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Drivers of plate waste at buffets: A comprehensive conceptual model based on observational data and staff insights

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ABSTRACT

The harmful tourist behaviour of taking a lot of food from a buffet, but not eating it all, remains under-researched. This study gains key insights into drivers of plate waste. Observational data show that: dinner buffets are worse than breakfast buffets; the latest breakfast serving time is worse than the earliest; high-end breakfast buffets are worse than budget buffets. The first meal a guest eats at a hotel and the presence of children also lead to more plate waste. Staff offer consistent and plausible explanations for these observations, resulting in a comprehensive model of drivers of plate waste. This model offers a basis for intervention development to reduce plate waste and by so doing minimise environmental damage caused by the tourism industry.

1. Introduction

The food supply chain is responsible for 43% of global land use, uses two thirds of withdrawn fresh water, and contributes 23% of anthropogenic greenhouse gas (CO_2eq) emissions (Poore & Nemecek, 2018). Producing food requires a lot of energy, water and chemicals (Foley, Ramankutty, Brauman, et al., 2011). If the food is not eaten, and instead disposed of in landfill, it causes environmental damage through land use and the production of powerful CO_2eq emissions (Papargyropoulou et al., 2016). One kilogram of food waste causes 1.9 kg of CO_2eq (BIO Intelligence, 2010). Total food waste emissions are equivalent to 87% of global road transport emissions (FAO, 2019). Reducing food waste by 38% could reduce the negative impact on climate by 40% and on biodiversity by 30% (Beretta & Hellweg, 2019).

Enjoying food is an integral part of any travel experience (Björk & Kauppinen-Räisänen, 2017). The role of food in tourism is more complex than it is at home because of the foreign and unfamiliar contexts, and its symbolic meaning in the travel context. Tourists' food experiences are often novel and contrasted with everyday eating. Because of the importance of food in the tourism context, food waste contributes substantially to the environmental harm caused by the tourism industry (Gössling et al., 2012). Some of this environmental harm is unavoidable: tourists must eat and they like to try many different foods, including those that are environmentally less sustainable. The environmental harm of the provision of food, therefore, cannot easily be reduced. But the environmental harm caused by food served to guests, but not eaten (plate waste) could be reduced without negatively affecting tourists' vacation enjoyment. This is because it is the eating, not the leaving behind of the food that is the source of enjoyment. Yet, all the resources invested in the uneaten food are lost, and plate waste emits CO_2eq in landfill.

Plate waste is the most easily avoidable type of food waste generated in hospitality (Beretta & Hellweg, 2019). Up to 92% of plate waste could be prevented (Papargyropoulou et al., 2016) without reducing people's vacation enjoyment (Dolnicar, 2020a). Yet, plate waste in tourism and hospitality has not been extensively studied to date (Dolnicar, 2020a; Gössling & Buckley, 2016). Only few empirical studies have documented plate waste at hotel buffets (e.g. Juvan, Grün, & Dolnicar, 2018; Papargyropoulou et al., 2016). Even fewer have developed and empirically tested the effectiveness of interventions in reducing waste (e.g. Dolnicar, Juvan, & Grün, 2020; Kallbekken & Sælen, 2013). This is despite the fact that reducing plate waste benefits not only the environment, but also hotels and restaurants; they can save money by reducing their food orders and their waste disposal fees.

The aim of the present study is to provide detailed empirical measurements of plate waste, and derive from them a number of drivers of plate waste. These drivers contribute to our theoretical understanding of plate waste generation in tourism and hospitality, and provide guidance to hotel and restaurant managers on how to reduce plate waste without negatively affecting their guests' and patrons' enjoyment of the meal.

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2. Literature review

2.1. Impacts of food waste on the environment

Different types of foods generate different levels of carbon emissions in production. Beef performs worst: 100 g of protein from beef causes 50 kg of CO_2eq and is responsible for about 164m^2 annual land use. The same amount of proteins from poultry produces only six kilograms of CO_2eq and is responsible for only seven square metres of annual land use. Similarly, 100 g of proteins from pork or farmed fish produces between six and eight kilograms CO_2eq emissions and use between three and seven square metres of land. In terms of dairy, 100 g of cheese proteins causes 11 kg of CO_2eq and uses 41m^2 of land, while one litre of milk generates only some 3 kg of CO_2eq, using 9m^2 of land. Vegetables and fruits are more environmentally friendly, causing between 0.4 kg (root vegetables) to 2.1 kg of CO_2eq (tomatoes), and using between 0.3m^2 (root vegetables) to 0.8m^2 (tomatoes) of land (Poore & Nemecek, 2018). The variation across types of oils – representing a substantial fraction of hospitality food waste (ARSO, 2018) – is also considerable. One litre of palm oil causes 7.3 kg of CO_2eq, the same amount of rapeseed or sunflower oil only 3.8 kg. The picture is reversed when considering land use with palm oil using only slightly more than two square metres, rapeseed oil 11m^2 and sunflower oil 18m^2.

