




Article

A Sum of Incidentals or a Structural Problem? The True Nature of Food Waste in the Metropolitan Region of Barcelona

Raquel Diaz-Ruiz ^{1,*}, Montserrat Costa-Font ², Feliu López-i-Gelats ^{1,3} and José M. Gil ¹

¹ Center for Agro-Food Economy and Development (CREDA-UPC-IRTA), C/Esteve Terrades 8, 08860 Castelldefels, Spain; feliu.lopez@uvic.cat (F.L.-i.-G.); chema.gil@upc.edu (J.M.G.)

² Land Economy, Environment and Society Research Group, Scotland's Rural College (SRUC), West Mains Road, Edinburgh EH9 3JG, UK; Montse.CostaFont@sruc.ac.uk

³ Chair of Agroecology and Food Systems, University of Vic - Central University of Catalonia, 08500 Vic, Spain

* Correspondence: raquel.diaz.ruiz@upc.edu; Tel.: +34-935-521-208

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Abstract: Addressing the generation of food waste is a major challenge nowadays. An increasing interest in studying food waste generation has emerged over the last decade. However, little attention has been devoted to understanding the root of the problem by carrying out a whole-supply-chain analysis and applying multidimensional approaches. The aim of this paper was to identify the causes of food waste in the metropolitan region of Barcelona along the food supply chain, considering the relevant stakeholders' perceptions. Moreover, we examined the circumstantial or structural nature of the identified causes. We conducted a qualitative study consisting of 24 in-depth interviews of key stakeholders in the region along the food supply chain from October 2014 to January 2015. The interviews were analyzed by content analysis, and the main results are presented here. We used a conceptual framework that differentiates among micro, meso, and macro causes to disentangle the nature of the causes. The results from this study show the great interest of regional stakeholders in the issue of the generation of food waste and provide a complete map of the causes of food waste in the metropolitan region. From our study, we advocate that food waste is not only a sum of incidentals but it a structural problem.

Keywords: food waste; stakeholders; causes; food supply chain; interviews; Barcelona metropolitan region

1. Introduction

Finding alternatives to develop more sustainable food systems is a major challenge that society is facing today. Multiple efforts are being devoted to better understand such food systems, and consequently, to develop more sustainable alternatives (e.g., [1–4]). In this context, food waste has emerged as one of the most relevant domains of the current unsustainability [5]. The estimates of the Food and Agricultural Organization of the United Nations (FAO) suggest that one-third of the food produced globally is being lost or wasted along the food supply chain [6]. In Europe, a recent estimation has indicated that 88 million tons of food are wasted annually [7]. The magnitude of the numbers has fostered wide and growing agreement regarding the necessity of urgently addressing the issue of food waste generation. The United Nations agreed in 2015, within the definition of its Sustainable Development Goals, to halve food waste and reduce food losses by 2030 [8]. In Europe, the European Union's (EU) recently approved Circular Economy Package has allocated a key role to food waste prevention and reduction [9].

The increasing awareness of the importance of the food waste challenge has grown in parallel with the number of publications devoted to better understanding this phenomenon, especially during

the last decade [10]. Such publications have been particularly focused on the consumption stage [11]. The research on food waste has been diverse. To date, the relevant publications have mainly been focused on understanding consumer behavior (e.g., [12–15]) or quantifying the generated volume of food waste (e.g., [16–18]) and its associated environmental or economic impact (e.g., [16,19–21]). However, there is still considerable room for advancement. Numerous gaps still prevail concerning the underlying factors of food waste generation [10,22]. Despite efforts to standardize food waste quantifications (e.g., the Food Loss and Waste protocol [23] and the Food Use for Social Innovation by Optimising Waste Prevention Strategies (FUSIONS) protocol [24]), there is still no single agreed-upon definition of food waste, neither internationally nor in Europe [22,25,26]. The discrepancies in the more adequate methodologies for undertaking the sound quantification of food waste make it difficult to compare results from different studies [10,26,27]. The complexity of the phenomenon suggests the necessity of taking a step back and examining the roots of the food waste phenomenon.

Despite the rapidly increasing body of literature dealing with the food waste issue, only a few studies have attempted to focus on analyzing where the roots of the problem lie, that is, the causes of the phenomenon. A great diversity of studies, ad hoc reports, papers, and books have been published in the last decade (see Table 1). They fundamentally employed secondary data to identify the causes of food waste at different geographical scales, ranging from worldwide to regional levels of analysis. Most of these studies used a partial view approach, that is, they included only specific stages of the supply chain in the analysis. On the other hand, those considering all the stages of the food supply chain dealt with secondary data. To our knowledge, there is only one study—by Göbel et al. [28]—that has used primary data, which was collected by means of expert interviews along the whole food supply chain in the region of North Rhine-Westphalia in Germany to examine the causes of food waste using whole-supply-chain analysis.

Table 1. Review of studies analyzing the causes of food waste.

References	Type of Document	Type of Data *	Geographical Scope	Farm	Industry	Wholesale	Retail	Consumption
WRAP et al., 2007 [29]	Report	1	United Kingdom (UK)					●
WRAP and Quested, 2009 [30]	Report	2	UK					●
Stuart, 2009 [31]	Book	2	Worldwide					●
Parfitt et al., 2010 [32]	Paper	2	Worldwide	●	●		●	●
Bio Intelligence Service, 2010 [33]	Report	2	Europe		●		●	●
Mena et al., 2011 [34]	Paper	1	UK and Spain	●			●	
HISPACOOB, 2012 [35]	Report	1	Spain					●
ARC and UAB, 2011 [36]	Report	1 + 2	Catalonia, Spain				●	●
Buzby and Hyman, 2012 [16]	Paper	2	United States	●	●		●	●
Beretta et al., 2013 [37]	Paper	1	Switzerland	●			●	
European Union, 2013 [38]	Report	2	Europe					●
Stefan et al., 2013 [39]	Paper	1	Romania					●
FAO, 2013 [40]	Report	1 + 2	World	●	●		●	
Garrone et al., 2014 [41]	Paper	1	Italy	●	●			
Magrama, 2014a [42]	Report	1	Spain	●				
Magrama, 2014b [43]	Report	1	Spain					●
Magrama, 2014c [44]	Report	1	Spain		●			
Mena et al., 2014 [45]	Paper	1	UK	●	●		●	
HLPE, 2014 [22]	Report	2	Worldwide	●	●	●	●	●
Montagut and Gascón, 2014 [46]	Book	2	Worldwide	●				
Parizeau et al., 2015 [47]	Paper	1	Guelph, Ontario, Canada					●
Göbel et al., 2015 [28]	Paper	1	North Rhine-Westphalia, Germany	●	●	●	●	●
Derqui et al., 2016 [48]	Paper	1	Spain					●
Thyberg and Tonjes, 2016 [49]	Paper	2	Worldwide	●	●	●	●	●
Canali et al., 2017 [50]	Paper	2	Worldwide	●	●	●	●	●
Hebrok and Boks, 2017 [51]	Paper	2	Worldwide					●

