and quantification methodologies. The recently created *Monitoring Framework* developed by FAO together with the MUFPP [90] could be a useful starting point to monitor food waste-related performances at the urban level.

3.2. Investigating Leading Practices in Urban Food Waste Policies

The leading initiatives analysed allowed the identification of further types of policies and initiatives and actors, thus supplementing the existing literature. The analysed sample included best practices from 40 European cities across 16 EU Member States (Figure 1. Sample of urban food waste policies analysed) (see Supplementary Materials, Table S2, for the complete list).

Below, we present the three main results obtained from the review of the European leading practices. As a first contribution, the analysis allowed the applicability to urban contexts of the types of policies and initiatives that emerged from the literature to be assessed. In particular, all the types of policies and initiatives defined by previous literature were confirmed by the case studies, but for the nudging tools: namely, the 40 cities implemented information based (60%), regulatory (48%), food sharing (40%), voluntary (25%) and market based (8%) initiatives (Figure 2a). Additionally, a further category characterised by an orientation towards social protection emerged as peculiar in 30% of cases. In particular, 12 of the cities analysed (Almere, Bordeaux, Bruges, Cremona, Genoa, Ghent, Lille, Ljubljana, Riga, Turin, Venice, Zaragoza) turned the food waste challenge into an opportunity to alleviate the conditions of vulnerable citizens by, for example, creating jobs or donating surplus food.



Figure 1. Sample of urban food waste policies analysed.



Figure 2. Types of policies and initiatives (**a**), areas of interventions (**b**), and actors (**c**) emerged from the analysed leading case studies.

Secondly, the study identified the main areas of intervention in putting the policies and initiatives into practice (Figure 2b). These areas emerged from a qualitative analysis of the intervention mechanisms (since in the majority of the cases no quantitative targets or indicators were reported). In this context, the most frequent interventions are those dealing with education (68%), food donations (50%) and circular economy (40%). Educational programmes, campaigns and training are organised to raise awareness about food waste among different categories of citizens, such as food operators or students (e.g., Bruges, Ghent, Milan). Food donation activities are usually enabled through voluntary agreements and involve charities (e.g., Ghent, Milan, s-Hertogenbosch) but also retailers and restaurants to redistribute surplus food (e.g., Almere, Amsterdam, Ghent, Milan, s-Hertogenbosch). Projects to promote a circular economy of food from farm to disposal (e.g., by transforming food waste into clean energy, biofuels and bio-fertilizers) emerged in 16 cases (including Helsinki, Linkoping, Riga and Valladolid). Other initiatives analysed included fiscal incentives (i.e., waste tax deduction for actors that contribute to reducing food waste through donations) for food donations (two cities, i.e., Milan and

Ljubljana) and the use of digital tools (eight cities, e.g., s-Hertogenbosch) to help consumers buy food at a discounted price in small shops and retailers to avoid food waste. The creation of jobs contributing to alleviating food waste and increasing the socio-economic inclusion of the most marginalized groups such as migrants was implemented in seven cities (Bordeaux, Cremona, Ghent, Ljubljana, Riga, Turin and Venice). Furthermore, in five cities (Brussels, Cremona, Ljubljana, Montpellier, Riga, and Turin) urban food waste policies were also functional to supporting shorter supply chains, enabling direct and shorter connections between food producers and citizens. Finally, in nine cities, food waste management was part of wider strategies touching on several topics and involving different city departments, but also regional authorities. In one case (i.e., Milan), food waste management was one of the pillars of an integrated approach to food coordinated by the Milan Food Policy Office.

