Who cleans the plate? Food waste assessment in an Italian restaurant

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Summary

Dining out of home is becoming a common habitude for an increasing number of consumers, and the food service sector is expected to see significant rates of growth in the next few years. This expansion is likely to increase the amount of food waste generated at restaurants and food service institutions, which are currently believed to produce 12% of the total food waste in the European Union. Food service is also one of the stages of the food chain where the greatest potential of food waste reduction can be expected. While many studies are available on the quantification of food waste in public food services, much less information is available on the dynamics and the extent of food waste at private restaurant. This study provides an assessment of the plate waste produced in one case study restaurant, located in Central Italy, over a week. The plate waste of 640 diners were separated into 5 course and weighted at the end of the service. The average waste of 9.15 kg per day, out of which 39% was made of pizza, followed by 22% of meat dishes with sides, 15% of starters and 14% of pasta. Fruits and desserts, with 10%, represented the smallest share of the total plate leftovers Plate waste per capita was 85.79 grams on average, and it was significantly associated with the type of dish ordered by the diners, as well as with the total number of serving prepared at the restaurant during the day. Although it is not possible to get conclusive results from this study, some hints on strategies against food waste as well as paths for further research are drawn in the paper.

Keywords: food waste, plate leftovers, restaurant, food service, waste assessment

JEL Classification codes: L83, Q01, Q18, Q53

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1. INTRODUCTION

The food service sector is expected to see significant rates of growth in the next few years, due to changing lifestyles and increased food consumption out of home. This expansion is likely to increase the impact of the new food consumption habitudes on the diet of the consumers as well as the amount of food waste generated at restaurants and food service institutions. Currently, it is estimated that the food service sector contributes to 12% of the total food waste produced in the European Union (Stenmark et al., 2016), therefore representing the second largest source of food waste following households (Brautigam et al., 2014; Monier et al., 2010). Food service is also one of the stages of the food chain where the greatest potential of food waste reduction can be expected (Parfitt et al., 2010).

While several studies have tackled the quantification and analysis of food waste in public catering services, such as hospitals (Sonnino & McWilliam, 2011; Silvennoinen et al., 2015; Eriksson et al., 2018) and schools (Eriksson et al., 2017; Falasconi et al., 2015; Boschini et al., 2018; Eriksson et al., 2018), much less research has been conducted on the food waste generated by the hospitality sector, i.e. restaurant, bars and hotels. In this sector, there is a huge lack of data (Principato et al., 2018; Pirani and Arafat, 2016; Schneider, 2013), both concerning the quantity of food waste produced and the underlying causes (Heikkilä et al., 2016).

Recently, studies to this regard have been conducted in the UK, where the amount of food wasted by the hospitality sector has been estimated as 682 million GBP (£) per year, including food procurement, labour and service costs, utilities and waste management costs (WRAP, 2013). In Finland, about 20% of all food produced and served in licensed restaurants is discarded (Silvennoinen et al., 2015). In another study involving 195 restaurants located in 4 different Chinese cities, an average waste per meal of 93 g was calculated, consisting mainly of vegetables and rice (Wang et al., 2017). The amount of food waste at restaurants varies according to the type of meal (e.g. more food is wasted at friends gathering and business banquet; Wang et al., 2017) and to the type of restaurant (diners tend to waste more in upscale restaurants; Principato et al., 2018).

The most common causes of wasted food in the restaurant service sector include: incorrect storage, preparation residues, improper handling of food products, over-preparation, leftovers on plates, difficulty in forecasting number of clients, forgotten and spoiled food, lack of awareness by the restaurant managers (Sakaguchi et al., 2018).

Possible strategies to prevent and reduce the quantity of food waste generated at restaurants have also been discussed in the literature, among which: the search of a higher efficiency in food service operations (Sakaguchi et al., 2018), the ability to use food scraps in cooking (Principato et al., 2018); donating the prepared food that remains unserved (Sakaguchi et al., 2018) or inviting customers to use doggy bags to take

leftovers away (Mirosa et al., 2018; Principato et al., 2018), along with education and awareness rising initiatives tackling restaurant managers or 'nudging' clients to more sustainable food choices (Sakaguchi et al., 2018; Filimonau et al., 2017; Kallbekken and Sælen, 2013).

This study aims to contribute to the emerging knowledge about food waste at restaurants by analysing the data gathered at a case study restaurant in Italy. The focus of the paper is on the quantification of plate leftovers and on the analysis of the features of the service that may have an influence on such quantity.