Note: * 1 means primary data, and 2 means secondary data.

As shown in Table 1, the great majority of the existing works dealing with the causes of food waste partially examine the issue. Thus, there is a need to implement approaches better suited to capture the inherent complexity of the occurrence of food waste. In this context, there is also a growing concern among the leading organizations about the importance of implementing multidimensional and whole-supply-chain approaches to more adequately examine the food waste phenomenon [5,22,46,52–56].

The geographical scope of the analysis is also relevant when addressing food waste. The scale determines the governance of all the agents implicated in the design of alternatives to the identified problems [57]. Global recipes are often disseminated to address food waste at different levels: the international, European, country-specific, regional, or municipal level. Nevertheless, recent evidence has suggested that cultural and regional characteristics could be, to a certain extent, key determinants of food waste generation [58,59]. In this context, the Resource Centres on Urban Agriculture and Food Security (RUAF) Foundation and FAO have advocated for the use of City Regions Food Systems as an appropriate approach that provides a valuable and useful scope for understanding food waste occurrence within a food system [5,60]. Moreover, as a result of the Milan Urban Food Urban Pact, food waste has become one of the priority areas for the sustainability of cities [61].

Thus, considering both the lack of multidimensional and whole-supply-chain approaches and the key role regions will have to play in the fight against food waste, here, we aimed to fill this void by conducting a holistic analysis of the causes of food waste in a particular region, the metropolitan region of Barcelona. The objective of this work was twofold: first, to identify the causes of food waste in the metropolitan region of Barcelona; and second, to examine the circumstantial or structural nature of the causes of the food waste. In doing so, we examined the perceptions of key stakeholders along the food supply chain in the metropolitan region of Barcelona through in-depth interviews. All the interviews were analyzed by content analysis, and the main causes identified by the regional stakeholders were classified according to a specific framework based upon the previous literature.

2. The Case Study: The Metropolitan Region of Barcelona

The metropolitan region of Barcelona is one of the most populated areas of Europe, located on the Mediterranean coast in the autonomous community of Catalonia, in Spain. It has a population of more than 4.8 million people in an area of 3236 km² [62]. The agri-food sector is highly relevant in the metropolitan region through all stages of the food supply chain. A peri-urban agricultural park is located in the region, with more than 2800 producers (Baix Llobregat Agricultural Park). The land allocated to agricultural production is not very large, yet, the agricultural park has contributed to preserving the farming sector in the peri-urban environment [63]. The industrial agri-food sector is the second most important economic sector in Catalonia. Multiple national and international food companies' central headquarters are located in the region [64]. The Barcelona central wholesale market is one of the main food clusters in southwestern Europe. Moreover, Barcelona city is known for its hospitality sector's broad offerings and fresh food local markets. Regarding waste generation, the food industry is the major generator of tons of industrial waste, which represented 25% of the total industrial waste in Catalonia in 2013 [65]. At the municipal level, 475 kg of waste per person per year was collected in 2013—bio-waste was the main contributor [66].

During recent years, different initiatives to prevent and reduce food waste have been started in Spain. They are largely led by grassroots movements and NGOs (e.g., *“Yo no desperdicio”* [67] and *“No tires la comida”* [68]), but also by other different agents, such as public bodies (e.g., *“Mas alimento menos desperdicio”* [69] and *“Som gent de profit”* [70]) and private companies (e.g., *“La alimentación no tiene desperdicio, aprovechala”* [71]). However, it should be noted that, in Spain, the authority to regulate waste and food has been transferred to autonomous regions since the 1980s. Consequently, each autonomous region might show a different level of engagement in the food waste challenge. Catalonia

concentrates most of its initiatives for food waste prevention and reduction in the metropolitan region in particular.

In spite of this growing interest, the scientific literature on food waste in Spain is scarce (e.g., recent publications [34,48,72]). The dissemination of research results has been primarily conducted through outreach documents and reports. In any case, most of the studies have been focused on one single stage of the food supply chain—whether primary production [42], the food industry [44], the supplier–retailer interface [34], food distribution and food service [43,48], or the consumption stage [35,59,73]. In Catalonia, a specific quantification of food waste from distribution to households was carried out in 2010 [36]. Additionally, most of the studies have used different food waste conceptual frameworks and scopes, if any, which makes it difficult to make comparisons between them or even with other studies abroad. In the metropolitan region of Barcelona, there has been no specific study on food waste, apart from studies addressed to better understand consumers' behavior in relation to food waste [74,75].

3. Conceptual Framework to Distinguish Structural and Circumstantial Causes

According to the High Level Panel of Experts (HLPE) on Food Security and Nutrition [22], the causes of food waste are complex and can be classified into three levels—micro, meso, and macro—according to their complexity and relationship with other drivers, as follows:

- Micro causes: specific causes of food waste occurring at each stage of the food supply chain due to the actions or inactions of agents at the same stage. They are not necessarily linked to other causes. Micro causes are not influenced by the behavior of agents at other stages.
- Meso causes: secondary or structural causes that can be found in another stage. They occur because of the interaction between agents or because of the existing infrastructures where food is produced, distributed, sold, and so forth.
- Macro causes: those rooted in the food system dynamics as a whole. These are systemic issues affecting the two previous levels (micro and meso), such as the policy conditions in terms of regulation or the functioning of the food system; that is, “macro causes favor the emergence of all the other causes of food loss and waste” [22].

