What Drives Food Waste in Higher Education Event Catering?

Charlotte Brockbank. Ringtons, Ltd, charlotte.brockbank@ringtons.co.uk, Diogo M. Souza Monteiro, School of Natural and Environmental Sciences, Newcastle University, diogo.souza-monteiro@newcastle.ac.uk, Graeme Heron, Newcastle University Business School, graeme.heron@newcastle.ac.uk

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Abstract

The most recent estimates suggest the hospitality and food service industry generates 9% of the total amount of food wasted annually in the UK (WRAP 2017). Within foodservice, event catering is a significant generator of food waste (Parfitt et al., 2013). The higher education sector is both a supplier and buyer of catering services for internal and external meetings, conferences and other events. There is limited research quantifying the determinants of waste in institutional event catering services. This research had two main aims: to measure how waste is generated in different events and how it is affected by environmental and human factors. Using a mixed-method methodology, we quantify food waste generated in a events at Newcastle University and a survey to event organizers asking what factors influence their choices. We find there are significant differences in the average waste across venues and food categories. We also find that experienced event organizers significantly waste, on average, around eleven percent less food.

Keywords: Food waste, Event catering, Higher education

1. Waste in food service and event catering

The hospitality and food service industry generates an estimated 900 thousand tons of food waste in the UK annually (WRAP, 2017). The food service industry is particularly susceptible to waste generation as businesses are paid by the amount of food *served* rather than the food *consumed*. Wastage is likely even larger in event such as business meetings conferences and social and leisure gatherings like weddings, art gallery receptions or private parties. The reason being that nature of the event (either a ludic or professional) affects the way food is ordered, prepared, served and consumed. Also in these types of events the success of the catering is associated to the volume and variety of food offered and failure to cater for all attendees' is not acceptable. Finally, until recently, there were limited costs of food waste disposal and therefore limited incentives to mitigate its volume.

Waste generation in event catering is due to multiple factors. These include, event type, venue, time in the day, and food served (Parfitt et al., 2013). These can be designated as the environmental drivers of food waste in events. But, human factors should also be considered in this equation. Waste in events may be due to errors in ordering, preparing, serving and cleaning (Gustavsson et al., 2011; Mena et al., 2012; Buzby and Hyman, 2012; Parfitt et al., 2013). So the behaviour of planners, organizers, those involved in preparation and serving food, as well as event attendants, all contribute to waste generation (Lazell, 2016). Despite the potential for waste generation in this sector of the food industry there is limited research quantifying and determining the drivers of waste in event catering.

This work aims to fill this gap by proposing a method to measure waste in event catering and determine the main drivers of food waste in higher education event catering. Our goal is to assess how much food waste is generated in events and how it may vary with environmental and human drivers. More specifically we aim to answer the following research questions: 1) How the size, time of the day, venue and type of catering service affects the amount of waste generated in higher education events; 2) To what extent the person ordering the food influences the amount of food waste generated.

Higher education provides a reasonable context and platform for analysis as Parfitt et al. (2013) suggests that catering in the UK education sector generates 123,000 tons of food waste yearly. Also, most higher education institutions in the UK have catering services that not only serve meals to the students in residency halls, but also for daily smaller and larger staff meetings, large celebratory occasions (for example graduations), conferences and workshops that include coffee breaks, lunches and often dinners. Thus in universities it is very likely a proportion of the food waste estimates by Parfitt are due to event catering. However, with the notable exception of Trivedi (2015), to the best of our knowledge there isn't any work estimating what level of waste may be generated in higher education and in event catering.

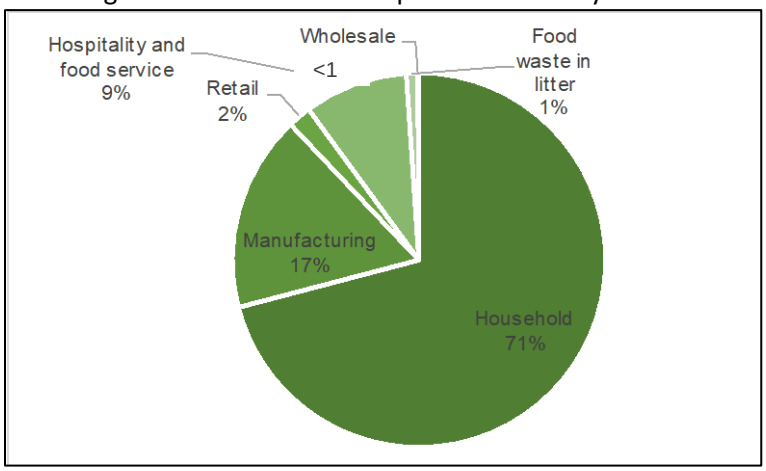
This paper is organized in four further sections. Next we briefly resume the extant literature investigating the food waste in food service in general and, more specific, in event catering. Then we describe our methodology. The fourth section presents and discusses our results and finally the last section concludes and suggests future research.

2. Waste in the food service industry

The most recent data made available by the Waste Resources Action Programme (WRAP) estimates approximately 10 million tonnes of food is wasted annually in the UK (WRAP, 2017). This has an

estimated value in excess of £17 billion (WRAP, 2017)[1]. Moreover, this contributes approximately 20 million tonnes of GHG emissions (WRAP, 2017). Figure 2.1 presents a breakdown of the total volume of waste between different sub-sectors of the food industry and households. Households have the largest proportion of food waste generated, but the hospitality and food service sector are significant contributors with just under 10% of waste estimated. WRAP (2017) suggests that 60% of this waste is avoidable, for example through correct storage, handling and preparation, therefore, there is significant scope for food waste reduction in the UK.

