Food waste in the catering and hospitality sector: generation factors and innovative practices

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Summary

The present study focuses on the problem of food waste and food losses which can be recorded throughout the production, supply and consumption chain, and the causes are varied. In this document an attempt is made to record some of the causes of waste production, as well as a review of the literature on their management, but specifically for the catering and hospitality sector. So after referring to the size of the problem and the effects it has on both the environmental and socio-economic level, a more focused study is made in the selected area, as it is one of the most important "feeders" of waste. This is followed by sections that provide a more detailed account of the possible causes that lead to food and feed loss or waste generation from these structures. Finally, there is a brief overview of innovative tools and approaches for food waste management and possible loss management practices, as well as indicative ways to reduce food waste production for the always catering and hospitality sector.

Keywords: Food losses, costs, effects, quantification, mitigation

1. Introduction

The main pillar in the latest policy-making worldwide is the targeted promotion and implementation of sustainable development, part of which is the mitigation of biodegradable waste, with the main emphasis being given to the prevention and avoidance of waste and food waste. Several studies on food waste have been conducted in this direction in recent years [1]. Food is a necessary commodity for human survival and its production requires significant resources. Therefore, reducing food waste leads to a reduction in their total financial and environmental production costs. Directive (2018/851) introduced a definition of "food waste" based on the general food law, while "asked" the European Commission to adopt legislation on the measurement of food waste. For the sake of brevity, the term food waste will henceforth refer to food waste and food waste, as defined by European legislation, which has been adopted by all EU Member States.
Food loss and waste is observed at all stages of the food supply chain, including the consumption stage [2]. The quantities of food losses and their waste, in industrialized-developed countries, are as high as in developing countries, but their distribution is different [3]. Moreover, the fact of increasing the production of food waste in the catering and hospitality sector is a frequent reference issue for the media, but has not yet received sufficient academic attention [4].

In total for the EU it is estimated that approximately 88 (± 14) million tones [5] of food waste are generated annually and the majority of this is produced at the consumer level [6]. Indicatively, approximately 46.5 (± 1.5) million tones in households and another 10.5 (± 1.5) million tons in the food consumption sector [5], with a total related cost of 143 billion euros [5]. In 2014, a study by the Alliance for the Reduction of Food Waste found that only 14.3% of food waste is "recycled", while the donation of edible leftover amounts to only 1.4% of the food produced. This means that 84.3% of the food produced ends up as waste [7].

Food waste in the catering and hospitality sector, is consumption of food outside the home / household [8]; [9], is recorded to account for about 12% of food waste generated [10]. Catering therefore accounts for a significant share of the total food waste that occurs in restaurants, fast food chains, cafes, canteens and dining halls, as well as event catering [11]; [12]. The trend for this type of consumption is increasing worldwide and in developed countries specifically an important factor that reinforces this trend is the increase in income and tourism [13].

It is understood that the reduction of food waste is a critical goal both nationally and internationally and due to its relationship with food sustainability [14] but also due to a variety of effects.

2. Impact of food losses and waste

Food-related wastes have serious implications in terms of sustainability [15]; [16] food safety [13], but also environmental issues. In this way, limited natural resources are exhausted, including water, soil components, energy, etc. At the same time, they increase greenhouse gas emissions, contributing to global warming and climate change [17]. A key concern, therefore,

is climate change [18], as all food waste has one thing in common, which is that they emit biogenic greenhouse gases. Every day, food waste transported to landfills accumulates, creating an anaerobic environment that increases greenhouse gas emissions by 50%, such as that of methane and carbon dioxide [19]. For Europe, food waste, according to Scherhaufer et al. [20] contribute about 15–16% to the environmental impact of the entire food supply chain and emit about 186 million tonnes of CO_2 equivalent per year.

At the same time, however, there are financial losses [21];[22], which result from food waste and are indicatively related to the cost of discarded raw materials, the cost of hourly wage of workers employed during collection or production energy costs for cooking as well as the cost of disposing of food waste. Estimates indicate that food waste corresponds to a loss of 23% of the cost of value purchased [23]. It is therefore found that when a quantity of food is discarded, it is "accompanied" by a hidden cost [19]. In a study by Leverenz et al. [24] the results revealed a negative trend between the number of visitors and the monetary equivalents of the reduced buffets per visitor. This finding means that the monetary equivalents per visitor decrease with an increasing number of visitors. The highest prices, at around EUR 1.7 ± 0.6 per visitor were documented at events with less than 100 guests, and events with more than 500 guests had buffet leftovers with a cash equivalent of around EUR 0.5 ± 0.1 per visitor [24]. At the same time it is noted that depending on the size of the business, companies can save between 5,000 and 70,000 euros in a year by reducing food waste [25].

