Towards Zero Waste: an exploratory study on restaurant managers

ACCEPTED VERSION

Paper Published in *International Journal of Hospitality Management*

Final published version (please cite as):
Principato, L., Pratesi, C. A., & Secondi, L. (2018). Towards zero waste: An exploratory study on restaurant managers. International Journal of Hospitality Management, 74, 130-137.

The final publication is available at Elsevier via https://doi.org/10.1016/j.ijhm.2018.02.022

Abstract

Approximately one third of global food production is wasted along the food supply chain causing economic, environmental and social impacts. At EU level, restaurants occupy the second highest position in the classification of bodies responsible for food waste generation and a significant share of restaurant costs "*goes*" to waste. However, few studies have been carried out on the factors and managerial implications associated to this type of waste.

By introducing the GME estimator, this paper focuses on data collected in 127 restaurants located in the regions of Lazio and Tuscany (Italy) with two specific aims. Firstly, to propose a theoretical framework for exploring factors that make restaurants waste food. Secondly, to comprehend whether food waste in restaurants is related to cooking and to clients.

The results show that the attitude of restaurant managers as well as types of menus served and restaurant size play significant roles.

Key words: Restaurant waste; Kitchen food waste; Client food waste; Waste Management; GME estimator; Doggy bag

1. Introduction

Worldwide 1,3 billion tons of food, equal to one third of the global food production is lost or wasted every year along the food supply chain (Gustavsson et al., 2011). The economic value of the food wasted globally is approximately 1,000 billion dollars per year, this figure rises to 2,600 billion considering the hidden environmental costs that result from the phenomenon (FAO, 2013). Since food waste represents a major public policy issue, it has recently been included in the United Nations Sustainable Development Goal 12, "Responsible Consumption and Production", which aims to halve "per capita global food waste at retail and consumer level and reduce food loss along production and supply chains by 2030" (UNDP, 2016).

According to literature, there is a specific classification for food loss and food waste (Griffin et al., 2009; Parfitt et al., 2010; Gustavsson et al., 2011). Food losses

occur in the first stages of the food supply chain and are mainly due to poor technology and investments, which is why they specifically occur in developing countries. Food waste is related to the final consumption phase (retail, household and out of home consumption) and is a consequence of consumer's behaviour, therefore it is typical of the Western Countries (Mondéjar et al., 2016; Principato et al., 2015; Parfitt et al., 2010; Griffin et al., 2009; Gustavsson et al., 2011).

As much as 42% of all the food produced in Europe gets lost at consumption level, this corresponds to approximately 89 million tons of food wasted every year. This figure could rise to 126 million tons per year within 2020 if no action is taken (BIO Intelligence Service, 2010) thus causing significant economic, environmental, and social impacts (Graham-Rowe et al, 2014; Göbel et al, 2015). In Italy, the estimated coost of food waste occurring in the final phase of the food supply chain is approximately 12 billion Euros per year (Ministero dell'Ambiente Italiano, 2015).

In Europe, the second source of food waste generated at consumption level occurs in restaurants following households (Brautigam et al., 2014; Monier et al., 2010) and in Italy this tendency is continued with household food waste which amounts to as much as 54%, followed by restaurant waste amounting to 21% (Coldiretti, 2017). A similar situation can be seen in the US where families and restaurants waste approximately 39 million tons of food per year (Buzby et al, 2011).

Although much research has been carried out at household level, the same cannot be said for the food waste generated by the hospitality sector which includes food served in restaurant/bars, hotels, canteens and by catering services. To date in-depth studies have not been carried out on this phenomenon both at academic and practical level (Pirani and Arafat, 2016; Schneider, 2013). Indeed, most of the studies on food waste at restaurant level have focused on the amount instead of the underlying causes (Heikkila et al., 2016).

Food waste represents a serious issue and economic cost for the restaurant industry (WRAP, 2013a). According to a recent study conducted in the UK, the amount of food wasted by the hospitality sector amounts to more than £682 million GBP per year which includes food procurement, labour and service costs, utilities and waste management costs (WRAP, 2013a). Considering the economic losses, in addition to environmental and social damage, it is essential to identify the factors that contribute to the amount of food wasted in restaurants. In fact, the less food wasted, the fewer the

related impacts which would lead to an improvement in the sustainability of the entire food service sector (Heikkila et al. 2016).

According to WRAP (2013b), the main causes behind restaurant food waste generation occur in the preparation phase (45%) or are due to food deterioration (21%) and food scraps left by clients (34%).

In this study, we focus on avoidable food waste generated in the hospitality industry which includes restaurant, bars and cafeterias that provide table service; therefore canteens, catering services, hotels and fast food restaurants are excluded from the analysis. For avoidable food waste, we intend leftover edible food (e.g. slices of bread, apples, meat) which could have been consumed if it had been better portioned, managed, stored and/or prepared. 'Avoidable' food waste also includes some otherwise acceptable food items that are not eaten due to consumer preferences, such as bread crusts and jacket potato skins (WRAP, 2013b).

Restaurant food waste occurs at two levels: during preparation and service (or consumption) phase (Risku-Norja et al., 2010; Papargyropoulou et al., 2016). We should therefore consider the food wasted as avoidable food waste discarded during the preparation/processing of the meals as well as spoilage and expiration, as well as food left over by client (i.e. food scraps) (Marthinsen et al., 2012; Pirani and Arafat, 2016).

The main aim of this study is to determine the factors associated with restaurant food waste by distinguishing between food waste generated in the kitchen (hereafter Kitchen Food Waste, KFW) and that generated by clients (hereafter Client Food Waste, CFW). We used the logit model within a segmentation approach in order to achieve our aim. However, considering the small sample sizes which can characterize exploratory research as in our study, we suggest using the Generalized Maximum Entropy Estimation – introduced by Golan et al, 1996a – which does not require strong parametric assumption on the models, is suitable for small sample and for ill-posed or ill-conditioned situations in the matrix data.

Our study adds to existing literature by making two main contributions. Firstly, by exploring the main factors associated with restaurant food waste generated both in kitchens and in dining rooms, we can understand whether and to what extent food waste is generated by inefficient dish preparation and/or client leftovers. Secondly, the GME estimator represents a novelty in the field of exploratory research and can help researchers and analysts (marketer analysis, economists) to carry out proper analyses

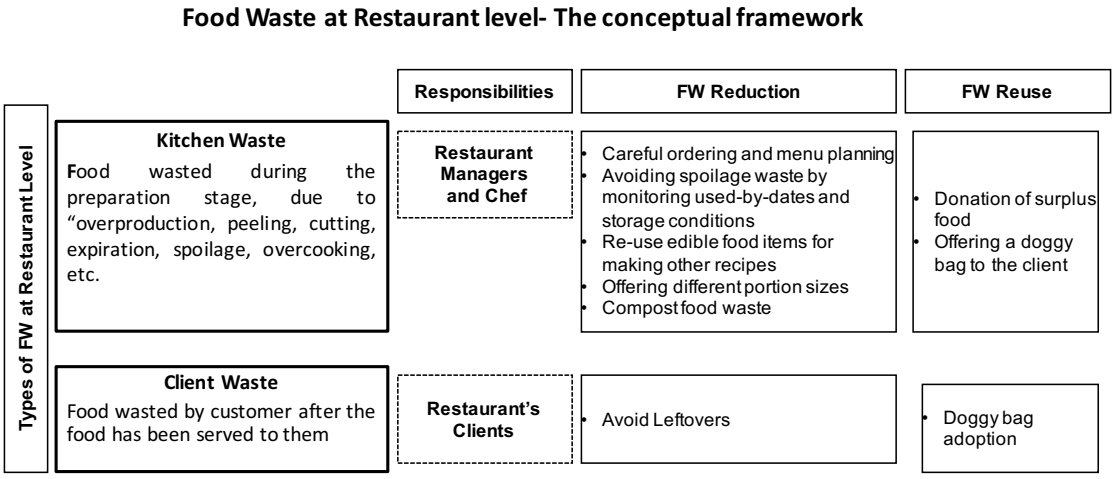
using flexible estimators which do not condition data to strong parametric assumptions and may not fit with the data collected.