Figure 2.1: UK food waste per food industry sector

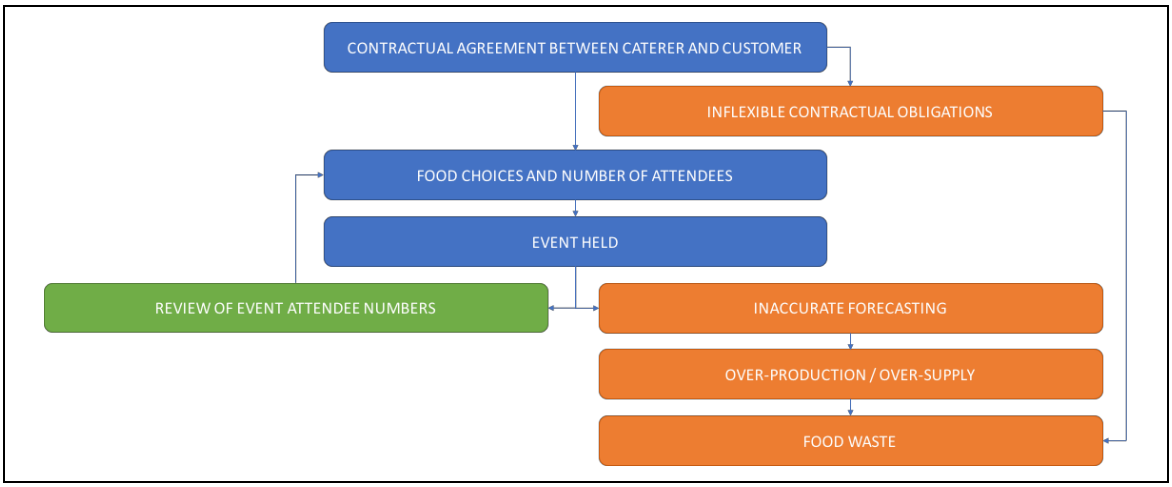


Source: Adapted from WRAP (2017).

Another report identified causes of food waste in events catering, these are: inflexible contractual obligations forcing caterers to overproduce, the need for third party caterers to meet the expectations of their customer and of consumers, and over-production influenced by inaccurate forecasting and incorrect estimation of event attendee numbers (WRAP 2015). Figure 2.2 draws on this WRAP study and details the processes that result in the generation of food waste within institutional event catering services, as well as practices to avoid food waste generation. The practices of ordering and producing event catering are detailed in blue, with best practice to minimize waste production in green. Factors that contribute to the generation of food waste are highlighted in orange.

Figure 2.2: Sources and processes of waste generation in institutional catering (WRAP 2015)

[1] In a recent paper Bellemare et al (2017) challenge these types of figures, suggesting a considerable overestimation of the volume and value of food waste generated.



Apart from the studies by policy agencies, non-governmental organizations (such as WRAP in the UK) and advocacy groups there is limited academic research quantifying food waste in the food service industry (Bellemare et al 2017). Also most studies are either conducted at national level or specific case studies.

Notable exceptions are recent studies conducted in Finland, Sweden and Switzerland. Silvennoinen et al (2015) evaluated and mapped the volumes and composition of waste streams across the food service sector. Specifically the study measured food waste in communcal food services, student canteens, restaurants, cafes, petrol stations and related food service outlets. Data collection involved the registrations of the daily amount of food prepared and served in a diary completed by the food service personel for 5 days. The diary included details on the types of dishes prepared and their composition. Then waste was measured by weighing the volume of two main waste streams: edible and non edible waste deposited in bespoke containers which were weighed daily and registred in the same diary also for 5 days. They found that about twenty percent of the food prepared was wasted and day-care centres, business and student canteens where the most wasteful outlets. They further found that waste was larger in self-service meals and was often linked to over production. Finally they found that vegetable dishes had the largest proportion of food waste. They suggest that better planing and a system to redistribute leftovers may significantly reduce the amount of waste ending in garbage bins.

Beretta et al (2013) quantified and modelled the food losses in Swiss food industry based on data from previous studies. This study assessed the average food waste across 22 food categories and different points of the supply chain. Regarding losses in food service, they find it averages 20% across the different food categories. Eggs are the food category with the largest and bread the lowest amounts food waste in the Swiss food service industry. Betz et al. (2015) conducted further research of the Swiss food supply chain finding that the foodservice industry is the third largest generator of food waste. Moreover they also found that 16% of the food waste can be attributed to human factors in education foodservice establishments and 18% to consumers in business foodservice establishments. An earlier study conducted in Sweden found that approximately 20% of food is lost or wasted in the foodservice industry (Engström and Carlsson-Kanyama, 2004).

Closer to our research, Trivedi (2015) conducted case studies of catering and foodservices at UK universities[2]. He examined food and packaging waste across univeristy institutions, for all food outlets, not specifically events catering. He found that the main drivers of waste are: a) poor forecasting, due to the fact that whilst event caterers are given the attendance numbers for which to cater for, often they are not informed of cancellations which leads to over-production; b) personnel within foodservice tend to be process and output focussed in relation to order confirmations as a tue picture of demand. Consequently, Trivedi concluded that there are opportunities for behavioural change to reduce and eliminate food waste, specifically plate waste at the point of consumption.