Distinguishing between these three groups of causes is useful to evaluate the magnitude and the nature of the problem posed by food waste in each case. This classification helps to differentiate between the circumstantial nature of the causes of food waste, aligned with the micro causes, and the structural nature of the causes of food waste, aligned with the meso and macro causes.

Alternative literature has suggested other classifications as well, to disentangle the true nature of the different causes. In this study, we will use such classifications to better describe the identified causes. Thus, the causes of food waste within each level (micro, meso, and macro) can be subdivided into four additional categories: (1) technological causes [50,76], which are related to technical inefficiencies or failures at different stages of the food supply chain; (2) economic and business management causes [28,49,50,76], linked to the business strategies of the different actors along the food chain: contract standards, operational actions, and the commercial relationships of the stakeholders in the food chain; (3) regulatory and policy causes [28,50,76], which are rooted in norms and regulations that affect the food sector, such as urban waste or food regulations, which may affect food waste generation; and (4) appreciation and enhancement causes [28,49,76] (also known as values, information, and skills in other studies), which are related to awareness, information, or specific habits. This classification helps to identify the domains where food waste occurs and to anticipate the skills (profiles) and contexts that would be required to solve such drivers. These four domains were proposed by Canali et al. [50] based on consultations with experts and an extensive literature review. Moreover, a similar classification is used in other publications such as Göbel et al. [28] or Thyberg and Tonjes [49]. Finally, the specific stages of the food supply chain where the identified causes apply are also relevant for analyzing the food waste conundrum.

4. Materials and Methods

To achieve the objectives of this research, we conducted qualitative research to map the causes of the food waste along the food supply chain and to understand the perceptions of stakeholders regarding food waste. In-depth interviews of members of a panel of key stakeholders from the case study region (the metropolitan region of Barcelona) were implemented. Thereafter, we analyzed the results considering the conceptual framework described above. We explain the procedure of the interviews and the characteristics of the panel below.

4.1. In-Depth Interview Procedure

Semi-structured interviews were conducted of 24 key stakeholders along the food supply chain in the metropolitan region of Barcelona to elicit their perceptions on food waste and its causes along the food supply chain and at all stages. Semi-structured interviews—in which the researcher makes use of an interview guide, which is not fixed—are a useful tool for gathering in-depth insights. Researchers can modify the question flow and adapt it to the answers of the interviewee, who, on the other hand, answers all the questions without any limitation. This method is especially appropriate in exploratory studies. One of its weaknesses, however, is that it is time consuming, and hence, costly [77].

The interview guide included different questions about the importance of food waste, the interviewee's interest in the prevention of food waste, an evaluation of food waste conceptual frameworks, the interviewee's knowledge about the current volume of food waste along the food supply chain, the allocation of responsibilities for the volume of generated food waste, and the causes of the generation of the volume of food waste along the food supply chain. The interview also included questions about possible solutions to food waste, which were discussed at the end of the interview. This part of the interview was beyond the scope of this paper and is therefore not included. The survey focused on the situation in the metropolitan region of Barcelona. Due to the maturity of the food waste phenomenon, we did not restrict the concept of food waste to a specific definition; instead, we discussed it in a very broad sense (food waste was understood as food that had been thrown away). It is worth noting that all the stakeholders participated in the identification of the causes at different stages of the supply chain regardless of their field of activity.

The interviews were conducted from October 2014 to January 2015. They lasted from 45 to 100 min and were recorded and verbatim transcribed. Subsequently, the meaning of the texts was examined through qualitative content analysis. This consisted of thoroughly analyzing the transcripts of each participant to identify the themes and topics. This is an iterative process of analysis and classification and re-classification into broader categories. The concepts are coded and classified according to the discussion guide, tendencies, and observed patterns [77,78]. In our case, we analyzed each interview, identifying the causes of food waste and the stakeholders' perception about food waste. After having an extensive list of causes from each participant, broader categories of causes arose, and we followed the process of classification multiple times until we had a complete map of the causes. Thereafter, we classified and summarized the causes following three criteria: (1) the level (micro, meso, and macro); (2) the nature (technological, economic and business management, regulatory and policy, and appreciation and enhancement); and (3) the stages of the food chain involved.

4.2. Sampling

The main objective of the study, to map the causes of food waste, required us to capture the diversity of perspectives rather than identifying the importance of each identified driver. Hence, having as diverse a panel of stakeholders as possible was key. We used the intentional sampling technique, which is commonly used in qualitative studies where experts' judgments are necessary. It is a non-probabilistic method in which the selection of the participants is based on subjective criterion related to the aim of the study [79]. The value of each respondent is related to his/her particular understanding of the phenomenon studied; not on his/her representativity. Therefore, more than

the number of interviews, it was important that the sample represents all the perspectives about the phenomenon. We used the snowball technique; individuals from initial interviews identified new participants. The sampling was finished when the interviewees did not offer alternative answers in explaining the phenomenon.

We obtained a final sample of 24 key stakeholders from along the food supply chain and with different profiles (see Table 2). The sample included a total of 4 representatives from the primary production sector (a regional public body, a metropolitan body, a farmers' organization, and an ecologic farmers' cooperative), 2 members of the food industry (a representative from a food industry association and a food industry group), 2 from the wholesale market (1 wholesale central market body and a small wholesaler), 4 distribution participants (3 from supermarkets of different sizes and 1 local food markets organization), 2 from consumer associations, 2 from redistribution entities (a food bank and a local food pantry), 1 from a social enterprise with a gleaning redistribution and a food transformation model, 1 expert on food waste from the university, 1 environmental NGO, 1 from a freegans organization, 3 representatives of regional public bodies (in food safety, waste management, and consumption), and 1 from the municipality environmental department.

Table 2. Sample characteristics.