The remainder of this paper is structured as follows. Section 2 presents the theoretical framework with which we carried out our exploratory research. Section 3 illustrates the data collection process and the method used for the analyses. A descriptive analysis and the GME logit estimation results are presented in section 4. In section 5 we discuss the implications of our study and some concluding remarks are drawn in section 6.

2. Food waste in restaurants: the selected theoretical framework

Although to date little is known about food waste at restaurant level, based on the findings of the most relevant studies on this topic (Betz et al., 2015; Marthinsen et al., 2012; Pirani and Arafat, 2016; Heikkila et al. 2016; Sustainable Restaurant Association, 2010), we defined a new conceptual framework (Figure 1).

Figure 1 – The conceptual framework



Based on previous studies (Risku-Norja et al., 2010; Papargyropoulou et al., 2016) we considered two types of food waste at restaurant level: "kitchen food waste" (*KFW*) which is food wasted during the preparation stage due to "overproduction, peeling, cutting, expiration, spoilage, overcooking, etc." (p.4) and "client food waste" (*CFW*) which is "food wasted by customers after the food has been served to them" (p.4). Papargyropoulou et al. (2016) also considered "buffet leftover waste" which was not included in our analysis since we only consider table service.

Therefore, according to this overview, the main responsibilities related to the food waste phenomenon fall respectively on the chef and restaurant managers (for kitchen waste) and on the clients.

As regards these issues we firstly identified from existing literature the main factors and incorrect behaviours related to food waste generation both from the manager/chef and client perspectives.

Considering the manager/chef perspective, the behaviours that have resulted in the reduction of food waste are: careful ordering and menu planning (Sustainable Restaurant Association, 2010), avoiding spoilage waste by monitoring used-by-dates and storage conditions (WRAP, 2013b), re-using edible food items for making other recipes (Sustainable Restaurant Association, 2010), portion size, and composting food waste (WRAP, 2013b, Sustainable Restaurant Association, 2010).

From the client perspective, in order to reduce food waste, it is essential to avoid leaving leftovers on one's plate and large portions play an important role in food waste generation (WRAP, 2013b, Sustainable Restaurant Association, 2010). This is the main reason why managers should adapt portion sizes according to the clients' needs and preferences (WRAP, 2013b; Sustainable Restaurant Association, 2010). Indeed, a study conducted in the UK, which focused on CFW highlighted that 27% of respondents leave leftovers on their plates, especially in the case of large portions (WRAP, 2013a) and approximately 40% of the respondents suggested that a possible solution would be to reduce the cost of the meals according to the size of the portions.

Our conceptual framework not only considers the reduction of food waste, which is obviously the most important aspect for avoiding waste, but also the recycling of food when this phenomenon occurs. From the managers' perspective, it is preferable to donate surplus food in the case of KFW and/or give the client a bag of his/her leftovers - commonly called takeout bag or doggy bags (Siriex et al, 2017) - to take home and consume at a later time in the case of CFW (WRAP, 2013b; Sustainable Restaurant Association, 2010). In Northern Countries (such as the UK and the USA) this is a commonly used practice accepted at any social level while in Mediterranean Countries (like Italy) this is still uncommon mainly due to cultural reasons. Indeed, according to a recent study carried out by Coldiretti (2017), approximately one out of three Italians (36%) have taken leftovers home at least once while 22% consider this practice unsophisticated and are ashamed to ask for it (similar results were found by Sirieix et al., 2017). Similarly, although 90% of Italians believe that restaurants waste a large

amount of food, as many as 41% are embarrassed to take home their leftovers (Last Minute Market, SWG, 2016).

3. Materials and Methods

3.1.Data

The study was carried out between September 2015 and February 2016 and it was based on a sample of 127 restaurants located in Tuscany and Lazio regions. With the aim of increasing the range of competence and investigation of the phenomenon under study, the research design focused on restaurants located in tourist sites such as cultural, coastal and lakeside resorts and by distinguishing the type of business in restaurants and cafes with restaurant service. In the Lazio region, we considered restaurants located both in the metropolitan area of Rome and surrounding towns and lakeside resorts (Bracciano and Bolsena lakes) as well as other cultural sites located in the provinces of Viterbo, Latina and Rieti – while in Tuscany we focused on the provinces of Lucca and Massa-Carrara which include important coastal areas (i.e. Versilia coast).

Participation in the survey was voluntary. The member of our research group responsible for collecting data in specific areas asked restaurant managers whether they agreed to be included in the survey.

After the restaurant managers had consented to participate in the survey, the data collection process, which entailed calculating the amount of food wasted, was carried out by means of a questionnaire – available in the Appendix – which was designed specifically for the survey and suited our exploratory research theoretical framework. More specifically the questionnaire was composed of 29 open-ended and closed questions divided into 5 sections: i) Knowledge and awareness of food waste phenomenon; ii) Food waste measurement and its "causes" in one's own restaurant; iii) Actions carried out (and/or intentions) for contrasting food waste; iv) Management of food surplus; v) Restaurant information.

More specifically, the first section is aimed at understanding whether restaurant managers are aware of the level of criticality and the widespread diffusion of the food waste issue as well as its main impacts. In the second section, restaurant managers are asked to name the principal causes of FW in their restaurants and to evaluate - in percentage terms - how much food waste is generated in the kitchen and how much

208 food waste is left on client's plates after meals. It is worth noting that indirect
209 measurement through questionnaires – as foreseen by our exploratory design – have
210 proved to be suitable for linking self-assessed responses with qualitative information
211 related to food waste (Secondi et al, 2015). On the other hand, we do not aim to exactly
212 quantify the amount of food wasted by restaurants since indirect surveys have resulted
213 not completely appropriate for assessing this specific aspect (Neff et al, 2015).
214 The third section of the questionnaire is aimed at assessing whether and to what extent
215 each restaurant has implemented strategies to prevent and/or reduce food waste by
216 asking the restaurant managers to specify their relative actions. Section 4 focuses on
217 food waste management by asking the restaurant managers what types of actions they
218 had implemented. The last section of the questionnaire is centered on gathering
219 information on the restaurants such as their location, number of restaurant covers and
220 the average price paid per person for meals.
221 The process of data collection was carried out in two separate steps. At day d=0 face-
222 to-face interviews were carried out with restaurant managers who responded to the
223 questions in Section 1 (knowledge on food waste) and Section 5 (restaurant
224 information). Subsequently, taking into account our theoretical framework and
225 distinguishing food waste according to its origin (KFW and CFW), we considered a
226 "three-day study period" for each restaurant during which the questionnaire was left
227 with the restaurant managers who were responsible for filling in the questionnaire
228 together with their kitchen staff involved in food preparation and dining room staff
229 involved in customer service. At day d=4 the completed questionnaire was returned to
230 the research assistant responsible for data collection and checked by the RA.
231 It is worth noting that this is an exploratory study, therefore it may be advisable to
232 obtain general addresses and advice from both researchers and restaurant managers and
233 business decision-makers in order to address the food waste topic effectively and carry
234 out further investigations on this issue, while generalization to the representative
235 population of restaurant outlets is not possible.
236
237 **3.2. The Logit-based segmentation: a Generalized Maximum Entropy approach**
238 Considering the exploratory nature of our study we referred to the *approach of*
239 *segmentation per objectives* by using logit models (Chen and Hsu, 1999) in order to
240 identify the factors associated to food waste within restaurants. Firstly, we constructed
241 a dichotomous variable for each of the two types of food waste (KWF and CFW) by

following the procedure described in detail in the next section and defining the percentage of wasted food corresponding to the first quartile of the empirical observed distribution as threshold. Secondly, we specified and estimated the logit models within the Generalized Maximum Entropy (GME) framework.