2.1 Determinants of food waste at the consumer level

The research reviewed in the previous section clearly suggests that human attitudes, practices and behavior affect the generation of waste (Evans, 2014). Behaviours that generate food waste must first be understood before mitigation strategies can be put in place to prevent food waste (Lazell, 2016). The literature regarding consumer food waste behaviours has reported that some consumers feel guilty when wasting food (Visschers et al., 2016), but research findings regarding food waste attitudes differ. For example, Parizeau et al. (2015) found that awareness of food waste led to reductions in food waste. Similarly, a number of studies found that the more consumers intend to avoid waste, the less waste is produced (Stefan et al., 2013; Graham-Rowe et al., 2015; Visschers et al., 2016). However, research by Buzby et al. (2011) and Pearson et al. (2013) has found little consumer awareness or concern over food waste. Additionally, research by Graham-Rowe et al. (2014) has found that avoiding food waste is not a priority for most consumers. Therefore, it is unlikely that consumer awareness alone will reduce food waste as required.

Whilst there is extant literature researching consumer food waste behaviours within the household, there is limited research focusing on consumer concerns over food waste outside of the home (Lazell, 2016). Stancu et al. (2016) and Visschers et al. (2016) identified several consumer determinants of food waste within households. Motivations present within a consumer's home may not be present in other settings, therefore consumer behaviour will likely differ in institutional settings. For example, behavioural differences may be attributed to the perception that consumers feel they have less control compared with when they are within their own home (Visschers et al., 2016). Therefore, it is likely that such determinants vary within different settings.

Miao and Wei (2013) assessed consumer's "pro-environmental" motivations and behaviours, which include reducing waste, in both household and hotel settings. Although direct comparisons cannot be made between hotel and institutional event catering settings, some findings of Miao and Wei (2013) provide important insights. For example, it is reported that pro-environmental behaviours are most prominent in consumers within their home. Additionally, further determinants exist. For example, financial concerns have been identified as a determinant of food waste, as price-conscious consumers desire to waste less food (Visschers et al., 2016). Thus, consumers are motivated economically to behave pro-environmentally (Miao and Wei, 2013). However, financial concerns present for the individual consumer within household settings may not be present amongst individuals in their place of work (Parfitt et al., 2010; Thyberg and Tonjes, 2016). Outside of the consumers' home, food produced by others is generally valued less by consumers, and subsequently, consumers are more likely to waste such food (Strasser, 1999; Thyberg and Tonjes, 2016). Miao and Wei (2013) identify the need for further

[2] His study was based on catering services at the University of Salford, Manchester Metropolitan University, University of Manchester, Newcastle University and Small World Cafe (Manchester).

research of consumer behaviours to be conducted in hospitality settings, including foodservice and catering.

2.2 Measuring and quantifying food waste

It is not surprising there are only a few studies measuring food waste in specific institutions or sub-sectors of the food service industry as there are practical implications associated with collecting data on food waste (Langley et al., 2008). Recently three studies proposed alternative methodologies to estimate the volume of food waste within foodservice and catering environments. Hanks et al. (2013) compared three methods: photography, half-waste and quarter-waste methods. Whilst the photography method allows quick data capture, Hanks et al. (2013) found low reliability of photography methods due to difficulties in estimating waste in packaging and containers. This limitation is dependent on the types of food items under assessment. For example, in buffet event catering it is likely that this limitation is reduced as few, if any, items are served within individual packaging. The quarter-waste method was found to be the most reliable and produced measurements similar to weighing containers (Hanks et al., 2013). However, both the half-waste and quarter-waste methods have limited accuracy as some measurements may lie outside of the pre-determined boundaries (for example, 'none', 'half' or 'all' and 'one-quarter', 'one-half' and 'three-quarters') and are subjective due to interpretation.

Martins et al. (2014) compared two methods: direct weighing and visual estimation methods. The direct weighing method is also detailed by Hanson et al. (2016). The visual estimation method used by Martins et al. (2014) can be likened to the quarter-waste method used by Hanks et al. (2013). The direct weighing method is limited as the method is time-intensive as weighing is required before and after serving. However, weighing allows accurate information to be recorded. The visual estimation method allows data to be captured quickly, however, as with the half-waste and quarter-waste methods used by Hanks et al. (2013), the visual estimation method is subjective. Martins et al. (2014) concluded that visual estimation over-estimated plate waste values, however visual estimation methods combined with weight measurements allowed verification.

In conclusion, the literature provides some evidence that the type of food service and the way food is presented may affect the generation of waste. Also, it is clear that consumers don't see food waste as a major concern, but there is some evidence that those that are conscious of waste are willing to commit to reduce waste. Finally, one of the major challenges is how to best measure food waste. The literature proposes a few methods that will be adapted and discussed in the next section where we present our methodology.

3. Methods

Our research aims to measure waste and determine what are its main drivers at the micro level. Specifically we focus at event catering in higher education and want to understand how both the environment and the person ordering the event catering may drive the waste generated. Thus the methods described in Hanks et al (2013) and Martins et al (2014) are better suited to our case than the methods developed and applied by Beretta et al., (2013) and Silvennoinen et al. (2015) which sought to assess waste along a range of different outlets or along the supply chain.