As a third outcome, the actors involved in the food-waste-related initiatives have been identified (Figure 2c). This analysis confirmed the existence of a plethora of actors that are active in urban food waste policies review. First of all, citizens are explicitly directly or indirectly involved in the majority of the cities (75% of the cases), with some initiatives addressing vulnerable categories promoting social inclusion (e.g., Turin specifically involves migrants). Moreover, city authorities are active actors in 80% of the initiatives analysed, whereas nine cases also explicitly mentioned integrated governance (i.e., Ghent, Milan, Turin, Riga, Gothenburg, Almere, Liège, Hertogenbosch, Brussels). In total, 45% of the initiatives involve charities (e.g., NGOs, Foundations and Food Banks), 40% involve food servers (i.e., restaurants, canteens, caterers), while waste management companies, bigger retailers (including supermarket) and schools (including universities, e.g., in Milan) are involved in 30% of the cases. Seven initiatives analysed were targeted at street food markets, whereas producers, in particular farmers, were the main targets (Ljubljana) or part of the targeted beneficiaries (Amsterdam, Linkoping, Milan and Valladolid) in five initiatives assessed. Entrepreneurs, start-ups and chefs (grouped under the category "entrepreneur" in Figure 2c) contribute as food donors and/or promotors of awareness on food waste (e.g., with cooking classes) in four of the cities analysed. Finally, some peculiar cases involve hospitals (Bruges), the city's transport company as user of the biofuel produced from food waste (Linkoping and Malmo), and urban gardens and hotels (Ljubljana).

3.3. Framework to Analyse Urban Food Waste Policies

This section presents the new framework for the analysis of urban food waste policies and initiatives. It is characterised by the three dimensions and related categories that emerged from the review of the literature on food waste policy and leading case studies: the types of policies and initiatives, the areas of intervention, and the actors.

As for the first dimension, the proposed framework draws on existing frameworks [51,59,65,66] and includes two additional types of policies emerging as specific to the urban context: food sharing and social protection. These two new categories allowed some of the dynamics specific to the urban level to be identified. The authors are aware that for some initiatives the categorisation may be blurred. For instance, some policies involving food donations were classified as "food sharing" but the difference between "food sharing" and "information based" policies is very limited, as well as between "food sharing" and "social protection" in some cases. In those cases, the "food sharing" option was selected for two reasons: firstly, the category allowed the aspect of sharing of surplus food to be stressed; secondly, it allowed the growing role played by food sharing initiatives to tackle food waste at the urban level, particularly in times of crisis (e.g., during the COVID-19), to be highlighted. Finally, the nudging tools category has been excluded because it did not emerge as relevant in the leading case studies. The final list of types of policies and initiatives included in the framework includes: (a) information-based; (b) market based; (c) regulatory policies; (d) voluntary agreements; (e) food sharing; (f) social protection (Table 1).

Type of Policies and Interventions	Aims
Information Based	Raising awareness among several urban actors of the food supply chain.
Market Based	Reducing urban food waste through market-based instruments, including fiscal incentives and tax reductions.
Regulatory	Tackling food waste by means of a wide range of activities in which cities are central, such as school meals reforms, legislation to facilitate food donations or easy food safety standards, but also wide strategies, plans or regulatory documents launched at city or regional level to address food governance.
Voluntary Agreements	Reducing urban food waste and raising awareness through agreements signed among a wide range of actors including national and local governments, private companies, charities, NGOs, food companies. These agreements may have different levels of formality and institutionalisation, with some cities merely playing the role of facilitators. These agreements enable collaborative initiatives involving exchanges of food and/or food waste.
Food Sharing	Enabling food sharing operated by profit organisations (e.g., distributors, retailers, restaurants), non-profit ones and even private citizens through food donations and sharing of food through digital technologies.
Social Protection	Reducing food waste by empowering vulnerable citizen groups (e.g., the elderly, poorer households, long-term unemployed, migrants), through job creation as well as cultural integration measures. These policies include projects that are explicitly targeting specific groups (e.g., people in need) of the population. Therefore, they may include food donations where marginalised groups (i.e., people in need) are explicitly identified as the main beneficiaries.

Table 1. Urban Policies and Interventions Against Food Waste.

Source: Data from [38,51] processed by the authors.