Organization (role)	Food supply chain	Farm	Processing	Wholesale	Retail	Redistribution	Consumers	Education
Social Enterprise "rescue" food (managerial position)	●							
Food safety regional body (managerial position)	●							
Waste management regional body (managerial position)	●							
Environmental municipality (technician position)	●							
Regional consumption body (technician position)	●							
Primary production metropolitan body (managerial position)		●						
Agri-food regional body (managerial position)		●						
Farmers' organization (representative and farmer)		●						
Farmers' ecologic cooperative (managerial position and producer)		●						
Industry association (food waste project manager)			●					
Industry (environmental department technician position)			●					
Wholesaler central market body (managerial position)				●				
Small wholesaler (managerial position)				●				
Retailer (Social Responsibility and Environment department position)					●			
Retailer (institutional relationship department position)					●			
Retailer (environmental department managerial position)					●			
Local Markets body (managerial position)					●			
Charity Food pantry (managerial position)						●		
Charity Food Bank (project manager)						●		
Local Popular dinning "freegans" (activist and member of the group)							●	
Consumer association (managerial position)							●	
Consumer association (managerial position)							●	
Expert academia (waste and food waste researcher)								●
Environmental NGO (project managers and managerial position)								●

5. Results and Discussion

The in-depth interviews were analyzed through exhaustive content analysis to get insights into the regional stakeholders' perceptions on food waste, their knowledge about the volume of food waste, their views regarding who is responsible for its generation, and their food waste conceptualization. Furthermore, we collected all the potential causes of food waste that emerged during the interviews using the HLPE framework (micro, meso, and macro) [22]. In the following section, we show the main results and compare them with the findings in the previous literature.

5.1. Stakeholders' Perceptions

The stakeholders showed interest in the problem of food waste despite the fact that it was not a priority in their daily activities. Those involved directly in the food supply chain (food

operators) prioritized their own business management, logistics, knowledge of consumer demand, and modernization over food waste minimization. For the rest of the stakeholders—institutions, consumers' associations, and so forth—food waste was becoming relevant as a waste management and food security issue. All the participants demonstrated an increasing interest in the food waste phenomena during the last several years, especially due to the economic crisis and its visible impact on society. It is worth mentioning that the impact of the Spanish economic crisis, which started in 2008, was visible in society at the time of the interviews in 2015 (e.g., an unemployment rate of 22% and, an AROPE rate of 28.6 [80]). The AROPE rate represents people at risk of poverty or social exclusion, which is considered to be the case when they face at least three risks out of a battery of nine, such as struggling to feed themselves adequately, being late on payments on their home, or being unable to heat their homes in winter [80].

Despite their recognition of the great importance of the problem, we observed a generalized lack of knowledge about the volume of food waste along the food supply chain. The participants were reluctant to quantify the magnitude of the problem either in volume or as a percentage. On the contrary, they were more open to discussing who was responsible for the volume of food waste. The participants recognized that the responsibility could not be assigned to a single food supply chain agent, but rather it should be distributed among all agents. In general, they attributed the responsibility for the generated food waste in every stage to the main stakeholder in that stage. This was true in all food supply stages except for at the farm level, where a shared responsibility among farmers, retailers, and industry agents was associated with farm food waste volumes. Considering the entire food value chain, farmers were seen as the least responsible for the volume of generated food waste. Moreover, public institutions were also seen as having a certain responsibility for the volume of food waste, although they are not directly involved with food handling. The key role of public bodies in the matter of food waste was also identified in the Flash Eurobarometer 425, when asking consumers about the role of different actors in preventing food waste [81]. The shared responsibility of the finding is important and reinforces HLPE's idea [22] of distinguishing between the stage where the volume of food waste is found and the responsibilities associated with that volume.

It is important to note that we did not find a single conceptual framework of food waste within our panel of stakeholders. Many different words were used when referring to food waste and food loss, including concepts such as surplus, wastage, byproducts, and so on. Despite the diversity of concepts and perspectives, all of the stakeholders had in mind the same broad idea about what food waste was in order to express their perceptions about the causes. The general understanding of food waste was that it is food intended for human consumption that was not ultimately used for this purpose. Finding different perspectives and vocabularies is common in the food waste debate, as the previous literature has also shown [27,82,83]. This might be caused by multiple factors such as the novelty of the topic and the coexistence of multiple perspectives. The food waste debate has emerged from different fields—food security, waste management, and nutrition, among others—which involve, per se, multiple conceptual approaches.

5.2. Causes of Food Waste

The interviews allowed us to identify an extensive map of causes of food waste in the metropolitan region of Barcelona. Despite the novelty of the food waste debate to some of the stakeholders, they demonstrated a great deal of knowledge of and fluidity in explaining the dynamics in the regional food system in the region that ultimately provoked the throwing away of food, no matter how they named it. They explained multiple circumstances and behaviors that have been synthesized and classified according to the conceptual framework explained in Section 2. We classified the causes into three main groups, micro, meso, and macro causes. In the following sections, each group is explained in more detail by subdividing the causes according to their nature (technological, economic and business, regulatory and policy, and appreciation and enhancement) and the stage or stages of the food supply chain in which the cause was identified to apply (farm, wholesaler market, industry,

retail, or consumption). We observed the great interest of the stakeholders in food redistribution and all the difficulties related to redistributing food not sold through marketing channels. Consequently, we included an additional section to explain the issue of food redistribution below. We compare the causes identified in our case study with the causes in previous studies. Each table identifies whether the cause from the metropolitan region has been found before by providing its reference.

5.2.1. Micro Causes

The stakeholders described different incidentals occurring at different stages that can be identified as micro causes. Most of them were located downstream, at the wholesaler market, the food industry, the retailers, and households. We classified the causes as technological, economic and business and appreciation- and enhancement-oriented (see Table 3).

Technological

A set of technological-related causes were identified in different stages without any connection to the higher-level dynamics. Most of them have been extensively described in the previous literature as shown in Table 3. Technical inefficiencies during the processing and manipulation of food products take place at different stages of the food chain. The interviewees highlighted that in the wholesale market, the lack of a proper preservation and storage system could influence food waste generation. This is a commonly mentioned cause of food waste in the literature [16,32–34,37]. A second cause of food waste was related to logistics, mainly when food products have to be transported over long distances. In such circumstances, the likelihood of unexpected situations and handling problems that lead to food waste may increase, which was also cited in the work of Canali et al. [50] and HLPE [22]. In the food industry, the stakeholders identified food packaging as a key issue, referring to either mistakes with the labeling or its poor quality. Packaging failures can result in withdrawal of products that are unable to be sold or be consumed. Such failures were identified in the industry during transportation and at the retail stage. These difficulties with packaging have been extensively documented in the literature [22,32,34,37,41,45,50,84]. The improper use of food technology, mentioned also in Buzby et al. [85] and Gustavsson et al. [6], was relevant to our stakeholders as well. The lack of food waste prevention in manufacturing processes was also raised as an issue, that is, not reintroducing to the manufacturing line, shrinkages and surpluses that may occur during the manufacturing of food.