From a methodological point of view, traditional Maximum-Likelihood (ML) logit and probit formulations – generally used in social science (Golan et al, 1996a) – impose a parametric structure on probabilities (Corral and Terbish, 2015) which in the logit (probit) model corresponds to the logistic (standard Gaussian) cumulative density function linking the probabilities p_{ij} with the linear structure $\boldsymbol{x}_i'\boldsymbol{\beta}_j$. Indeed, the underlying distribution for the probabilities is unknown and the selection of logit and probit models relies on this strong assumption (Golan et al, 1996b). In order to overcome these tightening conditions, Golan, Judge and Miller (1996) introduced the Maximum Entropy (ME) and GME estimators for which restrictive moments or distributional assumptions for error components are not required and all the data points are used as information in optimization problems (Golan, 2008; Golan et al, 1996a).

The exploratory nature of our research that fits well to being analyzed with the segmentation strategy via logit/probit analysis has further advantages when analyzed within the GME framework. In fact, as demonstrated by Golan et al (1996a) and reported by Corral and Terbish (2015), when considering finite (limited) samples, GME outperforms its ME and ML counterparts. GME proved to be more efficient, performs well for both small and ill-posed samples and when the covariates are highly correlated (ill-conditioned situations).

Estimating logit models within the GME framework solves the problem of estimating the parameters in the general multinomial framework for unordered discrete choice data.

In order to develop the statistical model that captures the basis of the data generation process Golan et al (1996a) considered an experiment consisting of N trials, for which binary variables y_{1j}, y_{2j}, …, y_{Nj}, are observed where y_{ij} for i =1 ,2,...,T takes on one of the J unordered categories j =1 ,2,...,J. As a result, on trial *i*, one of the J alternatives is observed in the form y_{ij}, that is equal to 1 if alternative j is observed and 0 otherwise. This multinomial formulation reduces to the logit formulation when only two alternatives are observed corresponding to a binary variable y_{ij} which can assume values equal to 1 (in the case of alternative J is observed) and 0 (in the case of alternative J is

not observed). Referring to our study the two alternatives – for each type of food waste analyzed – are whether KFW (CFW) in the restaurant *i* is greater than the observed first quartile – and it takes value 1 – or not, and it takes value 0.

Let p_{ij} be the probability of alternative *j* for individual i be related to a set of covariates by the following equation (Corral and Terbish, 2015):

$$p_{ij} = Prob\left(y_{ij} = 1 \middle| x_i, \beta_j\right) = F\left(\boldsymbol{x_i'\beta_j}\right) > 0 \qquad for\ i = 1,2,\dots,T;\quad j = 1,2,\dots J$$

where $\boldsymbol{\beta}_{ij}$ is a $(K\ x\ 1)$ vectors of unknowns, $\boldsymbol{x_i'}$ is a $(1\ x\ K)$ vector of covariates, and $F(\cdot)$ is a function linking the probabilities p_{ij} with the covariates $\boldsymbol{x_i'\beta_j}$ such that $\sum_j F\left(\boldsymbol{x_i'\beta_j}\right) = 1$. Generalizing equation (1) to include an additional noise components yields:

$$y_{ij} = F\left(\boldsymbol{x_i'\beta_j}\right) + e_{ij} = p_{ij} + e_{ij} \qquad [1]$$

With the aim of recovering the unknown and unobservable $\boldsymbol{p}$ and $\boldsymbol{e}$, the indirect empirical measurements on the noisy observable **y** and the known covariates $\mathbf{x_i}$ must be used. When formulating the GME approach to the multinomial choice problem, the information contained in the (T x K) matrix **X** of covariates are introduced in the model described by [2] which involves the TJ data points, y_{ij}. According to Golan et al (1996a), the introduction of this information is carried out by transforming the statistical models into the following, linear (in **p**), ill-posed inverse problem with noise:

$$\left(I_j \otimes \boldsymbol{X'}\right)\boldsymbol{y} = \left(I_j \otimes \boldsymbol{X'}\right)\boldsymbol{p} + \left(I_j \otimes \boldsymbol{X'}\right)\boldsymbol{e} \qquad [2]$$

The estimation of the model within the GME framework firstly requires the re-parameterization of the unknown terms. Since **p** is already in probability form, we only need to reparametrize the elements of **e**. By considering the nature of the observed dependent variable **y**, each error term may range between [−1,1]. Therefore, over this interval, we adopted the support space $v = \left(-1/\sqrt{T}, 0, 1/\sqrt{T}\right)$ composed by M=3 support points, with corresponding probabilities w_{ij} to be estimated such that $e_{ij} = \sum_m v_{ijm} w_{ijm}$ where $\sum_m w_{ijm} = 1$.

Once the re-parameterization of equation [2] was carried out, the GME estimator is obtained by maximizing the joint entropy:

$$\max_{\mathbf{p},\mathbf{w}} H(\mathbf{p},\mathbf{w}) = \{-\boldsymbol{p}' \ln \boldsymbol{p} - \boldsymbol{w}' \ln \boldsymbol{w}\} \quad [3]$$

subject to data constrained reparametrized in the form:

$$\left(I_j \otimes \boldsymbol{X}'\right)\boldsymbol{y} = \left(I_j \otimes \boldsymbol{X}'\right)\boldsymbol{p} + \left(I_j \otimes \boldsymbol{X}'\right)\boldsymbol{V}\boldsymbol{w} \quad [4]$$

and the normalization (adding-up) constraints.

The solution of this optimization problem yields the estimated of p_{ij} and w_{ijm} (and therefore e_{ij}) as:

$\hat{p}_{ij} = \frac{\exp(-\mathbf{x}_i'\hat{\boldsymbol{\beta}}_j)}{\Omega(\hat{\boldsymbol{\beta}}_j)}$ where $\Omega(\widehat{\boldsymbol{\beta}_j}) = \mathbf{1}'\, exp(-\boldsymbol{x}_i'\widehat{\boldsymbol{\beta}_j})$

and

$\widehat{w}_{ijm} = \frac{\exp(-\mathbf{x}_i'\hat{\boldsymbol{\beta}}_j V_j)}{\Psi_{ij}(\hat{\boldsymbol{\beta}}_j)}$ where $\Psi_{ij}(\widehat{\boldsymbol{\beta}_j}) = \mathbf{1}'\, exp(-\boldsymbol{x}_i'\widehat{\boldsymbol{\beta}_j})\, V_j$.