The second dimension of the framework relates to the areas of interventions implemented for addressing urban food waste at the urban level. The final list includes:

- a. Food donations: enabled through voluntary agreements signed between public or private actors and third parties (e.g., NGOs, charities, local organisations);
- b. Education: wide range of awareness raising initiatives addressing and involving citizens, charities, NGOs, as well as private actors (e.g., retailers, restaurants) and public ones (e.g., municipalities, schools, hospitals). They aim to raise awareness about food waste, but also entail capacity building, training, activities in the schools, etc.
- c. Promoting short supply chains: initiatives and projects aimed at strengthening urban-rural linkages, to better connect local (e.g., peri-urban) producers with urban food consumers for instance by investing in food markets or farmers' markets.
- d. Circular economy: broad range of initiatives aimed at transforming food waste into new products (e.g., bio-fertilizers, animal feeding and clean energy by public or private waste management companies).
- e. Digital tools: initiatives aimed at tackling food waste by harnessing the potential of digital tools (e.g., apps, platforms, websites, etc.)
- f. Fiscal incentives: initiatives aimed at incentivising a broad range of actors to reduce food waste for instance by cutting taxes for those private actors donating surplus food;
- g. Employment: initiatives aimed at tackling food waste by employing citizens usually coming from marginalised groups (e.g., long-term unemployed).

h. Additionally, tackling food waste can be a key component of wider initiatives based on integrated management of the urban challenges and that promote the collaboration and coordination of the urban ecosystem.

Finally, the third dimension regards actors from the urban ecosystem that are involved in the fight against food waste. The list includes actors identified and described in the literature (Section 3.1) and in the case studies analysed (Section 3.2).

The resulting assessment framework for urban food waste policy is illustrated in Figure 3. The lists of types of policies and initiatives, areas of interventions and actors are the result of the present review of the literature and of the current practice, but they can be expanded as new urban food waste initiatives will be implemented and new research published.



Figure 3. Assessment framework for urban food waste policies (Source: devised by the authors).

3.4. Exploring the Multiple Nexus of Urban Food Waste Policies

The application of the framework to the analysis of the leading cities gave the authors an understanding of how the three dimensions are connected (see Table S2 for details). In particular, analysing the case studies according to the proposed framework helped grasping how the different types of policies (Table 1) are implemented in practice and identified the main actors involved. The current situation of (leading) urban food waste policies in Europe is summarised and illustrated in Figure 4. Information-based initiatives are implemented:

- Via educational programmes and campaigns, i.e., by sharing information, in order to create awareness about food waste. In these cases, schools usually play a key role as educators, and often the students (i.e., the people who receive education on food waste) then contribute to dissemination activities (e.g., other hospitals in Bruges);
- Through food donations, when information on the available food supply (i.e., potential food waste) is exchanged between food suppliers (i.e., surplus of food, such as in food markets or supermarkets) and donors to prevent food waste;

- Through digital tools that can improve the information exchanged to raise awareness and prevent food waste, for example, customers can access information about lower-priced food that is close to expiry in a specific supermarket; and
- To promote circular economy initiatives, awareness-raising campaigns on the correct disposal of non-reusable food waste among citizens while informing them about how they can contribute to optimising the production of biogas that it is in turn reused in the city.



Figure 4. Application of the framework to the analysis of the 40 European leading cities in urban food waste initiatives. The three horizontal axes represent the three pillars of the framework and the ribbons represent the link between specific elements of the different pillars. The width of each ribbon reflects the occurrence of the link between two categories belonging to different pillars within the sample of 40 cities and the bars of each category on the different axes correspond to the statistics in Figure 2 (abbreviations: integr. manag. = integrated management; empl. = employment; fiscal incent. = fiscal incentives; waste manag. = waste management; farm./prod. = farmers-producers; enab. = enablers; trasp. comp. = transportation company).