As we developed our approach we were confronted with a number of logistical and practical issues that conditioned our progress and initial plan. While we intended to weigh the actual volume of waste using a similar strategy to that of Silvennoinen et al (2015) and Martins et al (2014), in our pilot data collection we realized that we would have limited cooperation from waste disposal services to segregate into different waste streams. Furthermore, we faced complains by event organizers when our

research team arrived at the end of the event to gather data. Consequently we had to revisit and redesign our approach and chose to combine the methods described in Hanks et al (2013) and Martins et al (2014).

Given that we had detailed information on the catering invoice which detailed exactly the quantity and the type of items supplied in the event (along with the size, time and venue of the event) we had a very clear idea of the total quantity of food disposed. Consequently, we decided that rather than collecting the waste, we would simply photograph the left-overs, calculate what was left in each food category by inspecting photos and then calculate the difference of what was left to what was in the original order. The method of waste quantification was dependent upon the food category. For example for the sandwich category waste was estimated per unit, but for soup we used the half-waste method described in Hanks et al (2013). Table 3.1 details the waste method we use to assess waste in each category.

Table 3.1 Waste measuring methods per food category (adapted from Hank et al., 2013).

Method	**Method description**	**Food category***
Photography method	Waste photographed and food waste estimated.	All
Per unit method	• Used in combination with the photography method. • Determined how many units of a food item were wasted.	Light bites and snacks; Nibbles (e.g. Mozzarella sticks, Chicken skewers); Sandwiches, Sweet treats (e.g. whole cut cake); Wraps
Half-waste method	• Used in combination with the photography method. • Determined whether none, half or all of a food item was wasted.	Crisps; Soup
Quarter-waste method	• Used in combination with the photography method. • Determined whether one-quarter, one-half, three-quarters or all of a food item was wasted.	Afternoon tea; Selection platter (e.g. British, Chinese, Indian); Salads; Sharing platters (e.g. Mediterranean, Northumbrian, Ploughman's); Sweet treats (e.g. cake/biscuit platters, fruit platter)

The data was collected from a convenience sample of 91 events occurring between April and May 2017 in Newcastle University and catering using the University Catering services EAT@Newcastle. Our sample was designed to cover a variety of events characterized in terms of size (that is number of attendants) and menu type (ranging from just hot drinks, cakes and fruit to a more complete meal) as detailed in Table 3.2 below.

Table 3.2: Sample characteristics

Size of event	Menu Type			
	A	B	C	
	Cakes/fruit only	'A' and/or Sandwiches/Crisps only	'A' or 'B' and/or other food options	Total
0-10	1	10	4	**15**
11-50	10	17	0	**27**
51+	9	35	5	**49**
Total	**20**	**62**	**9**	**91**

Unfortunately we could not obtain a balanced sample of events in our data collection process, this is in line with other research in food catering and stresses the difficulty in rigorously estimate food waste reported in Bellemere et al (2017). Still, given that our unit of observation is the event we believe we have sufficient data to provide evidence on how waste may be related to the type of event. The data collected from this sample enables to meet our first goal which is to evaluate how environmental factors affect the waste produced. However we had a second objective which was to understand to which human factors affect the amount of waste. Specifically we aim to understand the extent to which the person ordering the food impacted on the amount of waste produced. Towards this goal we designed and administered a survey to a list of event organizers obtained from EAT@Newcastle in May 2017.

The survey was created to identify factors that influenced customers when ordering event catering, subsequently affecting the generation of food waste. The survey instrument (available upon request) was adapted from previous work examining consumers' attitudes to food waste, namely on instruments developed by WRAP (2007), Stancu et al. (2016) and Lorenz et al. (2017). The instrument comprised two main sections: firstly, the survey ascertained information about the customers' ordering history, namely: frequency, types and size of events ordered for, and how recently they placed an order. Secondly, the survey sought to discover the customers' perceptions of left-over and wasted food generated by event catering. Given we had information on who organized the events from which we collected waste data, we were able to match our survey responses to a particular event on which we gathered data on. This allows us to assess both the environmental and human drivers of food waste.

We distributed the survey to 672 event organizers listed in the EAT@Newcastle database registering orders over the period May 2016 to May 2017. The survey lodged in Qualtrics and administered to an email list. We obtained 188 valid responses, of which 29 coincided with the organizers of the events we gathered waste data on.

3.1 Data analysis methods

To establish our results food waste quantification data was used to establish how factors (including event size, time, venue and type of food chosen) affected the generation of food waste. Tests of normality (Shapiro-Wilks) were used to ascertain if data was parametric or non-parametric. For parametric data, one-way analysis of variance (ANOVA) was used to test for differences in average waste per factor (event size, time, venue and type of food chosen). For non-parametric data, Kruskal-

Wallis was used to test for differences in average waste per factor (event size, time, venue and type of food chosen). Analyses were completed in Rcommander (R Core Team, 2014; Fox, 2005).

Tests of normality (Shapiro-Wilks) were used to ascertain if data was parametric or non-parametric. For parametric data, one-way analysis of variance (ANOVA) was used to test for differences in average waste per size of event. For non-parametric data, Kruskal-Wallis was used to test for differences in average waste on hour on which events took place, venue (divided between administration and academic buildings and food categories per factor. Analyses were completed in Rcommander (R Core Team, 2014; Fox, 2005).