In terms of water use, meats have the biggest requirements per kilogram: between 15.4 (beef) and 4.3 (chicken) cubic metres of water, followed by nuts (9m^3) and pulses (4m^3). Cereals (1.6m^3), fruits (0.9m^3) and vegetables (0.3m^3) are substantially less thirsty (Mekonnen & Hoekstra, 2010).

Different types of foods generate different levels of carbon emissions when wasted. Scholz, Eriksson, and Strid (2015) investigate the carbon footprint of food waste in supermarkets. While the fruit and vegetable department contributed 85% of wasted mass, this waste accounted for only 46% of the waste carbon footprint. The meat department created only 3.5% of the food waste mass, but that caused 29% of waste carbon footprint.

Food waste in Europe causes 190 million tons of CO_2eq emissions annually (Scherhaufer, Moates, Hartikainen, Waldron, & Obersteiner, 2018). Most of the food waste is produced by consumers, either at home or when dining out (Beretta, Stucki, & Hellweg, 2017). The amount of plate waste is remarkably constant, whereas food waste produced in kitchen has been decreasing (Engström & Carlsson-Kanyama, 2004). People leave more uneaten food behind when dining out (Li, Wang, & Cheng, 2019), and eat more environmentally harmful food when travelling (Gössling & Peeters, 2015).

2.2. Food waste generated by tourism and hospitality

In Europe, the hospitality sector produces less (12%) food waste than households (53%); in Asia, the hospitality sector produces more (Papargyropoulou et al., 2016; Wang et al., 2017). Hospitality food waste is problematic because: tourism is a large and growing industry; tourists eat more environmentally harmful foods (Gössling, 2015); tourists leave behind 8% more food uneaten than they do at home (Li et al., 2019).

Upscale tourists consume about 3100 g of food daily (Gössling, 2015), average tourists about 1800 g – 500 g more than at home (Peeters & Gössling, 2015). In China, patrons leave behind some 93 g of uneaten food per meal in restaurants – mainly vegetables, rice, seafood, pasta and pork (Wang et al., 2017). The tourists among restaurant patrons produce more (103 g) than locals (88 g; Wang et al., 2017). This study also shows that people waste more food in larger restaurants (132 g) than in medium-sized restaurants (77 g), small restaurants (69 g) and snack bars (38 g). Plate waste varies also between meal purpose (gatherings of friends 107 g; business meals 102 g; family gatherings 95 g; work meals 90 g; personal dining 67 g) and the meal type (lunch 89 g; dinner 104 g).

Differences in plate waste exist also across nations. Hotels in Austria produce less plate waste (20 g per person per meal; 32% of total avoidable waste) than hotels in Germany (40 g; Beretta & Hellweg, 2019). In the United States, restaurant patrons leave behind uneaten about 17% of their meal; half is thrown away (Gunder, 2012). Hotel guests in Slovenia generate 15 g of plate waste every time they have breakfast at a buffet (Juvan et al., 2018). Families in the same hotel generate 45 g of plate waste per person at the dinner buffet (Dolnicar et al., 2020). In a five-star international hotel in Malaysia, hotel guests eating at buffets are responsible for 300 g of plate waste at breakfast, and 400 g at dinner (Papargyropoulou et al., 2016). A study from Finnish buffet restaurants (Katajajuuri et al., 2011) shows that plate waste accounts for between 4 and 8% of food waste. Engström and Carlsson-Kanyama (2004) show that 11–13% of food served is not eaten, mostly vegetables. Nearly 20% of restaurant patrons admit not eating up everything. Curiosity about new foods and satisfaction with food are key drivers of plate waste (Li et al., 2019). About 80% of plate waste is avoidable (Betz, Buchli, Göbel, & Müller, 2015).

Although, studying food waste has a long history (for example, Grey & Dubois, 1947; Kantor, Lipton, Manchester, & Oliveira, 1997) empirical evidence on the amount of food waste in hospitality is scarce (Filimonau & de Coteau, 2019), mainly because of measurement challenges. From prior work (see summary in Table 1), we can conclude that variability in food waste is substantial across countries, businesses, and food service formats. Because of this variability, no comprehensive model of drivers of plate waste could be developed to date.