Economic and Business Management

Concerning the commercial dynamics, the stakeholders pinpointed the drivers of food waste at the food industry, retail, and household levels. The lack of sales planning, which is widely cited in previous studies [6,22,32–34,50], was also identified as one of the main drivers of food waste at the wholesale market and retail levels. The agents at these stages were acknowledged to have the tendency to work on a daily basis. Moreover, possible mistakes when ordering products to be sold can create food waste at the selling points. Within the industry, not using the best available techniques without entailing excessive costs, was mentioned as a driver of the industry's food waste.

At the retail level, the stakeholders differentiated between the dynamics of small stores and those of supermarkets and hypermarkets. In small stores, the size of the business and the provisioning system used (mainly purchases at the wholesale market) were singled out as possible drivers of food waste. For instance, some interviewees explained a common practice among small store managers, who buy products on promotion at the wholesaler—usually an offer with a very short perishability timespan—which increases the likelihood of having the food spoil later on at the store. This is not the case with supermarkets, in which the provisioning system is more systematized. However, the contact with the client is less direct in supermarkets than in small stores, which creates specific difficulties with relation to food waste. For instance, some stakeholders explained that supermarkets lack a good mechanism for adapting a retailer's supply to consumer demand patterns, which is a possible driver of food waste. This is crucial to avoid disappointing sales expectations and to encourage the successful

acceptance of a new product release or promotion, the failure of which could result in large quantities of food waste in the store at a given moment. Moreover, in supermarkets, fresh food, especially fruits and vegetables, are visible and accessible to consumers who sometimes incorrectly manipulate them. This manipulation might result in damage to the fruits and vegetables, which must then be removed from sale.

Appreciation and Enhancement

A generalized lack of knowledge and awareness regarding food waste among the different actors of the food supply chain was frequently pointed out during the interviews. On the commercial side of the supply chain, the interviewees highlighted that business strategies are more focused on economic profits than on environmental or social considerations. Nevertheless, the issue of food waste is gaining interest in the food sector, and this situation could potentially change in the near future through corporate social responsibility actions. The interviewees noted a widespread lack of awareness about the volume each actor generates in their own activity (from processors to households), which was also pointed out by Parizeau et al. [47]. The stakeholders offered different arguments to explain such circumstances. Some of them believed that waste management was not identified as a priority in company strategies, and historically, it has been very difficult to quantify it correctly. Others believed that companies seem to be reluctant to work on waste reduction.

Consumers were also singled out for their lack of knowledge regarding food waste and the poor management of food at home, which has been extensively covered in previous studies (e.g., [16,22,32,33]). The interviewees underlined the existence of myths about food safety that influence consumers' management of food. They claimed that consumers simply throw away what they think it is not good to eat. In this context, the lack of knowledge about expiration and best before dates was the main reason for the generation of food waste in the household. Furthermore, the stakeholders mentioned some incorrect purchasing habits (e.g., purchases oriented to promotions, shopping routines and patterns, and bad purchasing planning) and cooking habits (e.g., cooking more quantity than needed, damaging food while cooking, and the lack of knowledge on how to preserve food and leftovers), together with a possible lack of interest in cooking properly as some of the more significant causes of food waste in the home.

Table 3. Micro causes of food waste.

		F	W	I	R	C
<i>Technological</i>	– Insufficient preservation systems [16,32–34,37]		●			
	– Problems with transportation and handling [22,50]		●	●	●	
	– Mistakes in labeling			●		
	– Difficulties re-introducing surpluses in the manufacturing line [6,85]			●		
	– Poor quality of packaging [22,32,34,37,41,45,50,84]			●	●	
<i>Economic and business</i>	– Errors during purchasing within companies		●		●	
	– Lack of sales planning [6,22,32–34,50]		●		●	
	– Not using the best available techniques			●		
	– Lack of adaptability to the consumer demand pattern				●	
	– Response time and capability of selling food about to expire				●	
	– Failed sales expectations				●	●
	– Negative response of clients to a new promotion				●	●
– Clients incorrectly manipulating food at the store				●	●	
<i>Appreciation and enhancement</i>	– Primacy of economic profits		●	●	●	
	– Difficulties of quantifying food waste		●	●	●	
	– Waste management not being a priority in the business sector		●	●	●	
	– Companies' daily dynamics making it difficult to be aware of the inefficiencies			●	●	
	– Companies' reluctance to work on waste reduction			●	●	
	– Lack of awareness of the volume of food waste [47]			●	●	●
	– Lack of knowledge of consumers (food, date labeling)					●
– Poor management of food at home [16,22,32,33]					●	

Note: F: farm; W: wholesaler market; I: industry; R: retail (supermarkets, small stores); and C: consumption. Causes identified in previous literature are identified accordingly.

5.2.2. Meso Causes

We identified different causes linked to certain norms and regulations, business management, the forecast of agriculture, and lifestyle in general (see Table 4).

Technological

Food system infrastructures can have an important influence on other drivers that increase the likelihood of food waste generation. The difficulties and inefficiencies of the cold supply chain infrastructure were mentioned as issues in guaranteeing the preservation of food and food safety, which might result in food waste. This was also found previously in [22,32–34,50].

Economic and Business Management

The interviewees mentioned several business practices in the supply chain that can generate food waste in other stages. Most of these were related to retailers' practices, affecting farmers and wholesalers. One that was frequently mentioned was last minute cancellations, which is also explained in the previous literature [33,50,84]. Another bad practice was the quality and commercial requirements (not standards regulations) that retailers demand of farmers and the food industries. This has been identified previously in other studies [32,33]. These excessive requirements also influence food waste in other stages, such as the wholesale market, supermarkets, and small stores, for example, clients not buying small fruits, because they are difficult to manipulate, wash, peel, etc. Moreover, some stakeholders mentioned a specific situation, which does not happen very often, in which the response time of insurance companies in cases of truck accidents could also increase the likelihood of food being wasted.