In the interpretation and discussion of the estimation results – provided in Section 4 – we considered the Average Marginal Effects (AMEs) which provide information about the impact of each x on the probability of a positive outcome (Corral and Terbish, 2015). For a continuous variable, the AME is (Bartus, 2005):

$$AME_k = \beta_k \frac{1}{T}\sum_{i=1}^{T} p_i\,(1-p_i) \quad [5]$$

while if x_k is a dummy variable the AME is obtained as:

$$AME_k = \frac{1}{T}\sum_{i=1}^{T}\left[\{x_{ki}p_i(1-p_i)|_{x_k=1}\} - \{x_{ki}p_i(1-p_i)|_{x_k=0}\}\right] \quad [6]$$

4. Results

4.1.Wasted food within restaurants: a descriptive analysis

The data collected refer to the percentage of food waste generated and not to the amount of wasted food (both in restaurant kitchens and by clients). As we can see from the questionnaire, each respondent must indicate the percentage of the food wasted in the

kitchen and by clients, separately. Table 1 provides summary statistics of the percentages of KFW and CFW.

The results show that approximately 12.93% of the food prepared in the restaurant kitchens was wasted because it was spoiled or incorrectly prepared. On the other hand, when focusing on the percentage of waste generated by clients – obtained by asking the waiting staff to quantify the percentage of client leftovers –the average percentage of client leftovers was found to be equal to 15.83%.

Table 1 – Percentage of food waste generated in restaurant kitchens (KFW) and by clients (CFW): descriptive statistics

	Mean	*SD*	*CV*	*Min*	*Q1*	*Q3*	*Max*
% Kitchen FW	12.93	9.79	0.76	0	5	20	60
% Client FW	15.83	13.46	0.85	0	5	20	40

Approximately one out of ten of the restaurants under study (a total of 13 restaurants) declared that no food was thrown away in the kitchen, while 16 out of 127 participating restaurants (corresponding to 12.6% of the sample) declared that 30% or more of the food prepared in kitchen was wasted, with a maximum observed value of 40%.

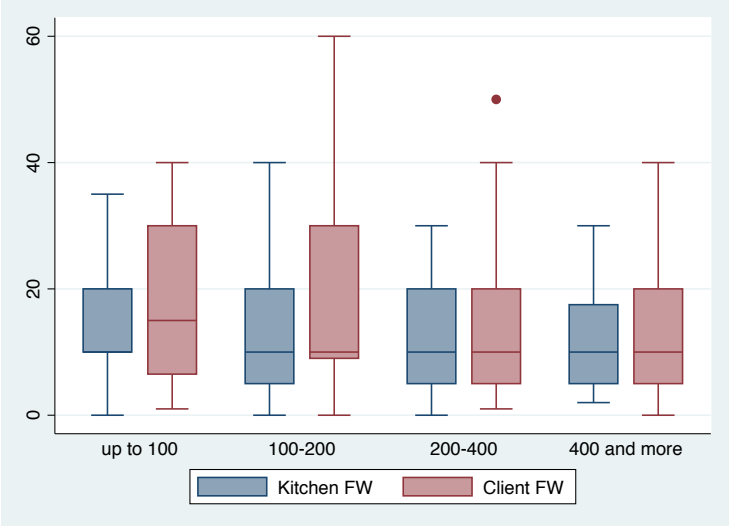
However, only 2 restaurants out of the 127 under study declared that customers do not produce waste, while 30 out of 127 (corresponding to 23.6% of the sample) reported that 30% or more of the food served to customers was wasted, with an observed maximum value of 60%.

Since there is a minimum intrinsic percentage of food wasted in restaurants and in households (Secondi et al, 2015), with the aim of avoiding to draw a subjective and discretional distinction between restaurants with low percentages of KFW and CFW waste and restaurants with high percentages of KFW and CFW waste, we created two dichotomous variables by considering the first quartile of the empirical distribution (reported in Table 1) as thresholds for identifying "*virtuous*" restaurants - the restaurants for which KFW (CFW) was lower than or equal to the first quantile - and restaurants producing large amounts of waste as those with KFW (CFW) percentages greater than the first quantile.

Using these two variables for modelling KFW and CFW enabled us to implement the segmentation strategy and therefore to identify the factors associated with food waste from restaurant kitchens and dining rooms (client leftovers).

Among other information requested in the questionnaire, the participants were also asked to indicate the total number of restaurant covers are served weekly. It was observed that restaurants that serve more than 400 covers per week showed the lowest levels of overall variability while restaurants that serve up to 110 covers per week showed the lowest levels of variability in the central part of the distribution (between the first and third quantiles). On the other hand, high levels of overall variability were observed for CFW in medium-sized restaurants (between 100 and 200 covers served weekly) while variability in the central part of the distribution was lower for large restaurants serving over 200 covers per week compared to the other categories. (Figure 2).

Figure 2: KFW and CFW distinguished by total number of covers served weekly



Furthermore, the main types of food and ingredients wasted in restaurants were also investigated by asking the restaurant managers to identify the three most commonly thrown away foods and to indicate the waste phase. The most wasted KFW ingredients and food proved to be bread (55.12%) raw vegetables (51.18%) and fruit (22.83%), while regarding CFW the foods most frequently left on clients' plates were bread (61.42%), cooked vegetables (33.86%) and raw vegetables (22.83%).

4.2.The GME logit models: estimation results

Table 2 shows the estimation results of the GME logit model for KFW. The dependent variable – whose construction is reported in Sections 3 and 4 – assumed a value equal to 1 if the restaurant produced a KFW percentage greater than 8%, while it assumed 0 if the KFW generated in the restaurant was lower or equal to 8%. The estimation results - obtained with STATA 14.0 software and the tools introduced by Corral and Terbish (2015) - are presented in terms of AMEs.

Table 2. KFW: estimation results of the GME logit model

	AME	Std. Err.	Sig.
Potential restaurant capacity: number of potential restaurant covers	0.0011	0.0008	
Number of weekly served covers	-0.0003	0.0001	**
Prevailing cuisine: meat	0.2320	0.0840	***
Average spending for a meal: (ref. 20 Euros or less)			
20-40 Euros	-0.0689	0.0937	
40-60 Euros	0.1786	0.1013	*
60 Euros and more	0.1882	0.6111	
Restaurant opening hours: ref. Both lunch and dinner			
Lunch only	-0.4492	0.1479	***
Dinner only	-0.1894	0.1028	*
Other opening hours (café, bar, etc…)	-0.6388	0.1642	***
Initiatives to raise awareness about food waste (ref. NO)	0.0615	0.0822	
Favourable to cooking food waste (ref. Definitely Yes)			
More YES than NO	-0.3240	0.1158	***
More NO than YES	-0.2282	0.1176	*
Definitely NO	-0.3648	0.1103	***
Reduction of FW= cost reduction (ref. Definitely NO)			
More NO than YES	0.1967	0.1791	**
More YES than NO	-0.3826	0.3516	
Definitely YES	-0.5478	0.2950	*

Notes: *** significant at 1% level; **significant at 5% level; *significant at 10% level. Normalized entropy = 0.7225; Ent. ratio stat =43.9 p-value for LR= 0.0002 Pseudo R2 = 0.2775

The AMEs obtained show significant associations between the generation of KFW/KFW generated and the number of covers served weekly by highlighting that the probability of observing high percentage of wasted food in kitchen decreases (AME=-0.0003) at the increasing of the number of weekly served covers. Moreover, we also specified and estimated a model (not reported here, but available from the authors upon request) in which we introduced the gap between the potential restaurant cover capacity per week and the total number of covers actually served with the aim of understanding whether and to what extent a difference (misalignment) in the number of covers plays

a significant role. However, this variable did not prove to be significantly associated with the generation of KFW.