In Australia, food waste costs the government $ 20 billion a year [26]. Food waste is also evident in developing countries such as India where about 45.35 million tonnes of fruit and vegetables are wasted annually and cost the country 440 billion [27]. However, this reinforces the paradoxical fact that although food service professionals are aware of the financial losses due to food waste and are willing to reduce waste, full customer satisfaction remains their primary priority rather than waste reduction [21].

In addition, reducing losses in the production and supply chain, according to studies developing "minimal damage" scenarios, could potentially save 78 Mha of arable land [28].In terms of increased use of natural resources [29] the ecological impact of food waste is very important and according to HORECA, for China it was found to be almost twice the size of its arable land [30]. In terms of water use, in 2007 the amount of water used worldwide for the agricultural production of waste products was estimated at 250 km^3, which is more than 38 times the footprint of water consumed by US households, or 3.6 times the water footprint of total US consumption [31]. Theoretically, around 20% of the environmental footprint in Europe could be reduced by completely eliminating avoidable food waste. According to Usubiaga et al.[32] in a similar study, it is estimated that more than 90% of the potential environmental benefits could be achieved by eliminating the amount of household food waste that was edible.

3. Losses and waste of food in catering and hospitality sector

Although food is lost or wasted throughout the food supply chain, many studies report that in developed countries, the highest rate of food loss / waste occurs at the consumption stage,[33];[34]. Hospitality industry has been widely discussed in this regard [35]; [36], as hotels are among the leaders in food waste generation. This is primarily attributed to the fact that only around 50% of the food in hotel buffets is consumed as hotels tend to overstock their buffets to ensure high level of guest satisfaction with regards to food service [37]. In Denmark, the hospitality industry contributes more than 50% of food waste-related waste [38] and 920,000 tons of food is wasted in the UK hospitality industry annually [39]. In Italy, restaurants produce about 21% of total food waste [40].

As described, many studies have focused on quantifying and avoiding food waste in the food service sector, but the literature has rarely dealt with food waste at events, such as individual services for private or business events and conferences [41]. A study conducted by Filimonau and De Coteau [4], combines the findings of studies on food waste in the hospitality sector and with the synthesis of previous findings, an attempt was made to create a framework for mitigating food waste, which could be taken into account by decision-makers working in the catering and hospitality sector.

The production of food waste in the catering and hospitality structures does not necessarily indicate bad operating practices, as it occurs for various reasons whether they can be avoided or not. There are various factors and status variables that affect the production of food waste in gastronomic kitchens [42]. However, understanding the causes of food waste generation in this area is important because effective food waste management requires a deeper assessment of the volume and origin of waste [43].

An attempt to review the main causes of waste generation according to the literature is presented in the following table 1.

Table 1. Causes of food waste before and after consumption	
Large portion sizes	[44];[45];[46]
The large size of serving trays and cans	[47]; [48]
The type of food served: restaurants serving meat-based menus created more grilled waste	[49]; [50]
Menu composition	[51]; [52]; [53]
The wide operating hours	[49]
Unspecified customer requirements and visitor characteristics	[19]; [42]
Overproduction, pre-prepared food and food spoilage	[54]; [55]
Overcooked or undercooked food or bad-tasting food	[56]; [57]
Unpredictable number of visitors	[21]; [58]; [59]
Insufficient cooperation of employees poor coordination of various operational areas	[58]; [60]
Organizing the kitchen supply chain: catering processes, kitchen management, preparation, technical equipment and guest features to more sophisticated approaches, such as regular staff training	[42]; [36]
Does the buffet serving style contribute to more food waste compared to the a la carte service style of	[61]; [57]; [58]
Customer habits and social patterns (culture, inventory management, and sensitivity to environmental issues)	[62]; [22]
Staff behavior / lack of training and experience / communication with suppliers and customers	[22]; [63]; [49]
When planning menus, do decision-making processes often depend on financial requirements, professional ethics, and the need to meet customer expectations	[21]; [64]
Food safety: The strong commitment of companies to various practices and quality assurance standards	[65]; [66]
Ordering and storing larger quantities than required, while others reported losses due to overproduction and spoilage of food product development and supplies	[54]; [22]
Unskilled pruning and cleaning of the former/ Skills levels of employees	[67]; [65]
Surplus food policy: internal consumption by unit employees or not	[22]
Personal preferences and excessive orders	[68]

4. Innovative approaches

II) General tools

At various stages of the supply chain, more and more often innovative tools related to the application of technology and the Internet, are used to improve food waste management (collection, transport, processing) [69]. One of the key elements of incremental innovation is that it leverages existing business processes and technology, so it is relatively less complex than radical innovation [2].