Regulatory policies are developed to:

- Allow and define circular economy schemes. Food waste is used to create clean energy, biogas or biofuels for public transport (e.g., Linkoping and Malmo) or compost, which is used as an input in other production processes (e.g., peri-urban agriculture). The flows of food waste and derived products are agreed/activated through voluntary agreement and then formally regulated.
- Promote shorter food supply chains. The Municipality supports the food-related urban ecosystem through plans or strategies aimed at fostering cooperation among urban actors (e.g., caterers, hoteliers) and local farmers in order to create an efficient network/chain and promote an expansion of demand for local food from small-scale productions by citizens and institutions and to influence the food supply criteria.
- Support wider educational programmes. The City launches a broad specific plan or strategy with several goals, including the need to raise food waste awareness among citizens.

Urban food waste initiatives with social protection purposes materialise through food donations to vulnerable categories of citizens, creation of jobs contributing to preventing and mitigating food waste and education programmes for marginalised groups (e.g., migrants, poorer households) on how to tackle food waste.

Food sharing initiatives are implemented through food donations, with food often being donated to the most marginalised households. These initiatives are usually coordinated by public authorities, but in some cases, such as in Amsterdam, Bari, Bologna and Venice, groups of citizens independently organise food sharing activities—for instance through digital tools. Cities, retailers, NGOs or private citizens use more or less sophisticated digital tools (apps, WhatsApp groups, etc.) to share information about food surpluses that can be shared in order not to get wasted.

Voluntary agreements are reached to enable:

- Food donations. Food is donated to avoid waste (valorisation of food waste) thanks to voluntary agreements between actors;
- Circular economy mechanisms. The city signs an agreement with NGOs to use (potential) food waste as a mean to enhance urban production of food (e.g., compost used in urban gardens), which is then consumed (e.g., in public canteens); and
- Educational programmes. Local organisations sign an agreement with local authorities to raise awareness among citizens on food waste via training and campaigns.

Market-based initiatives are usually implemented via fiscal incentives such as tax reductions. For example, waste taxes are reduced when food-related businesses (supermarkets, restaurants, canteens, producers etc.) donate their food losses to charities, or financial help is provided to support specific actors (e.g., farmers) in fighting food waste.

Additionally, a single initiative can be classified under more than one type and can be implemented through a set of interventions that often have a wider aim than food waste. For example, the integration of regulatory policies and voluntary agreements allows the development of wider strategies that also include action to reduce food waste, and that support collaborative actions within the urban ecosystem.

Finally, the lower part of Figure 4 shows the complexity or relationships occurring within the urban ecosystem with aim of tackling food waste: the practical implementation (central axis) of policies and initiatives (top axis) is obtained with the involvement and collaboration of several actors (bottom axis).

3.5. Aligning Urban Food Waste Policies with the Relevant SDGs

One of the challenges emerged from the literature review regards the commitment of urban food waste initiatives to the Agenda 2030. For this reason, a preliminary analysis of the contribution of urban food waste initiatives to the SDGs is carried out. The analysis of the European sample allowed direct or indirect linkages with 12 of the SDGs targets to be identified (3.4, 4.7, 7.2, 8.2, 8.5, 9.4, 11.6,

12.3, 12.5, 13.3, 17.16, 17.17). In four cases, food waste interventions were explicitly put in relation with the SDGs: in three cases (Cremona, Liège and Montpellier) there was only a general reference to the SDGs impacted by the different interventions: e.g., the City of Liège has instead committed to reducing the amount of household and similar waste under the threshold of 100 kg per year per inhabitant by 2025 [91] (the amount of waste was estimated to be 149 kg in 2017). On the other hand, in one case (Milan), there was a clear and more detailed reference to the SDGs targets. In particular, the City of Milan has explicitly declared its ambition to halve food waste by 2030 and its intention to adopt a food supply chain approach [82], in order to reduce food waste across all tiers of the chain from food production to final consumption. None of these cases mentioned concrete metrics and publicly available quantification tools developed at city level to achieve such targets, as well as their impact on the SDGs. This suggests that the SDGs are not yet mainstreamed as a framework for policy guidance in tackling food waste at the urban level. Nevertheless, the case of Milan shows that when cities have comprehensive food policy administrative structures at their disposal, there are higher chances that the SDGs are explicitly mentioned in food waste initiatives, although this may not be necessarily accompanied by clear quantification methodologies.