2. DATA AND RESEARCH METHODOLOGY

2.1. Case study

The data used for the analysis was retrieved in case study restaurant located in Viterbo, Central Italy. It is a family-restaurant opened in 1957 and settled in an ancient building overlooking the main square of the medieval village of Bagnaia. The restaurant is a large location with 250 seats, that offers a range of additional services including a bar/cafeteria, a pastry shop and the possibility to organize events.

The restaurant is open every day except Mondays, both for lunch and dinner. The menu covers all the traditional dishes of the surrounding area, especially home-made pasta, locally produced cold cuts and meats, as well as seasonal vegetables and mushrooms. A significant part of the menu available at dinner is devoted to pizza with different toppings.

The clients of the restaurant vary from people working in the surroundings (having lunch on weekdays), to groups of friends (dinners throughout the week) and families (mostly on Saturday night and for the lunch on Sundays).

2.2. Methodology of food waste monitoring

The study took place in December 2018, over one week, with 6 days of service (from Tuesday to Sunday) at lunch and dinner. The focus of the analysis was on the quantification of plate waste, i.e. the food left in the plates by the diners.

For each service, the following information was recorded:

- number of diners per day;
- number and type of courses served per day;
- weight of plate leftovers for each type of course.

The first two information were gathered through the collection of the data recorded by the software used at the restaurant to manage reservations and orders. Plate leftovers were separated and disposed in 5 different bins (starters, pasta, main course with sides, pizza, fruit/desserts) and then weighted separately on a digital scale. Data was noted per day, each day including both the lunch and the dinner services.

The assessment concerned plate leftovers only, while no information was available on the food scraps disposed at the kitchen during preparation.

2.3. Statistical analysis

The final dataset included 30 entries (6 days x 5 courses). Basing on the data available, the following variables were created:

- DAY: the different days of the week concerned by the analysis were divided among "early weekdays" (Tuesday and Wednesday), "late weekdays" (Thursday and Friday), Saturday and Sunday;
- COURSE: this variable had 5 categories, "starters", "pasta", "meat/sides", "fruit/dessert", "pizza";
- DINERS: number of diners recorded at the restaurant during the day;
- SERVINGS: number of serving ordered and prepared per day, by type of course;
- PLATE WASTE: weight (g) of plate waste per day, by type of course;
- AVERAGE COURSES: average number of courses per diner, calculated as the total number of servings prepared at the restaurant, divided for the number of diners, per day;
- WASTE PER SERVING: average weight (g) of food waste per type of course, calculated as the total waste of each course (i.e. the weight of each bin) divided for the number of servings prepared, per day.

"Waste per serving" was then used as a dependent variable in a regression analysis, where the quantity of plate waste per serving was studied against the day of service, the type of course, the number of persons dining at the restaurants, the number of servings prepared and the average number of courses per client.

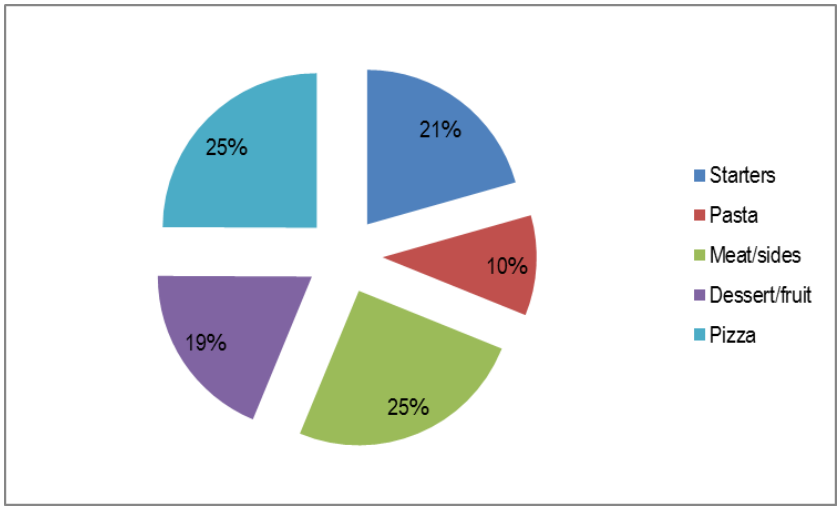
The ANCOVA model was used to this purpose (Tabachnick et al., 2007); this model blends a linear regression with an ANOVA analysis, as it allows to study the effect of numerical and categorical factors on a numerical dependent variable. Results are expressed as parameters of the model, which are estimated for all the numerical factors and for each category, with the exception of one reference category for each categorical explanatory factor.