4. Results and discussion

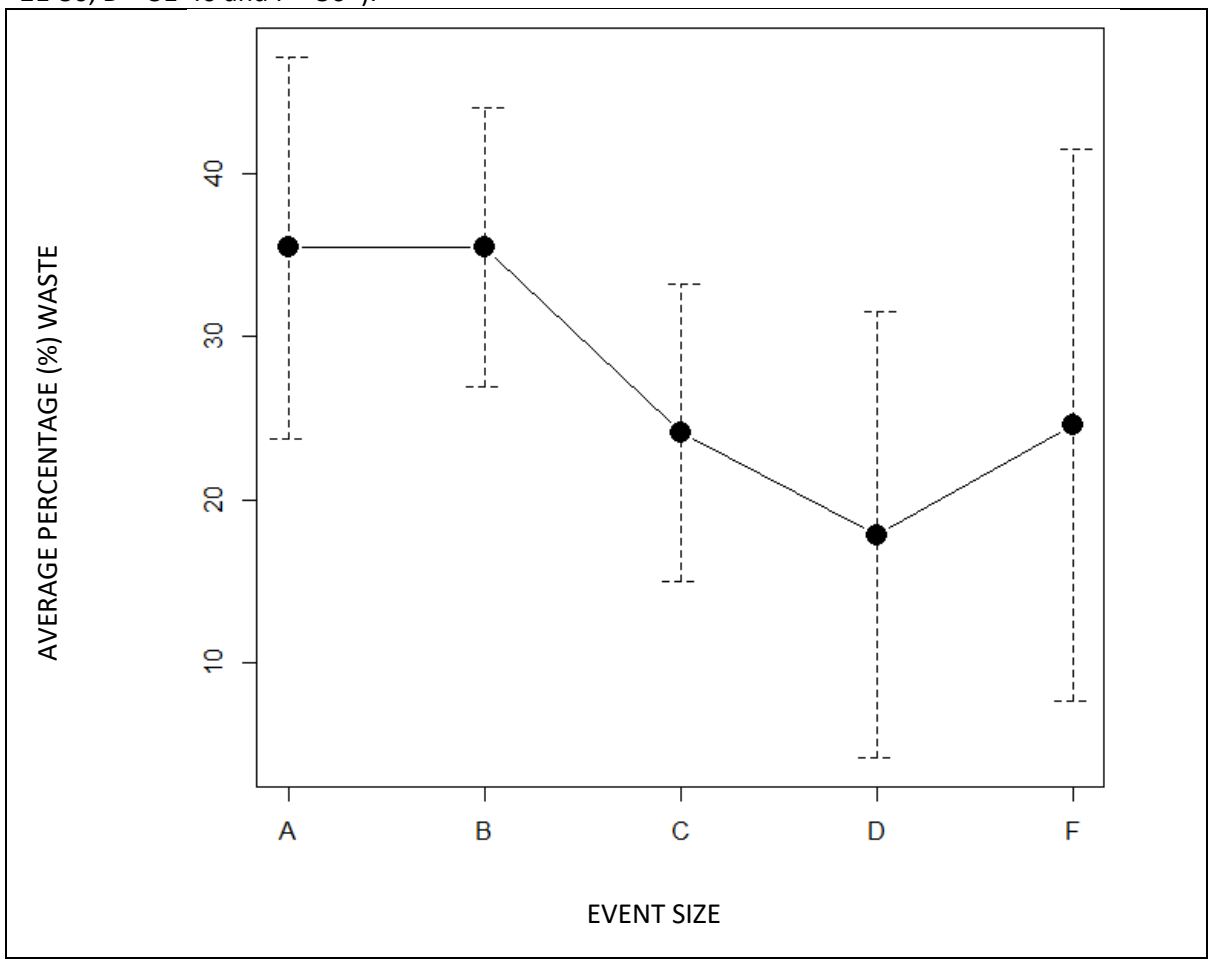
Here we present the results of our research, report on the extent to which they answer our research questions and relate them to the extant literature. Recall that our data was obtained from 91 events. We quantified the waste using the methods already described and then determined how the event size, time, venue and type of food served affected waste generation. These relate to the environmental factors influencing waste. Then, making use of the fact that we knew who ordered the food for each event for which we quantified waste, we matched the respondents to our survey with the event organizer which allowed us to investigate the human influence on food waste generated. To the best of our knowledge this hasn't been done in previous research.

It is important to recognize some of our limitations. The differences in the nature and venues where the events were held at Newcastle University influenced the number of events we were able to quantify, which may have affected the observed variation. For example, we could only collect data in one event with 41-50 attendants. Also, when assessing waste per food category, waste sandwiches were quantified 68 times, whereas selection platters were only quantified 3 times, and light bites and snacks were only quantified once. To overcome this variation in the dataset we decided to exclude from the analysis categories that did not have sufficient number of observations.

4.1 Environmental drivers of event waste

We start our presentation report the impact of the size of the event in the amount of waste generated. The larger the events the more food is ordered, but also the more chances there are that there will be participants with special requirements and last minute attendance cancellations. Figure 4.1 below shows the variation of waste according to size of event. We conducted a one-way ANOVA to test for differences of event size on average waste. No significant difference was found between event size and average waste (F_5=1.736; P>0.05).

Figure 4.1 Average waste per event size with 95% confidence intervals (where A = 1-10, B = 11-20, C = 21-30, D = 31-40 and F = 50+).