Additional links between urban food waste initiatives and SDGs have been identified through this analysis of leading EU practices. In particular, the analysed case studies overall have direct or indirect effects on 11 SDGs (Figure 5). Besides target 12.3, a strong link with SDG17 on partnership was identified, particularly with regards to multi-stakeholder partnerships and sharing (target 17.16) and to public, public-private and civil society partnerships (target 17.7). In addition, although SDG11 on sustainable communities does not make an explicit reference to food, several urban food waste policies or initiatives (e.g., Athens, Brussels, Burgas, Cremona, Dublin, Gothenburg, Malmo, Prague, Sofia, Tilburg and Turin), were functional to reducing the environmental footprint of our cities, as highlighted in target 11.6. Moreover, some cases (Bruges, Ghent, Helsinki, Riga and Turin) proved to be effective in tackling poverty and socio-economic exclusion through food donations (in line with targets 1.2 and 1.3 of SDG1) and, also, through the creation of new job opportunities for some marginalised groups (e.g., Bordeaux, Brussels Ghent, Riga and Turin) of the population (target 8.2 and 8.3 of SDG8). Finally, the urban food waste policies assessed through the framework confirmed the importance of education and awareness raising campaigns [51] to promote more sustainable lifestyles at the urban level, in line with target 4.7 of the Agenda 2030 (e.g., Amsterdam, Barcelona, Bari, Cremona, Dublin, Gothenburg, Liège, Ljubljana, Milan, Montpellier, Paris, Porto, The Hague, Turin, Utrecht and Venice).



Figure 5. Impact of urban food waste policies analysed on the SDGs (in brackets we reported the number of policies addressing each SDG). The size of each block represents the number of urban food waste policy initiatives that contribute to each SDG. The number is also reported in brackets.

4. Discussion

The present study presents a first framework to categorise policies and initiatives addressing food waste at the urban level. One of the main findings is that the scientific literature on the topic is still limited, despite cities having proved to be key actors in the food system transformation. Therefore, the review of the grey literature and of leading practices in tackling urban food waste complemented the results from the literature. The overall analysis allowed us to identify the three dimensions building the framework, i.e., types of policies and interventions, areas of interventions and actors, and an extensive list of examples for each dimension. The resulting framework can contribute to the research, implementation, and improvement of urban food waste policies at various levels. First of all, it aims to provide the research community as well as local policy makers with a tool to categorise the different policy areas where urban food waste policies intervent. In particular, the sample of policies and initiatives analysed enabled to screen the several areas of intervention activated by food waste policies or initiatives. This confirmed the importance of ensuring a multilevel, cross-sector approach when designing and implementing urban food waste policies.

Secondly, the framework can support the identification of the multiple connections among the actors involved in urban food waste policies. The mapping of all relevant stakeholders has confirmed the complexity of applying food waste interventions in urban contexts, where a wide range of subjects may be involved at various levels of the design and implementation of initiatives. Hence, the chosen approach reveals that a rigid classification and distinction among different policies risks being counterproductive at the urban level, as they involve various stakeholders and touch upon several areas of intervention.

Thirdly, the analysis of the links with the SDGs showed that the group of initiatives studied contributed overall to two thirds of the SDGs, showing the connections between urban food waste policies and the UN 2030 Agenda, and confirming the idea that empowering and engaging local actors is crucial to achieving the SDG targets [35–37]. The analysis showed that even those initiatives that seem to target very specific and sectoral aspects of food waste management can impact on other sustainability dimensions, from clean energy generation, to climate change action, to socio-economic empowerment. Although very few documents used the SDGs as a policy guidance for realising urban food waste policies, all initiatives mapped may have a direct or indirect impact on sustainability targets. While this reveals the need to increase efforts in raising awareness among policy makers and public officials about the importance of using the SDGs as a reference framework to guide urban policies, it also shows how crucial it is to develop assessment tools to properly monitor the impact that any urban policy can have on several targets of the Agenda 2030. In this sense, some international pilot projects such as the Monitoring Framework launched by the FAO [90], aimed at establishing a quantification methodology for food waste, may provide important tools for municipalities to effectively monitor food waste performances.