At the supermarket level, the interviewees highlighted that the tendency of retailers to keep as much of a variety of products as possible until the very end of the day can be one important cause of food waste in stores. Mena et al. [34] and HLPE [22] have explained this in their publications.

Although farmers around the metropolitan region of Barcelona are not the main food suppliers to the region, primary production received great attention from our stakeholders. As in Canali et al. [50], it seems that an important driver of food waste at the farm sector is the lack of agricultural production planning. The stakeholders believed that farmers in the region have an individualist approach, following the so-called "pendulum law". Farmers decide what to cultivate next season depending on the existing prices of the current one. Therefore, for different specific produce, scarce seasons with high prices and low food waste are followed by seasons characterized by excess supply, lower prices, and higher volumes of food waste.

Regional idiosyncrasies were also found to be a potential determinant of farms' food waste. There are no transformation alternatives in the metropolitan region in the case of production surpluses. Some interviewees specified that it is hard to establish a transformation infrastructure and compete with regions that are specialized in that. Moreover, they highlighted a clear lack of cooperation among producers, which is also mentioned in HLPE, [22]. The individualism that characterizes farmers in the metropolitan region of Barcelona makes it difficult to come to agreements, organize farmers within a farmer's cooperative, and find alternative marketing channels when traditional markets are saturated. Furthermore, even in the case where some light cooperative behavior exists, farmers do not strictly market their products through the cooperative. Some of the stakeholders hypothesized that this can be incentivized somehow by the proximity to the big central wholesale market in Barcelona, which constitutes an advantage and a disadvantage at the same time. The advantage is that farmers can quickly respond to demand shocks at the wholesale market, attracted by higher price. However, passing over the cooperative debilitates its structure and ability to find alternatives in a surplus/low-prices scenario.

Regulation and Policy

Specific standards and regulations were discussed during the interviews. The existence of certain rules or standards among food operators on the quality or the aesthetics and sizes of produce (e.g., EU No 543/2011)—which, indeed, are widely described in previous studies [16,28,37,41,50]—induce food waste at different stages of the food supply. The interviewees also cited the potential food waste occurring due to the expiration date norms. Apart from the specific regulations, some conventions in the food industry generate large volumes of food waste according to our stakeholders. They referred to the so-called “one-third rule”, which divides the product’s expiration date (also applied to “best before” dates) into three parts. Each part is allocated to a stage: the industry, the supermarket, and consumers’ households. Therefore, the first third of the date notes the maximum date that the product can be commercialized from the industry to other agents. The second third of the date is the time the product can be kept on a supermarket’s shelves. Finally, the last third of the expiry or best before date margin is the date until which the product can be kept in consumers’ households. This means that if a product is about to pass the first third of its date in the industry, it will be thrown away instead of being sold to a distributor, and the same will take place in the supermarkets. Similar behaviors have been identified in Garrone et al. [41] and Qusted et al. [84].

Appreciation and Enhancement

At the household level, the family structure was mentioned as one potential driver of food waste generation (e.g., having kids or working hours), as described in Parfitt et al. [32] and Parizeau et al. [47]. The stakeholders also mentioned that the percentage of the family expenditure allocated to food purchasing has decreased considerably over the last few years. Therefore, food expenditure is not so relevant compared with other household expenses (in Spain, the percentage of family income allocated to buy food and beverages decreased from 48.7% in 1964 to 14% in 2017 [80]. and could be a possible cause of household food waste, which has also been raised in Canali et al. [50] and Parfitt et al. [32]. Lifestyle was also identified during the interviews as a driver of food waste. Lifestyle is not a single behavior, but rather a combination of habits and values that influences food waste generation [14].

Table 4. Meso causes of food waste.

		F	W	I	R	C
<i>T.</i>	– Difficulties of guaranteeing the cold chain [22,32–34,50]	●	●	●	●	
<i>Economic and business</i>	– Lack of transformation alternatives in the case of farm surpluses	●				
	– No agricultural planning (“Pendulum law”) [50]	●				
	– No selling forecast and strategy	●				
	– Absence of cooperation of farmers [22]	●				
	– Last minute cancelations [33,50,84]	●	●	●	●	
	– Quality and commercial requirements [32,33]	●		●	●	●
	– Response time of insurances		●			
<i>Reg.</i>	– Huge variety until the end of the day [22,34]				●	
	– Quality standards and regulations [28,37,41,50]	●	●	●	●	
	– Expiration date norms			●	●	●
	– “One-third rule” [41,84]			●	●	
<i>App.</i>	– Cosmetic standards and requirements [16,50]			●	●	
	– Family structure [32,47]					●
	– Percentage of the income invested in food [32,50]					●

Note: F: farm; W: wholesaler market; I: industry; R: retail (supermarkets, small stores); C: consumption; T.: technological; Reg.: regulatory and policy; and App.: appreciation and enhancement. Causes identified in previous literature are identified accordingly.

5.2.3. Macro Causes

We found quite a range of causes identified during the interviews that are classified as macro causes. They are mostly economic- and business management-oriented drivers, although regulatory-

and policy-related, and appreciation and enhancement drivers were also identified. All the actors of the food supply chain were involved in these drivers. Yet, farmers and households, the two extremes, were those who were mainly implicated in the macro causes we found (see Table 5).

Economic and Business Management

A recurring issue that emerged during the interviews was the supply–demand mismatch of fresh food as a major determinant of food waste at different levels of the food supply chain. The stakeholders noted the national overproduction of food, which was also identified in previous studies within other geographical scopes [6,37,41]. The interviewees pointed out the tendency to oversupply food in a highly competitive market. This results in the payment of lower prices to producers that often do not even cover the costs of production. Thus, agricultural products are not harvested, a problem also shown in [6,50,85].