By refocusing on the restaurants' characteristics, the AME for restaurants with prevailing meat-based menus (AME=0.2320) show significant positive and strong relationships with the probability of generating large amounts of KFW. Another interesting result was obtained regarding the average price of a meal in the restaurants. In fact, significant (10%) and positive relationships were observed between medium-high priced restaurants (the price paid for a meal ranged between 40 and 60 Euros) and the probability of generating large amounts of KFW (Y_{KFW}=1), compared to restaurants where the average cost of a meal was lower than 20 Euros.

Restaurant opening hours proved to affect KFW generation: restaurants that only serve lunch are less likely to produce high percentages of KFW (AME= -0.4492) as well as other outlets (bars and cafés) where restaurant service is provided (AME=-0.6388). It is worth noting that restaurants, bar and cafés serving lunch or dinner buffets were excluded from the study. Moreover, a less significant relationship (p-value< 0.10) was found for restaurants which only serve dinner which were once again less likely to observe a positive outcome, compared to restaurants which serve both lunch and dinner.

As regards the restaurant managers' attitude towards FW we found that restaurant managers who agree (by replying "Definitely YES") with the sentence "I think the introduction of initiatives aimed at reducing food waste can lead to a reduction in the total costs incurred by my restaurant" are more likely to produce small levels of KFW (AME=-0.5478) in their restaurants. On the other hand, to be partially in disagreement with the same sentence is related to high levels of KFW (AME=0.1967).

Finally, we investigated the tendency of restaurant managers to put specific types of food on their menu. Specifically, to be unfavorable to the introduction of dishes using eatable food waste (and specifically as fruit and vegetable skins, fish scraps, etc.) is inversely linked to the probability of observing a positive outcome, i.e. high level of food waste in kitchen.

The diagnostics of the model was assessed with the normalized entropy measure defined by Golan, Judge and Miller (1996) or the reduction in uncertainty information index (Soofi, 1992). In our model, a value of the normalized entropy $S(\hat{\boldsymbol{p}}) = 0.7225$ indicates a departure from uniform distributions thus meaning that a reduction in uncertainty occurred through the selected explicative variables. Moreover, the pseudo

R^2 and the Entropy Ratio Statistic (Golan et al, 1996b) confirmed that a satisfactory amount of information was captured by the estimated model.

Focusing on CFW, Table 3 below reports estimation results of the GME logit model. It is worth noting that that the two different specifications of the estimated models – obtained with the aim of achieving the best departure from a situation of complete uncertainty – did not enable us to directly compare AMEs between KFW and CFW models. Therefore, KFW and CFW are treated separately both in the results and discussion sections by highlighting the factors that significantly influence the probability of observing elevated levels (greater than 5%) of kitchen and client FW, respectively.

Identifying CFW from restaurant managers' perspective is less usual than asking directly to the clients. However, several interesting results emerged with a moderate goodness of fit of the model which was supported by the normalized entropy criterion (and its complementary measure Pseudo R^2) and the Entropy Ratio Statistics.

Firstly, concerning restaurant characteristics, it was observed that the restaurants' specialities played significant roles in determining the probability of positive outcomes, in this case of observing a high (over 5%) CFW percentage. Specifically, there is a higher propensity to produce large amounts of CFW in meat-specialized restaurants compared to fish-specialized restaurants and pizzerias (AME=0.1513).

On the other hand, ethnic, fusion and other types of restaurants (including specialized vegan restaurants) are negatively related to high CFW percentages (AME=-0.6458).

Moreover, when focusing on the average cost of typical menus, it was observed that clients are more likely to throw away high percentages of food (AME=0.2755) in restaurants where a complete meal costs on average 60 Euros. On the other hand, a negative effect (AME=-0.3330) was observed regarding the probability of a positive outcome (Y_{CFW}=1) thus demonstrating that these restaurants produce significantly smaller amounts of CFW compared to restaurants in which both lunch and dinner are served.

By focusing on attitude of restaurant managers towards food waste, we found confirmation that larger amounts of CFW (AME=0.2651) were observed in the restaurants of the participants who do not believe that reducing food waste can lead to a reduction in the total costs incurred.

Table 3. CFW: estimation results of the GME logit model

	AME	Std. Err.	Sig.
Prevailing cuisine: meat	0.1513	0.0818	*
Prevailing cuisine: ethnic, fusion, and other type of cuisine	-0.6458	0.2508	***
Average spending for a meal: 20 Euros or less			
20-40 Euros	0.0195	0.0955	
40-60 Euros	-0.1320	0.1391	
60 Euros and more	0.2755	0.1195	**
Restaurant opening hours: ref. Both lunch and dinner			
Lunch only	-0.3330	0.1852	*
Dinner only	-0.0195	0.0996	
Other opening hours (café, bar, etc…)	-0.1535	0.3172	
Reduction of food waste= cost reduction (ref. Definitely NO)			
More YES than NO	0.1060	0.0806	
More NO than YES	0.0770	0.0970	
Definitely NO	0.2651	0.1085	***

Notes: *** significant at 1% level; **significant at 5% level; *significant at 10% level. Normalized entropy = 0.7760; Ent. ratio stat =39.4 Pvalue for LR= 0.0001 Pseudo R2 = 0.2240

4.3.Recycling and managing food waste

Specific questions in the questionnaire focused on the actions carried out by restaurants to reduce waste and to manage food surplus.

Firstly, the restaurant managers were asked to indicate if they had implemented strategies for reducing food waste. Auspiciously, approximately 80% of the restaurant managers declared that they had taken one or more actions aimed at reducing food waste. After analysing the responses given by 101 out of 127 restaurants concerning the specific strategies[1] implemented, it was found that approximately 86% of the restaurants declared to "have improved the day-to-day booking system so as to have a supply (purchasing management) closer to the demand of the day". Moreover, approximately 65% of the participants declared to "allow customers to take home the leftovers of their meal by providing the *doggy bag*". Lastly, we observed other types of actions taken such as "freezing food" or "using vacuum-sealers or blast-chillers" for reducing food waste.

[1] It is worth noting that this was a multiple-choice question. Therefore, the various percentages do not sum to 100.

We also carried out an in-depth analysis on the reasons why 43 restaurants out of 127 restaurants do not generally provide «takeout (doggy) bags». The restaurant managers were asked "*Why don't you provide doggy bag?*": more than 30% of the respondents declared that "*I do not know what it is*". Moreover, 17% of restaurant managers stated that "*clients do not ask for them*" while the same percentage replied that "*we do not propose leftover bag in order to maintain a positive reputation of the restaurant*" since – as one restaurateur affirmed - "*the food would not have the same quality*". Finally, the other open-ended responses of restaurant managers reported "*little waste from customers*" or "*an ad-hoc organization management is required for leftover bags*".

5. Discussion

Reducing food waste not only has a positive impact on the environment, but it also reduces associated economic costs. While from the financial point of view, it has been demonstrated that for each dollar spent for reducing food waste there is a return of investment of 14 Dollars and restaurants appear to be the companies with the highest returns (Hanson and Mitchel, 2017). The results of our study show that not all restaurant managers believe that limiting food waste can reduce costs. Indeed, restaurant managers' attitudes and behaviour towards food waste can greatly effect the amount of food waste generated. Our results showed a significant relationship between food waste behaviour and reduction. In fact larger amounts of waste are generated (above all in kitchens) especially if restaurant managers do not perceive limiting food waste as a cost-reduction opportunity. This result is in line with Heikkila et al. (2017) who demonstrated the importance of wise KFW and CFW management since food waste must be regarded as an essential element of the management system. Therefore restaurant managers must be aware of this and implement effective waste reduction strategies. Indeed, as stated by Pirani and Arafat (2014, p. 143) who focused on the reduction of food waste in the hospitality sector "there are many studies and reports which reflect on the activities that hotel staff can engage in to reduce food waste, including maintaining better inventory of ingredients and revising menus to serve less wasteful dishes".