Applications and platforms have also been used to reduce waste generated in the early stages of the supply chain, such as Plantix, which is an application that helps farmers increase their productivity. The application uses image recognition to detect plant diseases, pests and deficiencies of soil nutrients that affect plant health and connects growers with the community of plant-based scientists and agricultural associations to find immediate solutions.

New applications and online platforms simplify the food donation process and can help improve perceptions of donations. Examples include Zero Percent, Food Cowboy and Copia, which facilitate the logistics process, such as product registration, communication between interested parties, receipt and delivery of donations. They also monitor donated food so that restaurants can benefit from tax cuts. In addition, because these occupational support systems must comply with legal restrictions, they are likely to assure food service professionals that health issues are adequately addressed.

End-of-day sales are not a recent innovation: they are common in supermarkets and some F&B retailers in Europe and the US to motivate customers to buy surplus products. For example, the British chain ITSU offers discounts on all food products 30 minutes before closing, both in its stores and restaurants. In this case, the technology simplifies an already available measure: there are now many software applications such as PareUp (USA), FoodLoop (Germany), Optimiam (France), Justoclic (France), MOGO (USA) or Foodzor (Belgium, exclusively for event caterers) that allow restaurants to list products

to be thrown away so that consumers can buy them, usually at a reduced price. At the same time, there are partnerships with companies that may sell their waste to environmentally conscious consumers at a discount using smartphone applications such as ResQ or To Good To Go [70]; [71]. Another alternative is the cooperation with charitable organizations, such as those that have food distribution initiatives [72]; [73]. Something similar happens and in Greece and mainly through the NGO "BOROUME".

In all of the above ways, it is clear that new information and communication technologies facilitate and increase the attractiveness of pre-existing but impractical or unpopular food waste reduction measures.

II) Food waste monitoring systems as a measure to mitigate their generation.

The hospitality sector is quite complex [4], and although there are some commonalities, the nuances of food waste are different for the profit and cost sectors Marthinsen et al. [36]. So many restaurant managers are now well aware of the need to prevent food waste, as well as the fact that it leads to financial benefits from saving food costs [65]. With this in mind, most restaurants try to manage waste by ensuring proper slicing and cutting of vegetables and meat, efficient market planning and demand forecasts [54]; [74]; [49]. An additional case study in Germany showed that most food waste in schools, hospitals, business canteens and hotels is associated with food surplus, such as buffet leftovers or serving waste [75], so the type of serving is one way savings.

Technological solutions involve the introduction or modification of technologies and practices seeking to change behaviors around food (waste) [76]; [77]; [78]; [79]. So far, these include: changes in plate or portion sizes [79], smart cooking lessons [80], the introduction of refrigerator cameras or food sharing applications [81]; [82] and advertising and information campaigns [78]. In fact, all of the above can be proven to be effective, but no exact quantification is provided.

By comparison, radical waste innovations explore opportunities for significant change in waste management approaches, usually with the help of technology. They represent the tendency to move away from existing practices [83]. Paving a new and more modern path for research, the study of restaurant waste generation has been expanded to supply information to OFD platforms, including food delivery applications (FDAs) that provide the ability to order food for delivery from a variety of food service facilities [84]. In this regard, waste tracking systems from commercial providers offer support to gastronomic kitchens for the quantification of food waste and the development of individual prevention strategies [85]; [16].

Food waste prevention strategies and measures have been the subject of a growing body of scientific research, including case studies in collaboration with food service companies [86]; [24]; [87]; [85]; [58]; [8]. The literature study shows that power plants that use waste monitoring systems instead of semi-automated or non-automated tools record more data and achieve slightly higher reductions in food waste [88]; [24]. Among the providers of innovative solutions are companies from the USA such as Leanpath or companies from Europe such as Winnow Solutions, Kitro, eSmiley, Matomatic, and Visma, which are already helping to reduce the amount of food waste [89]; [90]; [91]; [92]; [93]; [94].