3. RESULTS AND DISCUSSION

3.1. Quantity of food waste generated at the case study restaurant

The assessment concerned the plate waste of 1.392 dishes, divided as showed in Figure 1, and ordered by the 640 customers that ate at the restaurant during the study period. Nearly half of the customers dined at the restaurant during the weekend, and ordering pizza was particularly common on Saturday night.

Figure 1: Share of the different courses served at the restaurant during the study period.



During the study period, 54.91 kg of plate waste were produced at the restaurant, with an average waste of 9.15 kg per day. The variability among the service days was remarkable, ranging from a minimum of 3.30 kg of food waste recorded on Tuesday (35 diners) to a maximum of 15.47 kg on Saturday, when the

turnout of customers was very high (185 diners). Out of the total plate waste recorded, 39% was made of pizza, followed by 22% of meat dishes with sides, 15% of starters and 14% of pasta. Fruits and desserts, with 10%, represented the smallest share of the total plate leftovers (Figure 2).

Figure 2: Share of plate leftovers per course.

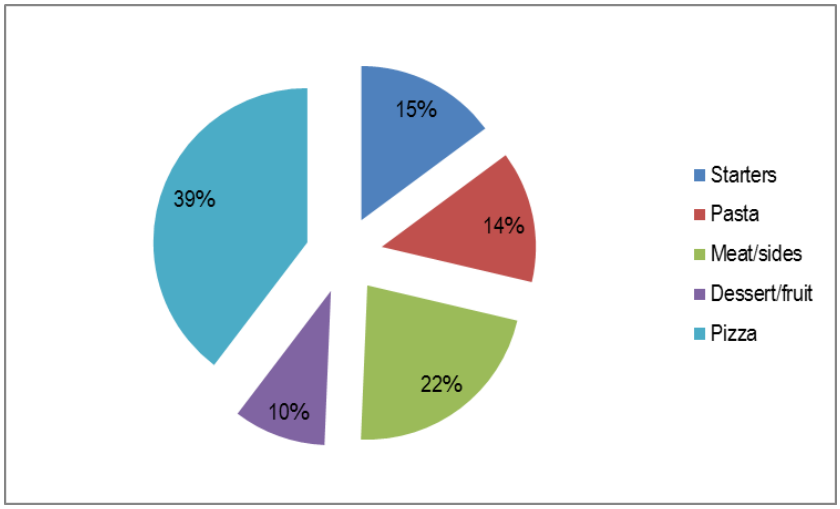


Plate waste per capita was 85.79 grams on average, corresponding to 39.45 grams per serving, with 2.18 servings consumed by each diner during the study period. As expected, the number of courses ordered by the diners each day and the average daily plate waste were highly correlated (r=0.77), showing that when customers order more courses, they are more likely to leave food in their plate.

The amount of plate leftovers per served dish was also assessed (Table 1), ranging from 20.32 grams for fruits and desserts to 62.73 grams in the case of pizza. For the latter, it should be remarked that the amount of leftovers was particularly relevant; given that an average weight of a pizza can be estimated of 350 grams, this means that almost 20% of each served pizza was disposed of. Starters show the lowest food waste per dish, probably because they are served first, when the diners are hungrier.

Table 1. Plate waste per serving, by type of course.

Course	Total number of servings	Plate waste (kg)	Plate waste per serving (g)
Starters	287	8.16	28.44
Pasta	146	7.58	51.92
Meat/side	350	12.08	34.50
Dessert/fruit	262	5.32	20.32
Pizza	347	21.77	62.73
Total	1,392	54.91	39.45

Source: own elaboration

3.2. Results of the statistical analysis

Before running the model, the correlation between the numerical explanatory factors and the dependent variable was studied (Table 2), showing a well expected correlation between the number of diners and the number of servings, but not any other relation among the variables.

Table 2. Correlation matrix among the numerical variables of the model.

	DINERS	SERVINGS	AVERAGE COURSES	WASTE PER SERVING
DINERS	1	**0,653**	-0,287	-0,072
SERVINGS	**0,653**	1	-0,031	0,024
AVERAGE COURSES	-0,287	-0,031	1	0,014
WASTE PER SERVING	-0,072	0,024	0,014	1

Source: own elaboration

The ANCOVA model provided an adjusted R^2 of 0.851, and the F test was significant for $p<0.0001$. The parameters of the model are reported in Table 3.

Table 3. Parameters of the ANCOVA model (N=30).