It is not easy to compare our results with those obtained in similar studies due to the novelty of the research topic which is characterized by a relatively small number of published research articles which mainly refer to case studies in various contexts that

535 adopt different approaches to quantify food waste thus complicating the comparison of
536 the results obtained from these studies (Betz et al, 2015).
537 On average, the percentage of CFW was generally higher than the percentage of KFW
538 generated in restaurants. Although our study mainly focused on restaurant managers
539 without directly considering clients, this result is in line with those of Eriksson et al
540 (2017) who analysed restaurant food waste for selected sites in Sweden and found that
541 the highest share of waste occurred during the serving phase.
542 As regards KFW – whose empirical range fell between 0 and 60%[2] – we showed the
543 relevance of restaurant dimension as a variable associated with food waste. Our
544 descriptive analysis and regression model both showed that the higher the number of
545 restaurant covers, the less KFW generated. From the client perspective, this relationship
546 is less evident as from our descriptive analysis it seems that the larger the restaurant,
547 the less CFW generated, but this result was not confirmed in the model. When analysing
548 specific aspects of food waste within the hospitality sector (recycling of leftovers,
549 charity donations and composting) in the United Arab Emirates, Pirani and Arafat
550 (2014) did not find any significant correlations between waste generation and restaurant
551 size. On the other hand, Papargyroupoulou et al (2016, page 330) who focused on a
552 case study of a hotel restaurant in Malaysia found that "the amount of food waste per
553 customer decreased with the number of customers served per day, due to economies of
554 scale". Despite the different contexts observed, the results suggest that further research
555 in this field is strongly recommended and in-depth studies should be carried out on the
556 effect restaurant size has on food waste generation.
557 Another interesting result is that restaurants with meat-based menus tend to waste more.
558 This finding reflects the importance of the type of ingredients used and the dishes
559 served. For example, Papargyroupoulou et al (2016) highlighted the importance of
560 cooking from scratch, using fresh ingredients and very few processed foods. As the
561 same authors stated (page 331) this practice "leads to having all the preparation waste
562 associated with a certain meal, produced within the restaurant and not in previous stages
563 of the food supply chain, e.g. food processing industries that which can be related to
564 the cooked ingredients and raw materials" and is therefore a factor that can limit food
565 wastage.

[2] For Sweden, Eriksson et al (2017) found that the empirical range fell between 12% and 42% for selected restaurants.

Opening hours also seem to influence food waste generation: restaurants, bars or cafés that only open at lunch or dinner waste less food compared to businesses where food is served both at lunch and dinner, although to our best knowledge no comparable studies have yet been carried out. As regards type of meal served, Papargyroupoulou et al (2016), who also considered the type of service ("à la carte" and "buffet service"), found that 'a la carte' meals generated larger amounts of food waste at lunch time.

To be adverse to cooking and introducing dishes prepared with scraps is not directly and positively associated to high levels of KFW. This result suggests that innovative cooking methods focused on environmental sustainability and economic circularity do not appear to make restaurants more mindful of the food waste generated in the kitchen. This finding may provide a good starting point for future studies.

As already mentioned, we interviewed the restaurant managers regarding their clients' behaviour towards food waste. From this point of view, it was observed that CFW – whose empirical range was between 0 and 40% – occurred more in meat-based restaurants, while clients tended to leave fewer leftovers in fusion and ethnic restaurants. This may be due to the larger portion sizes served in meat-based restaurants that exceed client needs, but further research is required to prove this assumption. On the other hand, we cannot exclude the influence of eating atmospherics which appears to be an important dimension in individual food choice when clients eat out-of-home as observed by Lorenz and Langen (2018).

Clients tend to waste more in upscale restaurants (where the average price of a meal per person is 60 Euros or over) which may be due to the fact that the clients are wealthier and tend to order more than they can eat without worrying about the bill. This result is consistent with the studies carried out on household food waste for which individuals with higher socio-economic status were found to be more likely to produce high levels of food waste (Principato et al, 2015; Secondi et al, 2015). It would be interesting to study whether and to what extent this relationship is confirmed when individuals consume their meals out-of-home. How do economic, social and ethical motivations affect meals consumed out-of-home?

Regarding the recycling and management of food waste, it is important to note that approximately 80% of the restaurants participating in the study declared that they carry out one or more actions aimed at reducing food waste through effective purchase planning. However, a deeper understanding of the logistic phase, especially regarding

menu planning, ordering food and managing stock would provide insight into how behaviour related to these aspects affects food waste at restaurant level.

Research is still required on the provision of takeout bags. Firstly, there is still a lack of information on this topic, as more than 30% of the respondents declared that they "*do not know what it is*". Secondly, some restaurant managers stated that they do not offer takeout (doggy) bags in order to maintain a good reputation since they believe that "*the food would not maintain the same quality*". Lastly, most clients do not ask for them. It is interesting to note that in line with our results, Siriex et al. (2017) who analysed consumers' attitudes towards doggy bags in France and the Czech Republic found that "asking for a doggy bag generates immediate shame" in consumers. This means that practitioners and policy makers should implement awareness campaigns to encourage its adoption by both restaurant managers and clients.

6.Concluding remarks

This study is one of the first to highlight factors, attitudes and behaviours related to food waste at restaurant level from a managerial perspective.

The distinction between food waste generated in kitchens (KFW) and by clients (CFW) enabled us to highlight the factors and characteristics causing food waste in the hospitality sector. From this perspective, the exploratory nature of the study may enable us to effectively address the research problem and provide advice to researchers for carrying out further studies on this issue, as well as restaurant managers and business decision-makers, while it is not possible to extend this generalization to restaurant outlets. On the other hand, we stress the importance of distinguishing between the food waste generation phases in order to identify specific factors related to each phase.

Moreover, exploring the motives underlying the provision (or not) of doggy bags by restaurants is an interesting topic for further research. From a theoretical perspective, an influential strategy should be implemented to promote the adoption and diffusion of doggy bags in order to increase our food waste recycling rate and reduce the economic and environmental impact of food waste. To this aim, in Italy the recent Law n.166/2016 (Legge Gadda) has incentivised the use of doggy bags for customers and the reduction of taxes regarding food waste generation for the most virtuous operators.