The results suggest shows a non-linear relation between average waste and size of the event. Small and large events generate more waste than medium sized. Thus it seems that mid size events are easier to plan and control. Higher waste volumes found in larger events may be attributed to poor attendance and consequently too much food being served.

Turning to the impact of time at each the event was held, Table 4.1 shows that events held around midday generated the highest amount of food waste, while events later in the afternoon generated less waste. The increase in average waste for events held at conventional lunchtime (12:00 and 13:00 hours) could be attributed to the wider variety of food categories served at these times. In contrast, less food categories were served in mid-afternoon events.

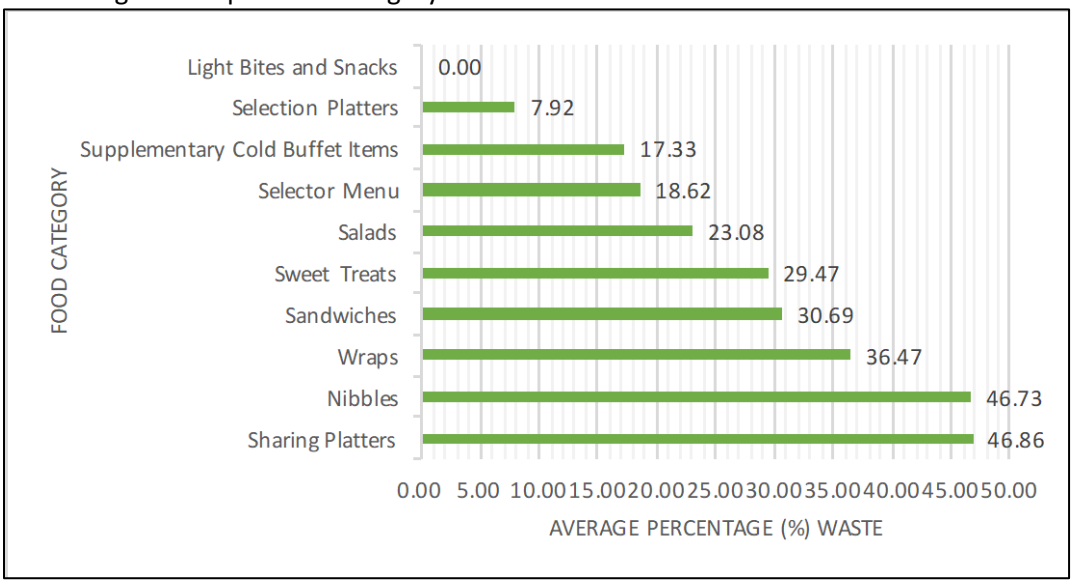
Table 4.1: Average waste by time at which event was held.

Event time	Average percentage (%) waste
11:00 hours	29.71
12:00 hours	29.86
13:00 hours	35.38
14:00 hours	18.47
15:00 hours	22.84

To investigate whether there were significant differences in waste across time we employed a Kruskal-Wallis. We could not find significant difference between event time and average waste (F_4=3.1092; P>0.05).

Given our findings that events around lunch time have a higher volume of waste and this might be attributed to a wider variety of foods served, we investigated how waste varied across food categories. This is reported in Figure 4.2 below.

Figure 4.2: Average waste per food category.



As Figure 4.2 shows 'Sharing Platters' generated the highest average waste (48.86%), followed by 'Nibbles' (46.73%), and 'Wraps' (36.47%). No waste was recorded for the 'Light Bites and Snacks' category (0%). The larger percentage of waste observed for 'Sharing Platters' may be explained by the way these are served. This category includes potatoes and other root vegetables chips, which in the events served by EAT@Newcastle are served in bowls from which people take their helpings. Participants may the reluctant to take food from bowls where others have touched which may explain why more product is left over. Other explanations are that event attendants may have health concerns regarding chips. A limitation of our study is that we did not interview participants in the event and therefore cannot but speculate about this human factor affecting waste. Note that other food categories with high levels of waste, such as 'Nibbles' have a similar way of being served. Consequently, the serving format of buffet food should be considered. However, trade-offs must be considered when choosing

alternative formats. For example, whilst individual packaging for some buffet items may reduce food waste, it may increase packaging waste.

We conducted a Kruskal-Wallis to test for differences over average waste across food categories on and we found statistically significant differences (F_9=19.776; P<0.01). We further investigated differences within categories using a Mann-Whitney U (two-sample Wilcoxon) test, which revealed significant differences between average waste in 5 food categories. Namely in average waste for 'Nibbles' and 'Sandwiches' (P=0.03282), 'Nibbles' and 'Selector menu' (P=0.02545), 'Sandwiches' and 'Selector menu' (P=0.05009), 'Selector menu' and 'Sharing platters' (P=0.04704), 'Selector menu' and 'Wraps' (P=0.0333), and 'Sharing platters' and 'Supplementary cold buffet items' (P=0.02936).

To conclude our analysis of environmental determinants of food waste, we investigated how the venue, that is the building where the event was held, affected the average amount of waste generated by event. We considered two categories of buildings: academic buildings and administration buildings. The results of our inquiry are reported on table 4.2 below.

Table 4.2: Average waste by event venue.