Moreover, some of the stakeholders pointed out that production and marketing models could also have a significant influence on the volume and the type of food waste that is generated. At the production stage, they suggested differentiating between two production models, the industrial agricultural model and the organic production model. The former was seen as a generator of significant waste volume, whereas the latter faces other problems, such as pest control or the marketing of the produce. As regards the marketing model, the structure and composition of the food supply chain could benefit or complicate the distribution of products that are about to expire. At the consumer stage, some stakeholders highlighted the purchasing options of consumers as a possible driver of food waste. They specified that, although consumers have lost purchasing options in some distribution models, the availability of stores has increased, so it is easier to buy food products at any time.

We have already identified the lack of agricultural planning as a meso cause of food waste. However, the interviewees mentioned the difficulties for farmers of forecasting their production due to factors beyond their control, not only in the metropolitan region. Fresh perishable food production is highly variable and depends on uncontrollable climate conditions—good climatic conditions could lead to excess supply and food waste. Furthermore, it was pointed out that farmers operate in a global market where geopolitics (e.g., Russian veto) and food safety crises (e.g., cucumber scandal) could also have a huge impact on food waste.

Regulatory and Policy

Some stakeholders noted the influence that policy decisions could have on food waste generation. This is also supported by the European Court of Auditors in their special report on “*Combating Food Waste: an opportunity for the EU to improve the resource-efficiency of the food supply chain*” [86]. In particular, some interviewees expressed their concern regarding certain regulations that promote the perfection of the external appearance and freshness of food. Consistent with previous studies [16,41,50], the members of our panel specified that excessive quality, size, and aesthetic standards induce food waste along the food supply chain. However, there was not a clear consensus about who is responsible for fixing such standards. Some referred to the ultimate and implicit consumer quality requirements, others held retailers responsible, and others considered that there is a shared responsibility influenced by the dynamics of the food system. Food safety standards and food labeling rules were also mentioned during the interviews. The stakeholders pointed out that a possible excessive implementation of these rules could lead to food waste generation. They also cited certain regulations not being clear and leaving space for misinterpretations. Some examples provided were the expiration or selling dates included in labels or the misinterpretations of animal byproduct flexibility on the interpretation of its categories (e.g., Regulation (EC) No 1069/2009).

Appreciation and Enhancement

The interviewees recurrently mentioned the importance of the knowledge and awareness of different agents about food waste and its impact. They perceived a certain lack of knowledge about

food waste as a potential resource to use, not only at the household level, but also along the whole supply chain. Specifically, they highlighted the limited awareness of stakeholders about the economic impact of food waste at the farm, wholesale, food industry, and retail levels. In relation to consumers, some stakeholders pointed out the level of importance citizens attached to food and diet as a possible driver of food waste. Parfitt et al. [32] and Stuart [31] have also described the role of food in consumer life and how this can have an influence on multiple behaviors, including food waste. In relation to valuing food, some stakeholders went one step further and linked the lack of social awareness and the involvement of every citizen with societal problems as a potential predictor of food waste.

Table 5. Macro causes of food waste.

	F	W	I	R	C	
<i>Economic and business</i>	- National overproduction [6,37,41]	●				
	- Low prices that do not cover the costs [6,50,85]	●				
	- Difficulties planning agriculture (variability, global market, cancellations)	●				
	- Market competitiveness	●	●	●	●	●
	- Production model of big volumes	●	●	●	●	
	- Food-supply-chain infrastructure	●	●	●	●	●
	- Difficulties introducing a product about to expire into the market	●	●	●	●	●
	- Consumer loss of buying options				●	●
	- Consumers' ability to buy food products at any time				●	●
	- Generalized oversupply in the distribution.				●	
<i>Reg.</i>	- Legislation promotes perfectness and freshness	●				
	- Excessive application of food safety standards and food labeling	●	●	●	●	
	- Misinterpretations of regulations	●	●	●	●	●
	- Quality, size, and aesthetic standards [16,41,50]	●	●	●	●	●
<i>App.</i>	- Lack of knowledge that food waste is a resource	●	●	●	●	●
	- No awareness of the economic impact of food waste	●	●	●	●	
	- No concern for the food value and the importance of diet and food [31,32]					●
	- Lack of social awareness and implication of citizens					●

Note: F: farm; W: wholesaler market; I: industry; R: retail (supermarkets, small stores); C: consumption; T.: technological; Reg.: regulatory and policy; and app.: Appreciation and enhancement. Causes identified in previous literature are identified accordingly.

5.2.4. Redistribution

The stakeholders showed a great interest in pointing out all sorts of difficulties that farmers, wholesalers, and supermarkets, as well as social entities, face when improving redistribution in the metropolitan region. Although the issue of food redistribution, as an acceptable alternative to food waste prevention and reduction, has been treated extensively in the literature [49,72,76,87,88], no previous study has referred to such difficulties (see Table 6).

At the farm and wholesaler levels, the main obstacles raised during the interviews were related to logistics (the cold storage infrastructure for perishable products and the time constraints to redistribute surpluses). Social entities, which in turn, would be the main beneficiaries of redistribution, also have some logistical problems related to their storage capacity (the lack of space in food pantries and cooling systems). Collecting and transporting such big quantities of fresh produce from farms was also mentioned, as well as the quality of the fresh produce donated by farmers and wholesalers. Sometimes, donations of surplus produce need some manipulation and processing to sort food that is adequate for human consumption from that which is not. This triage requires time and available space, which is scarce in food pantries. In Catalonia, there is a funded program at the Barcelona Food Bank to transform fruits into juices. However, it is difficult for industries, at specific moments in time, to absorb such big quantities of produce and transform it before it is spoiled. Some participants also highlighted the difficulties of engaging farmers in food donation.

The interviewees identified some of the difficulties of redistributing food from retailers (either big supermarkets or small stores) to social entities. First, there are logistical problems, as retailers might not have enough space to allocate to food that cannot be sold but should be donated. They also highlighted the difficulties caused by fresh produce and food sold loose (non-pre-packaged food), for instance, guaranteeing cold meat traceability and the best before dates of batches. Workers of supermarkets

were identified as key actors in the process of donation. Therefore, food safety precautions, poor information, and the protocols of supermarket workers could hinder food donations.