Further research is strongly recommended in the hospitality sector which generates more than 20% of overall food waste, as shown by the data recently released by Fusions (2016). Moreover, it would be interesting to gain insights on the reasons for the amount

633 of KFW generated in restaurants therefore in-depth and qualitative interviewing with
634 kitchen staff should be conducted. As regards CFW, primary data collected from final
635 consumers (i.e. restaurant clients) are strongly required (Lorenz and Langen, 2018) as
636 they can provide insight into the attitudes, behaviours and motivations of individuals
637 consuming meals out-of-home.
638
639

APPENDIX

QUESTIONNAIRE ON FOOD WASTE IN THE RESTAURANT INDUSTRY

SECTION 1 – KNOWLEDGE OF THE FOOD WASTE PHENOMENON

	Strongly disagree (1)	*Somewhat disagree (2)*	*Neutral (3)*	*Somewhat agree (4)*	*Strongly agree (5)*
I believe that the food waste phenomenon is very widespread	❑	❑	❑	❑	❑
I think that in the current economic situation, reducing food waste is a good way of tackling the crisis	❑	❑	❑	❑	❑
I believe that from a social point of view, reducing the amount of food we throw away is simply a respective attitude towards those who do not have enough to eat	❑	❑	❑	❑	❑
I think that wasting food has a negative impact on natural and energy resources from an environmental perspective	❑	❑	❑	❑	❑

SECTION 2 – IDENTIFICATION OF THE FOOD WASTED IN YOUR RESTAURANT AND ANALYSIS OF CAUSES

2.1 At your restaurant what are the main causes of food wastage? For each of the statements, please specify your degree of agreement/disagreement

In my restaurant food waste is generated from…	*Strongly disagree (1)*	*Somewhat disagree (2)*	*Neutral (3)*	*Somewhat agree (4)*	*Strongly agree (5)*
Overabundant portion sizes that are only partly consumed by clients.	❑	❑	❑	❑	❑
Inefficient purchase planning which often leads to product surplus.	❑	❑	❑	❑	❑
Fresh products that are not consumed within the expiry date	❑	❑	❑	❑	❑
Poor dissemination of the practice that enables customers to take home the "leftovers" of their meal in the so-called doggy or leftovers bag.	❑	❑	❑	❑	❑
Mistakes made by clients when ordering their meals	❑	❑	❑	❑	❑
Mistakes made by chefs during the prepaRation phase	❑	❑	❑	❑	❑
Other causes (please specify_____)	❑	❑	❑	❑	❑
Other causes (please specify_____)	❑	❑	❑	❑	❑

2.2. Considering the food surplus (food waste) that is generated for the above-mentioned reasons, would you be able to quantify (in percentage terms) how much of the food is wasted in "the kitchen" and how much is "attributable to clients"?

Food surplus (waste) in my restaurant

Attributable to the kitchen (preparation phase)	…….%
Attributable to the clients	……%
	100%

2.3. Can you identify **three types of food** (maximum 3 answers) that are more frequently thrown away in the kitchen

of your restaurant? Please select foods that have not yet been served to clients.

Milk	❑
Fresh cheeses and dairy products	❑
Aged cheeses	❑
Yoghurt	❑
Red meats	❑
White meats	❑
Cured meats	❑
Fish	❑
Legumes	❑
Vegetables	❑
Fruit	❑
Bread	❑
Pasta	❑
Eggs	❑
Fats/butter	❑
Ready foods	❑
Pre-cooked foods	❑
Frozen foods	❑
Other foods (please specify)	❑
Other foods (please specify)	❑

2.4. **Hereunder only refer to food waste generated in kitchens**. In percentage terms, could you estimate a percentage (from 0 to 100) of the amount of food purchased and not cooked or cooked but not consumed (not served to clients) that is thrown away in your restaurant?

_____% of the food purchased

2.5. In your opinion, which three foods are most likely to be left on customers' plates? Please refer to food scraps that are returned to the kitchen after being served to clients.

Cured meats	❑
Fresh cheeses	❑
Aged cheeses	❑
First meat courses	❑
First fish courses	❑
Red meats	❑
White meats	❑
Pork	❑
Fish	❑
Legumes	❑
Side dishes: cooked vegetables	❑
Side dishes: raw vegetables	❑
Fruit	❑
Bread	❑
Pizza	❑
Eggs	❑
Sweets/desserts	❑
Icecream	❑
Other foods (please specify)	❑
Other foods (please specify)	❑

2.6. As regards food served to clients: what is the percentage of leftover food from clients' plates (food returned to the kitchen)?

_____% of the food served to clients

SECTION 3 – ACTIONS AND INTENTIONS

3.1. Has the restaurant implemented actions/measures/strategies aimed at reducing food surplus and the amount of food destined to landfill?

YES	□
NO	□

3.2. (If you answered YES to question 3.1) If you have taken action to reduce waste, can you specify what type of

strategies were used?

	YES	NO
Proper management of daily bookings and therefore more efficient purchase planning for the effective demand of the day	□	□
To enable the clients to take home their leftovers in special containers (so-called "doggy bag")	□	□
Freezing food scraps within 2 hours to be consumed within the following 24 hours.	□	□
Other specific strategies: (please describe) _____	□	□
Other specific strategies: (please describe) _____	□	□

3.3. If you have never suggested using doggy bags, what was the main reason?

_____

3.4. Have you heard of the “Il buono che avanza” restaurant chain and its activities?

YES	□
NO	□

3.5. Has your restaurant activated a campaign to raise awareness on food waste and its various impacts in order to ensure that the chefs prepare meals with the least possible waste?

YES	□
NO	□

3.6. Would it be advisable to introduce some dishes made with kitchen scraps (for example fruit and vegetable peelings, fish scraps, etc ...)

- ☐ Definitely YES
- ☐ More YES than NO
- ☐ More NO than YES
- ☐ Definitely NO

3.7. Do you think that implementing initiatives aimed at reducing food waste can lead to a reduction in the total costs incurred by your restaurant?

- ☐ Definitely YES
- ☐ More YES than NO
- ☐ More NO than YES
- ☐ Definitely NO

SECTION 4. MANAGEMENT OF FOOD SURPLUS

4.1 How if the food surplus generated in your restaurant managed? Please indicate which of the following strategies are implemented in your restaurant.

	SI	NO
Selling food on secondary markets: food surpluses sold at a lower prices to people who are not clients	□	□
Donation of food surpluses to charitable organizations to help people with economic and social problems	□	□
Sale of food scraps to animal feed manufacturers or for making products that are not intended for human consumption	□	□
Recycling the product within the production process.	□	□
The food scraps are placed in appropriate containers for composting organic waste.	□	□

None of the above-mentioned strategies, the food scraps are thrown away as undifferentiated waste.	□	□

4.2. Have you identified any other ways of managing food surpluses?
If yes, indicate which:

_____

_____

4.3. From an economic point of view, does the management of food surpluses imply incurring extra costs for your business or are the can the various strategies be considered ways of recycling products at zero cost?

- ☐ Incurrence of additional costs, please specify which: _____
- ☐ management of surpluses at zero cost

5. INFORMATION ON THE RESTAURANT

5.1. Location (Municipality and Province) _____

5.2. Age of proprietor _____

5.3. Gender of proprietor _____

5.4 Number of restaurant covers (potential) _____

5.5. Number of restaurant covers served weekly (on average) _____

5.6 Frequency of opening: indicate the number of days the restaurant is open per week _____

Annual Opening

- □ YES
- □ NO (indicate the number of months the restaurant is open per year)

5.7. Opening hours:

- ☐ Lunch and dinner
- ☐ Only lunch
- ☐ Only dinner
- ☐ Other opening hours_____

5.8 Type of cuisine (mainly):

- ☐ Meat
- ☐ Fish
- ☐ Pizzas
- ☐ Ethnic
- ☐ Other prevailing dishes_____

5.9 Average price of a meal per person including drinks (if the restaurant is open for both lunch and dinner, consider the average price for dinner)

- ☐ Below 20 Euro
- ☐ Beween 20 and 40 Euro
- ☐ Between 40 and 60 Euro
- ☐ Over 60 Euro

5.10 Total number of people employed in the restaurant (including dining room and kitchen staff): _____

752 5.11 Business start date (year) _____

753

754 **References**

755 Bartus, T. (2005). Estimation of marginal effects using margeff. Stata Journal 5: 309–
756 329.

757 Betz, A., Buchli, J., Göbel, C., Müller, C., (2015) Food waste in the Swiss food service
758 industry – magnitude and potential for reduction. *Waste Management*. 35, 218–
759 226.