Waste analysis provides a high content of information because it follows the process of weighing discarded food directly at the source [95]. In addition, proper quantification can also serve as a benchmark for the prevention of food waste in various food service establishments. For example, automated quantification tools can serve as a cost-effective way to reduce food waste in the case of facilities that report a very high volume of waste [88] recommended prioritizing prevention strategies based on food cost-effectiveness, depending on the specific waste levels for each product.

In their study, [96] presented data from 86 catering establishments (e.g. restaurants, hotels, schools and universities) that used systems for measuring and storing waste food and found that they reduced on average 44% of food waste and 56 % of monetary equivalents for 3 years. Eriksson et al. [88] analyzed data from 735 hotels, restaurants and canteens completing a spreadsheet, special waste scales or online food waste monitoring platforms and found that 61% of catering units reduced their waste.

The basic functions of these monitoring tools are similar and differ mainly in relation to the relevant consulting services, such as staff training or personalized development of measures. Further differences relate to optional features such as optical photography and artificial intelligence technology for the automatic identification of food waste.

As described, many studies have focused on quantifying and avoiding food waste in the food service sector, but the literature has rarely dealt with food waste at events, such as individual services for private or business events and conferences [41]. Catering can be defined as the food service business and is associated with a wide range of business forms and facilities, such as hotels, hospitals, full service restaurants, professional canteens or event venues [97]. Indicatively in a study in Germany for the year 2015 the focus was 14% of the generated waste (1.69 million tons) in that year [98].

A typical example of the self-report process in the daily routine of a professional kitchen, is the food waste monitoring system called RESOURCEMANAGER FOOD [24], which is also applied to hotel owners in Crete in Greece, as one of the project actors: . It is a useful tool that focuses on the quantification and analysis of breakfast buffet leftovers in the hotel kitchens. The monitoring system contains software installed on a standalone computer, which is connected via a USB port to an electronic scale. Using the software is similar to a smartphone application and allows quick handling and easy operation. To ensure homogeneity in the records the products were classified into the following product categories: bakery products, dairy products, fruits, vegetables, cheeses, hot dishes, fish, cold meats and more.

Other software solutions, such as Delicious Data, provide forecasting solutions using machine learning to combine historical data from gastronomic kitchens with external factors to predict future demand for meal preparation. These forecasts provide information on kitchen management in terms of supplies, menu design and daily production [99]. The tare weight of each portion was stored in the program, which means that the net weight of the food waste was immediately measured and stored in the database. The monitoring system provided a real-time graphical representation of the measured data in the form of horizontal bar graphs. Thus, the program provided an immediate feedback and direct information about the breakfast buffet left to the operators, as the kitchen staff. These methodologies provide information on kitchen management in terms of supplies, menu scheduling and daily production [99].

5. Conclusions

In conclusion, the waste and waste generation of food affects many aspects of our daily lives, having an impact, economic, environmental and social. From the above analysis it is clear that there is a need to address the problem and adopt legislative and other actions that provide targeted solutions both nationally and globally. Moreover, the reduction of food and waste losses is important in order to achieve the goals of sustainable development as in this way it could [100] : i) support the effort to resist and adapt the planet to climate change (Food waste alone produces about 8% of global greenhouse gas emissions), ii) Strengthen the separation of edible food, with a view to redistributing it to those in need, helping to eliminate hunger and malnutrition (approximately 43 million people in the EU do not have the financial means to buy a meal every other day), iii) to guide farmers, businesses and households, to save money

The hotel and catering sector, together with the households, are the largest producers of this type of waste and this position is obviously justified, as, as mentioned, there is also the unavoidable waste that cannot be eliminated. However, waste reduction actions and the correct way to remove inedible stems can significantly reduce the problem. With the awareness and adoption of environmental policies by the catering and hospitality structures, it is possible to make a total change in the behavior of both employees and consumers - customers, and this way the most desirable stage of the hierarchy for waste management, that of prevention by avoiding their generation can be achieved. Sorting and measuring discarded food is by far the most important resource, which can be a starting point for preventing any future waste. The sorting and measurement process gives a good idea of the main reasons behind food waste, so that you can design and devise appropriate actions to mitigate the waste. Finally, it is quite optimistic that in a related study [87] showed that the reduction targets set by the United Nations in terms of reducing food waste in the food sector are realistic and can be exceeded in the long run.

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