Finally, some of the participants highlighted some problems that social entities (food pantries and food banks) face with respect to receiving and redistributing food. The structure and composition of social entities, heavily depending on volunteers, limit the collection of food from supermarkets. Moreover, the collected food requires very fast redistribution to beneficiaries, which is not always possible due to the food pantries' service hours. The bureaucracy and regulations regarding food donation were also highlighted as causes of food waste. Bureaucratic difficulties make it easier for supermarkets to throw food away, rather than storing it, preparing the documentation, and donating it. Moreover, some stakeholders pointed out that there are false myths regarding food donation that create some perceived legal barriers that hinder donations from retail companies.

Table 6. Food redistribution difficulties.

		F	W	I	R	C	RR
<i>Te.</i>	– Farmers' difficulties regarding logistical capacities	●					
	– Charities or social dinners' difficulties in preserving fresh produce						●
	– Lack of space and facilities for keeping the food or the redistribution of it				●		●
<i>Econ.</i>	– Urgency to distribute in the case of farm surpluses	●					●
	– Manipulation of the donated food is needed						●
	– Difficulties and reluctance to implement or improve food donation processes and actions				●		
	– Volunteers' reliance on food charities				●		●
	– Difficulties of food recovery transportation				●		●
<i>Re.</i>	– Potential donors misunderstanding the regulations and bureaucracy				●		
<i>A.</i>	– Lack of interest in or knowledge of donations protocols		●	●	●		

Note: F: farm; W: wholesaler market; I: industry; R: retail (supermarkets, small stores); C: consumption; RR: redistribution; Te.: technological; Econ.: economic and business; Re.: regulatory and policy; and A.: appreciation and enhancement.

6. Conclusions

To achieve more sustainable food systems, it is crucial to better understand all the negative externalities affecting such systems. Food waste is one of the key components of the current unsustainability of food systems and further attention should be devoted to it. Despite the generalized interest in preventing and reducing the current volumes of food waste, we believe that the partial approaches employed to study the situation so far have possibly blurred global comprehension of the nature of the problem. This paper has aimed to contribute to fill this gap by undertaking a participatory, holistic, and whole supply chain analysis of the causes of food waste generation in the metropolitan region of Barcelona. We have carried out a qualitative assessment of the perception and the causes of food waste. An extensive map of the causes of food waste in the region is provided by structuring these, according to their level (micro, meso, macro) and their nature (technological, economic and business management, regulatory and policy, and appreciation and enhancement). By comparing our findings with previous literature, we identified common and specific causes of food waste.

We fulfilled the two main objectives of the paper. First, the relevant stakeholders' perceptions and the causes of food waste in the metropolitan region were identified and detailed. The stakeholders in this study showed a great interest in food waste prevention. The social dimension of the problem (the difficulties of access to food faced by some segments of the population) is a key factor for the stakeholders. Therefore, food redistribution was a key issue during interviews. Moreover, the farming level was focused upon substantially, despite the fact that the metropolitan region is not a high-food-producing region. We have provided a detailed map of the causes of food waste at different stages in the region. However, it should be noted that this is a qualitative study that was focused on obtaining a wide picture of food waste drivers by considering a heterogeneous panel of key stakeholders. Further research on the impact and the importance of each identified cause on the current food waste volume should be conducted. Despite that fact, the set of the causes identified should be

useful to policy bodies and agri-food operators in the region to work towards food waste prevention and reduction. Each agent can better identify the domain they could have more influence on.

Secondly, this paper has differentiated between the circumstantial and structural causes of food waste. The approach used in this study has allowed us to identify the complexity of the food waste conundrum. Food waste drivers are spread throughout different stages of the food supply chain, at different levels—micro, meso, and macro. We employed this distinction, in line with the HLPE [22], to disentangle the circumstantial or structural nature of food waste generation. We believe that the ways to approach and solve these two causes should be radically different. Incidental or circumstantial causes can be addressed with stage-focused approaches. However, structural causes require holistic approaches. Moreover, we classified each cause according to its nature (technological, economic and business management, regulatory and policy, and appreciation and enhancement) which is useful for both further research and policymakers to identify the domains to focus on, according to their skills and/or domains of action. Additionally, alternative classification of causes can be conducted, the two approaches used here were useful to understand the food waste phenomenon in the region. We recommend that future studies use them to disentangle the complexity of food waste.

The results from this study indicate that food waste is a structural problem, which is mainly linked to the current structure of the food supply chain and not to particular and isolated inefficiencies. Nevertheless, micro causes were also identified in relation to the existing inefficiencies of specific processes at specific stages of the food supply chain. Hence, partial and focused measures and approaches would be enough to solve these. We encourage agri-food operators and policymakers to address them. However, they should not forget the structural nature of the food waste problem. We found that the meso and macro causes mentioned by the stakeholders were mainly related to the food system dynamics and the existing interrelationships among the stakeholders in the food supply chain. They cannot be understood with partial views, and whole-supply-chain measures are needed. Overall, our results are in line with the partial results found in the literature. However, this study provides a more global perspective. This holistic approach should be followed in future research in order to corroborate our results in other geographical contexts.

Food waste is a complex issue affecting a large number of agents. Although food waste awareness has significantly increased during the last decade, the literature review undertaken in this study indicated a lack of studies on food waste causes that utilize whole-supply-chain approaches. It is true that in the area of consumer behavior, there is increasing research focused on understanding consumers' behavior and perceptions. However, consumers do not hold the ultimate responsibility for food waste. Our research contributes to the literature by providing a regional stakeholders' perspective about food waste along the food supply chain.

Finally, this study shows that a regional scope is an adequate scale by which to analyze the problem of food waste. We found specifications from the region that would not have been identified with a broader geographical scope (e.g., national, European, worldwide). Most of the studies on food waste published in peer-reviewed journals are located in the United States or the United Kingdom. Replicating more regional studies would contribute to the international debate, and we would be able to identify alternative policies more suited to the relevant territories and cultures.

Despite all the cautions that should be considered in interpreting the results of this study, we consider that this paper offers an innovative approach to analyze the food waste problem. Moreover, the findings could be of interest to both researchers and policymakers from the studied region and further afield.

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