760 BIO Intelligence Service, European Commission, DG Environment. (2010).
761 *Preparatory Study on Food Waste across EU27. Technical Report - 2010* - 054.
762 European Commission.

763 Brautigam, K.-R., Jorissen, J., Priefer, C., (2014). The extent of food waste generation
764 across EU-27: different calculation methods and the reliability of their results.
765 *Waste Management*. Res. 32, pp. 683–694.

766 Buzby, J. C., Hyman, J., Stewart, H., & Wells, H. F. (2011). The value of retail-and
767 consumer-level fruit and vegetable losses in the United States. Journal of
768 Consumer Affairs, 45(3), 492-515.

769 Chen, J. S., & Hsu, C. H. (1999). The use of logit analysis to enhance market
770 segmentation methodology. Journal of Hospitality & Tourism Research, 23(3),
771 268-283.

772 Coldiretti, (2017), Consumi. Coldiretti, 6 Italiani su 10 tagliano sprechi nel 2016.

773 Corral, P., Terbish, M. (2015). Generalized maximum entropy estimation of discrete
774 choice models. *Stata Journal*, 15(2), 512-522.

775 Eriksson, M., Persson Osowski, C., Malefors, C., Björkman, J., Eriksson, E. (2017)
776 Quantification of food waste in food canteens – a case study from Sala
777 municipality in Sweden, Waste Management, 61, 415-422.

778 Exodus Market Research (2006) *A quantitative assessment of the nature, scale and*
779 *origin of post consumer food waste arising in Great Britain 2006*.

780 FAO, (2013), *Food wastage foodprint; Impacts on Natural resources*. Summary
781 Report.

782 Göbel, C., Langen, N., Blumenthal, A., Teitscheid, P., Ritter, G. (2015). Cutting Food
783 Waste through Cooperation along the Food Supply Chain. *Sustainability*, 7(2),
784 1429-1445.

785 Golan, A., Judge G. G., Miller D. (1996a). Maximum Entropy Econometrics: Robust
786 Estimation with Limited Data. Chichester, UK: Wiley.

787 Golan, A., Judge G., Perloff J. M. (1996b). A maximum entropy approach to
788 recovering information from multinomial response data. Journal of the
789 American Statistical Association 91: 841–853.
790 Graham-Rowe, E., Jessop, D. C., Sparks, P. (2014). Identifying motivations and
791 barriers to minimising household food waste. *Resources, Conservation and*
792 *Recycling*, 84, 15-23.
793 Griffin, M., Sobal, J., Lyson, T.A. (2009). "An analysis of a community food waste
794 stream", *Agriculture and Human Values*, Vol. 26 Nos 1/2, pp. 67-81.
795 Gustavsson, J., Cederberg, C. and Sonesson, U. (2011). *Global Food Losses and Food*
796 *Waste, Swedish Institute for Food and Biotechnology* (SIK), Gothenburg.
797 Hanson, C., Mitchell, P. (2017). The business case for reducing food loss and waste.
798 ChaMPioNs, 12, 7-8.
799 Heikkilä, L., Reinikainen, A., Katajajuuri, J. M., Silvennoinen, K., & Hartikainen, H.
800 (2016). Elements affecting food waste in the food service sector. Waste
801 Management, 56, 446-453.
802 Last Minute Market, SWG. (2016). *Waste Watcher 2016 Report*. Available at
803 https://www.lastminutemarket.it/home
804 Lorenz, B. A., & Langen, N. (2018). Determinants of how individuals choose, eat and
805 waste: Providing common ground to enhance sustainable food consumption out-
806 of-home. International Journal of Consumer Studies, 42(1), 35-75.
807 Marthinsen, J., Sundt, P., Kaysen, O., Kirkevaag, K. (2012). *Prevention of Food Waste*
808 *in Restaurants, Hotels, Canteens and Catering*. Nordic Council of Ministers,
809 Copenhagen.
810 Ministero dell'Ambiente Italiano, (2015) Perdite e sprechi alimentari. I numeri del
811 fenomeno.
812 Mondéjar-Jiménez, J. A., Ferrari, G., Secondi, L., Principato, L. (2016). From the table
813 to waste: An exploratory study on behaviour towards food waste of Spanish and
814 Italian youths. Journal of Cleaner Production, 138, 8-18.
815 Monier, V., Escalon, V., O'Connor, C. (2010). *Preparatory Study on Food Waste*
816 *Across EU 27 October 2010*. European Commission.
817 Neff, R. A., Spiker, M. L., & Truant, P. L. (2015). Wasted food: US consumers' reported
818 awareness, attitudes, and behaviors. PloS one, 10(6), e0127881.

819 Papargyropoulou E., Wright N., Lozano R., Steinberger J., Padfield R., Ujang Z.
820 (2016). Conceptual framework for the study of food waste generation and
821 prevention in the hospitality sector. *Waste Management*. 2016 Mar;49:326-36.
822 Parfitt, J., Barthel, M. and Macnaughton, S. (2010), Food waste within food supply
823 chains: quantification and potential for change to 2050, *Philosophical*
824 *Transactions of the Royal Society*, Vol. 365, pp. 3065-3081.
825 Pirani, S.I, Arafat H.A (2016). Reduction of food waste generation in the hospitality
826 industry, *Journal of Cleaner Production*, Volume 132, 20 September 2016,
827 Pages 129–145.
828 Principato, L., Secondi, L., Pratesi, C.A. (2015). Reducing food waste: an investigation
829 on the behaviour of Italian youths. *British Food Journal*, 117 (2), pp. 731–748.
830 Risku-Norja, H., Kurppa, S., Silvennoinen, K., Nuoranne, A., Skinnari, J., (2010).
831 *Julkiset ravitsemispalvelut ja ruokakasvatus: arjen käytäntöjen kautta*
832 *kestävään ruokahuoltoon*. MTT. Tampereen yliopistopaino Juvenesprint Oy.
833 pp. 56. Available in Finnish.
834 Secondi, L., Principato, L., Laureti, T. (2015). Household food waste behaviour in EU-
835 27 countries: A multilevel analysis. *Food Policy*, 56, 25-40.
836 Schneider, F. (2013) Review of food waste prevention on an international level. Proc.
837 ICE *Waste Resour. Manag*. 166, 187e203.
838 Sirieix, L., Lála, J., & Kocmanová, K. (2017). Understanding the antecedents of
839 consumers' attitudes towards doggy bags in restaurants: Concern about food
840 waste, culture, norms and emotions. Journal of Retailing and Consumer
841 Services, 34, 153-158.
842 Soofi, E. S. (1992). A generalizable formulation of conditional logit with diagnostics.
843 *Journal of the American Statistical Association* 87: 812–816.
844 Sustainable Restaurant Association. (2010). *Too Good To Waste*.
845 UNDP (2016) United Nations Development Programme, Sustainable Development
846 Goals, available at http://www.undp.org/content/undp/en/home/sustainable-
847 development-goals/goal-12-responsible-consumption-and-production/targets/
848 WRAP (2013a) *Understanding out of home consumer food waste*, Banbury, UK.
849 WRAP (2013b) *Where food waste arises within the UK hospitality and food service*
850 *sector: spoilage, preparation and plate waste*. Banbury, UK.