Against this backdrop, the framework could be applied by any municipality that wants to fully assess the complex dynamics in terms of range of policies and actors intervening in food waste policies that are displayed in Figure 4, as well as their link with the SDGs. For example, the use of this framework can help a city like Milan plan a policy to cut waste taxes for those private subjects who donate food surpluses to charities. It could also help public officials and researchers gain a better understanding of such policy. Drawing from the framework, the policy could be defined as a combination of market-based, food sharing and social protection policies. In addition, the framework could help identify all actors playing a potential role in this initiative, such as municipalities (i.e., the designers), retailers, restaurants, food markets, charities and the waste management utility (i.e., the implementers) and citizens (i.e., the beneficiaries). Moreover, such a policy would also entail awareness raising campaigns, and the framework would allow it to be categorised as information-based, as well as support the involvements of other potential actors (e.g., schools). Finally, such a policy could have several links with the UN Agenda targets, not only with SDG12, but also with poverty reduction (SDG1), zero hunger (SDG2), quality education (SDG4) through a broader knowledge of sustainable

lifestyles, and sustainable cities and communities (SDG11) with the reduction in the environmental impact of waste generation. This example confirms the complexity of the analysis of urban food waste policies and interventions, as well as the urgency of designing proper assessment tools to monitor the performance of cities.

5. Conclusions

Cities have repositioned themselves as crucial food security players at global level, and are increasingly required to do so due to the COVID19 pandemic, launching innovative policies and initiatives to fight against food waste. Three main conclusions can be drawn from this analysis. Firstly, it is crucial that cities (together with the research community) identify new tools and an assessment framework to evaluate the impact of urban food waste initiatives. The new proposed framework can be considered as a first attempt to improve understanding of food waste at the urban level and grasp the complex dynamics in order to design and implement interventions in a more coordinated and integrated manner, by increasing understanding of policies, specific areas of intervention and actors involved.

Secondly, it will be crucial to provide city officials with effective tools to collect data on urban food waste levels, to understand the scope of the problem and design action. This requires more coordination at European, national and local level to set up a common definition and quantification methodology, as well as important investments to recruit human and technical resources to map and monitor food waste at the urban level. In this sense, the newly adopted EU legislation [87] should bring more clarity and allow an easier comparative analysis across the EU, by also ensuring that legally binding targets can be proposed to reduce food waste across the Union by 2023. The recently launched Farm to Fork Strategy goes in this direction. New metrics are essential to compare several actions or interventions, such as those included in this framework, through a quantitative approach in order to understand their relevance and effectiveness (e.g., via multi-criteria analysis).

Thirdly, it is essential that urban food waste policies and interventions are fully aligned with the targets of the Agenda 2030. The research showed that cities seldom use the SDGs as a policy framework, thus limiting the evaluation of the impact of these interventions on the sustainability agenda. Therefore, it is important to raise more awareness among local policy makers, public officials, the private sector, and citizens to fully monitor the link and the impact of food waste on the SDGs. Finally, the adoption and testing of an effective framework to assess urban food waste policies and initiatives could be valuable for other non-European cities [33] that have started to tackle food waste and are struggling with similar types of hurdles and challenges. Although the framework has been created on a smaller sample of European cities, it contains dimensions and categories that are valuable for other cities, especially in the global North, hence the analysis could be easily expanded and replicated to other contexts.

Supplementary Materials: The following are available online at http://www.mdpi.com/2079-9276/9/99/s1, Table S1. List of reviewed publications. Table S2. Summary of the case studies analysed.

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