Event venue	**Average percentage (%) waste**
School building	26.42
Administrative building	40.06

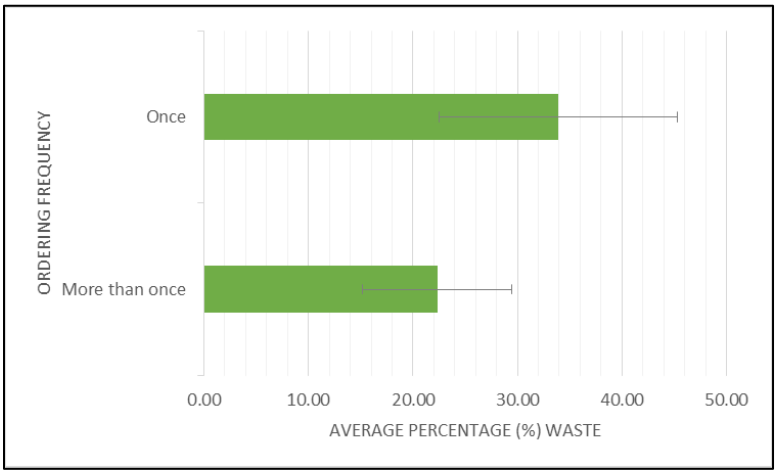
The results show there is a large difference in the average event waste across venues. Using a Kruskal-Wallis we tested for statistically significant differences on average waste between event venues. We find there is a significant differences in average waste (F_1=5.1341; P=0.02346). The reason we observe these results is that redistribution is easier in academic buildings for there are both staff and students. We suspect redistribution of food in academic buildings may have occurred before we had a chance to collect the data and contributed to lower average waste recorded. Therefore, measurement of average waste within school buildings may not be an accurate representation. To overcome this, further research should seek to adapt the methodology so to ensure redistribution of food cannot occur until waste quantification.

4.2 Human drivers of event catering waste

The amount of waste generated in events is also driven by human factors. As we suggest above, the high percentage of waste in specific food categories may be explained by event attendants' hygiene concerns. Food waste is a consequence of consumers' behaviour, attitudes and practices (Evans, 2014). Notwithstanding the impact of those preparing and serving the food in the events and that of participants in waste generated, the person ordering food also influences the volume of waste generated. Our work focuses specifically on the impact of those ordering food, in other words the direct customer of the catering service company.

Our survey instrument asked whether the person placing an event catering order had or not previous experience ordering food. As reported on figure 4.3 below we find that average waste is higher in events ordered by inexperienced customers. However there isn't statistically significant difference between ordering frequency. This result suggests that experience in ordering event catering is advantageous in the reduction of food waste.

Figure 4.3: Average waste per ordering frequency.



Furthermore we inquired on how much food respondents ordered for the event they organized. Table 4.3 reports our findings tabulating also over the level of customer's ordering experience.

Table 4.3:

	I order less food than the number of event attendees	**I order the exact amount of food for the number of event attendees**	**I order more food than the number of event attendees**
Ordered more than once (N=5)	20.00%	60.00%	20.00%
Ordered once (N=26)	23.08%	50.00%	26.92%
Total (N=31)	22.58%	51.61%	25.81%

First note that the results shown are based only on the survey so these are not actual amounts of waste generated. Rather what this table reports is the extent to which experience influences how much food is ordered. We find that 51.61% of customers report to order the exact amount of food for the number of event attendees, 25.81% of customers order more food than the number of event attendees, and 22.58% of customers order less food than the number of event attendees. Kruskal-Wallis was used to test for differences in average waste between the amount of food ordered. There was no difference between average waste and the amount of food ordered (F_2=0.71746; P>0.05). Research by Trivedi (2015) identified inaccuracies in forecasting and over-catering as causes of food waste. In the current research, it was observed during data collection that the number of event attendees was difficult to predict, particularly for larger events. Commonly the number of event attendees was less than ordered

for, subsequently generating food waste. Thus, causes of food waste identified by Trivedi (2015), specifically inaccuracies in forecasting, were found to be causes of food waste in the current research.

6. Conclusions, Recommendations and future research

Our study aimed to measure and associate levels of event food waste generated to environmental and human factors. We find that the size and time at which the event are held don't significantly affect the amount of waste generated, however we could find significant differences across venues where the event was held and food categories served in the event. Further we found that when the event organizer has previous experience ordering food, the even as a lower average food waste.

Our contribution is mainly methodological as we propose a practical way to estimate waste volumes in catering services by combining the methods proposed by Hanks et al (2013) and Martins et al (2014). Moreover, we developed a questionnaire to assess human factors that may lead to excessive food orders. This enables us to assess both the environmental and human drivers of food waste in event catering.

We faced a few logistic constraints that limited our research and results. Namely, in certain instances we were prevented from collecting data by the event organizer. Also we could not be sure whether the inexistence of waste in certain events was due to redistribution or earlier disposal. When in doubt we opted to delete the observation from the dataset but this affected our number of observations. Despite these limitations, our findings suggest there are a number of changes that could help reduce waste generated at events. First, the event catering service could avoid waste in more wasteful food categories by considering alternative ways to present the food or by reducing the amount of food offered in such categories. Also, since less experienced customers lead to more waste, there could be some advice or guidance to new clients helping them order an appropriate level of food. Regarding our findings on venue differences, we suggest either encouraging participants or organizers to take left overs home or to contact a charity that may redistribute the left-overs.