Factor	Parameter	Standard error	t	Pr > |t|
DINERS	-0.180	0.415	-0.435	0.669
SERVINGS	0.116*	0.062	1.862	0.078
AVERAGE COURSES	-1.144	21.776	-0.053	0.959
WEEKDAY-Saturday	17.096	64.775	0.264	0.795
WEEKDAY-Sunday	3.426	38.238	0.090	0.930
WEEKDAY-late week	8.559	31.788	0.269	0.791
WEEKDAY-early week	0.000	0.000		
COURSE-dessert/fruit	-16.270***	3.967	-4.102	0.001
COURSE-starter	-8.974**	3.915	-2.292	0.033
COURSE-pasta	19.485***	4.400	4.428	0.000
COURSE-pizza	24.773***	3.861	6.417	< 0.0001
COURSE-main	0.000	0.000		

Source: own elaboration

* significant for $\alpha<0.10$; ** significant for $\alpha<0.05$; *** significant for $\alpha<0.01$

The main factor shaping the quantity of plate waste was the type of course. Namely, with respect to the main course (meat dish with sides), pizza and pasta showed significantly higher plate waste, while the quantity of food discarded was much lower for desserts, fruits and starters. Although this effect can be partly due to the different weight of the food concerned by these dishes, with pizza and pasta showing the highest weight of the serving, the results appear clear in showing what type of dishes are associated with the highest waste by customers. Re-designing restaurant menus may help reducing the waste of the courses for which customers are more likely to leave meaningful quantities in the plate; however, the willingness of restaurant managers to adopt this strategy may not be very high (Filimonau & Krivcova, 2017).

Another factor showing a certain significance was the number of servings; the positive parameter associated with this variable suggests that as the number of ordered servings increase, the quantity of plate leftovers also does. Although this result is hard to explain, it may be linked to the higher number of servings prepared for meals organized for large groups of diners; during these gatherings, food is often served in trays placed at the centre of the table, which may increase waste with respect to courses served to individual diners. Instead, no effect was detected for what concerns the number of diners at the restaurant, the average number of courses that they ask for, nor for the different days of the week.

It was interesting to note that across the 6 days of the study only one diner asked for a "*doggy bag*" to carry home the food not eaten. This confirms the general non positive attitude of restaurant customers towards doggy bags (Sirieix et al., 2017) and it suggests, how highlighted by Principato et al. (2018), that more effort is needed to push restaurant managers to actively propose this option to their customers.

Several limitations shall be recalled with respect to the results of the study. First, we focus the analysis on plate waste only, therefore it is not possible to assess the rate of waste with respect to the quantity of food prepared in the kitchen, nor to measure the waste occurring during preparation. The latter may be particularly relevant in private restaurant, much more than in public foodservices (Silvennoinen et al., 2015). The data available, which only concerns one restaurant and a daily quantification of food waste (without being able to separately analyse lunch and dinner services), also show some weaknesses, thus preventing from the possibility to generalize the results. Findings shall be therefore intended as an attempt to have a first prospect on the phenomenon of food waste at private restaurants, which remains one of the most unexplored sources of food waste along the supply chain.

4. CONCLUSIONS

The research about the generation of food waste in food service operations is flourishing, however few studies have tackled the assessment of food waste at restaurants. This is a meaningful gap in the literature as eating out of home several times a week has become a common habit in many countries.

This study represents a first attempt to collect data about this topic through the assessment of the food left in the plate by restaurant diners. Even if the survey concerns only one restaurant and covers a relatively limited period, it provides interesting feedbacks.

First, the study suggests that the amount of plate leftovers is remarkable. In particular, it happens for pizza and pasta, where the average leftovers are more than 50 grams per diner. The food waste associated to pizzas is relevant, considering that, on average, about 20% in weigh is discarded and that pizza does not contain any inedible parts. Second, results suggest that the common Italian habitude to order several courses within a meal is likely to increase the amount of food left by the diners in their plates.

The doggy bag, which could represent a first and easy way to reduce food waste at restaurant, was very rarely requested by customers and it is not proposed by restaurant waiters. Taking home the leftovers from the meal is a uncommon behaviour in the Italian culture, however a progressive change of this habit could be induced both by increasing consumer awareness and by promote local policies aimed at pushing restaurants to reduce the amount of waste to be disposed.

The survey is too limited to provide reliable information on the variables affecting the amount of leftovers; some first indications, such as the number of servings or the table composition (in terms of number of diners and their characteristics) need to be validated by further studies.

Carrying out direct measurements of food waste in restaurants and, more in general, in private food services is not easy, as any recording activities may affect the service operations which are usually very much time-constrained. Therefore, researchers' efforts are needed to sensitize restaurant managers over the issue of food waste, thus convincing them to support food waste monitoring research activities. This may allow to get more information about the extent and the causes of this significant component of food waste at the consumption stage of the food supply chain.

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