We acknowledge that there may be other environmental factors (for example weather conditions, the way food is displayed or room conditions) affecting the amount of food consumed at a given event. Also, as already suggested, along with the person ordering the food for the event, the participants and those preparing and serving the food also need to be considered, as do the options made available to the person ordering food at the point of contact with the catering entity. Notwithstanding these factors we believe that out multiple method approach significantly extends the ability and knowledge base to efficiently measure catering waste. We also believe that generalisability is readily achievable by adaptation of our approach to reflect local conditions at other potential venues as future units of assessment. Future research needs to further investigate how environmental factors and a more comprehensive measure of human factors may explain differences in waste generated in food catering services.

References

Bellemare, M. F., Akir, M. C., Peterson, H. H., Novak,L. and Rudi, J. (2017) On the measurement of food waste. Amer. J. Agr. Econ. 99(5): 1–20; doi: 10.1093/ajae/aax034

Beretta, C., Stoessel, F., Baier, U. and Hellweg, S. (2013). 'Quantifying food losses and the potential for reduction in Switzerland.' *Waste Management*, 33, pp. 764-773.

Betz, A., Buchli, J., Gobel, C. and Muller, C. (2015). 'Food waste in the Swiss food service industry - Magnitude and potential for reduction.' *Waste Management*, 35(October), pp. 218-226.

Buzby, J. C. and Hyman, J. (2012). 'Total and per capita value of food loss in the United States.' *Food Policy*, 37, pp. 561-570.

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

Evans, D. (2014). *Food Waste: Home Consumption, Material Culture and Everyday Life*. Bloomsbury: London.

Fox, J. (2005) 'The R Commander: A Basic Statistics Graphical User Interface to R.' *Journal of Statistical Software*, 14(9), pp. 1-42.

Graham-Rowe, E., Jessop, D. C. and Sparks, P. (2014). 'Identifying motivations and barriers to minimising household food waste.' *Resources, Conservation and Recycling*, 84(March), pp. 15-23.

Graham-Rowe, E., Jessop, D. C. and Sparks, P. (2015). 'Predicting household food waste reduction using an extended theory of planned behaviour.' *Resources, Conservation and Recycling*, 101(August), pp. 194-202.

Gustavsson, J. C. (2011). *Global food losses and food waste – Extent, causes and prevention*. Rome: Food and Agriculture Organisation of the United Nations.

Hanks, A. S., Wansink, B. and Just, D. R. (2013) 'Reliability and Accuracy of Real-Time Visualization Techniques for Measuring School Cafeteria Tray Waste: Validating the Quarter-Waste Method.' *Journal of the Academy of Nutrition and Dietetics*, 114(3) pp. 470-474.

Langley, J., Yoxall, A., Heppel, G., Rodriguez, E. M., Bradbury, S., Lewis, R., Luxmoore, J., Hodzic, A. and Rowson, J. (2008). 'Food for Thought? - A UK pilot study testing a methodology for compositional domestic food waste analysis.' *Waste Management & Research*, 28(3), pp. 220-227.

Lazell, J. (2016) 'Consumer food waste behaviour in universities: Sharing as a means of prevention.' *Journal of Consumer Behaviour*, 15, pp. 430-439.

Lorenz, B. A-S., Hartmann, M. and Langen, N. (2017) 'What makes people leave their food? The interaction of personal and situational factors leading to plate leftovers in canteens.' *Appetite*, 116, pp. 45-56.

Martins, M. L., Cunha, L. M., Rodrigues, S. S. P. and Rocha, A. (2014). 'Determination of plate waste in primary school lunches by weighing and visual estimation methods: A validation study.' *Waste Management*, 34(May), pp. 1362-1368.

Miao, L. and Wei, W. (2013). 'Consumers' pro-environmental behaviour and the underlying motivations: A comparison between household and hotel settings.' *International Journal of Hospitality Management*, 32, pp. 102-112.

Parfitt, J., Eatherley, D., Hawkins, R. and Prowse, G. (2013). *Waste in the UK Hospitality and Food Service Sector (Technical Report No. HFS001-00 6)*. Banbury: Waste and Resources Action Programme (WRAP).

Pearson, D., Minehan, M. and Wakefield-Rann, R. (2013). 'Food waste in Australian households: why does it occur?' *Australasian-Pacific Journal of Regional Food Studies*, 3, pp. 118-132.

Silvennoinen, K., Heikkilä, L., Katajajuuri, J-M. and Reinikainen, A. (2015). 'Food waste volume and origin: Case studies in the Finnish food service sector.' *Waste Management*, 46, pp. 140-145.

Stancu, V, Haugaard, P. and Lahteenmaki, L. (2016) 'Determinants of consumer food waste behaviour: Two routes to food waste.' *Appetite*, 96, pp. 7-17.

Strasser, S. (1999). *Waste and Want: A Social History of Trash*. New York: Metropolitan Books.

Trivedi, B. G. (2015). *Food Waste Prevention and Management in Higher Education*. In: Filho, W. L., Muthu, N. Edwin, G. and Sima, M. (2015) Implementing Campus Greening Initiatives. Springer International Publishing, Switzerland. pp. 93-102.

Visschers, V. H. M., Wickli, N. and Siergrist, M. (2016). 'Sorting out food waste behaviour: A survey on the motivators and barriers of self-reported amounts of food waste in households.' *Journal of Environmental Psychology*, 45, pp. 66-78.

WRAP. (2015). *Guidance Document: wasting less food from banquets, meetings and events*. Oxon: Waste and Resources Action Programme (WRAP).

WRAP. (2017). *Estimates of Food Surplus and Waste Arising in the UK*. Banbury: Waste and Resources Action Programme (WRAP).