2.3. Interventions proven to reduce plate waste

Developing and experimentally testing interventions to make tourism more environmentally friendly is a stream of research that has only recently developed. Dolnicar (2020b) proposes a classification of possible approaches into: altering choice architecture, increasing enjoyment, leveraging social norms, and changing beliefs.

A few of these approaches have been tested in the context of plate waste reduction. A successful alteration of choice architecture was the reduction of plate sizes at hotel breakfast buffets by 3 cm. This simple intervention reduced plate waste by 20%, saved hotels money in food costs, and did not reduce guest satisfaction (Kallbekken & Sælen, 2013). Similarly, Ravandi and Jovanovic (2019) observed a reduction in plate waste of 30% as a consequence of reducing plate size at all–you–can–eat buffets.

Increasing enjoyment as a strategy was used in an experiment targeting families specifically. Introducing a stamp collection game for children reduced food waste generated by families at a dinner buffet by 34% (Dolnicar et al., 2020). Families received a stamp every time they generated no plate waste at dinner. They could exchange their completed stamp collection book for a prize at checkout. The game also increased children's holiday enjoyment, while supporting common parental messaging among central European tourists that no food should go to waste.

Social norms formed the basis of an intervention at hotel breakfast buffets. Inviting guests to return to the buffet as many times as they want using a table sign reduced plate waste by 21% (Kallbekken & Sælen, 2013), from 48 kg to 34 kg per hotel and day.

Changing beliefs as a strategy of achieving behavioural change has not been successful in the plate waste context to date. This may be due to the uniquely hedonic context of vacation, which means that planetary health is less of a priority to tourists (Dolnicar, 2020b).

In addition to these scientifically proven measures, industry associations and researchers offer a number of recommendations, including: serving food a la carte; informing guests about the issue of plate waste; not offering too wide a variety of food; serving food in portions; developing menus that consist of popular food items (PATA, 2018); not serving food items that are not suitable to being displayed for long periods of time at the buffet; providing guidance to patrons about optimal food combinations; providing guidance to patrons about how to eat unusual food items; offering tasting plates; setting up the buffet in a way that it is easily accessible from most tables, and reducing the perception of food abundance and anonymity (Dolnicar & Juvan, 2019), reducing portion sizes (WWF, 2017); providing take-away containers to take uneaten food home (Hamerman, Rudell, & Martins, 2018); and educating patrons and

Table 1
Prior work on plate waste in tourism.

Reference	Context		Methodology		Plate waste	
	Location	Service style	Method	Data source	Amount	Drivers
Kantor, Lipton, Manchester, & Oliveira, (1997)	Hotels, restaurants, cafeterias	/	Bibliographic study, research interviews	Staff, research centre	22% of edible food	Portion size
Engström and Carlsson-Kanyama (2004)	Restaurants	/	Weighting, observations, interviews	General customers, staff	10–11% (52–60 g)	Diners variation, menu items
Freedman and Brochado (2010)	University canteen	Self-served	Weighting, observations	Students	4.2–6.1 g (8%)	Portion size
Katajajuuri et al. (2011)	Restaurants	/	Weighting, workshops	General customers, staff	4%–8%	Overserving, food quality
Betz et al. (2015)	Commercial canteen	/	Weighting, diners survey	Customers (employees)	25%	Gender (female), portion size, lack of hunger, taste preference, overserving, time pressure, distraction, malaise
Kuo and Shih (2016)	University campus restaurant	Self-served, served	Weighting, observations	Students, visitors, staff	94.3 g	/
Papargyropoulou et al. (2016)	5* hotel restaurant	Self-served, served	Weighting, interviews, observations	Tourists, locals	100 g–1400 g	Meal type
Wang et al. (2017)	Restaurants	/	Weighting, interviews, observations	Tourists Locals	103 g 88 g	Location, restaurant size, meal purpose, meal type
Juvan et al. (2018)	4* hotel restaurant	Self-served	Weighting, guest mix	Tourists	15.2 g	Nationality, children, food amount, restaurant occupancy
Dolnicar et al. (2020)	4* hotel restaurant	Self-served	Weighting, observations	Tourists	28 g–45 g	Menu design
Wang, Filimonau, and Li (2020)	/	/	Self-reported % of wasted food	Tourists	14.6%	Food neophilia, food satisfaction, food taste
Filimonau, Nghiem, and Wang (2021)	Chinese restaurant	/	Weighting, interviews, observations	General customers	16.1 g	Portion size

increasing their awareness for the environmental damage caused by plate waste (Filimonau & De Coteau, 2019).

A conceptual model of plate waste generation is required to facilitate a more systematic development of new approaches to reducing plate waste. To date, only one such conceptual framework has been proposed (Dolnicar & Juvan, 2019). This preliminary framework resulted from a small qualitative study conducted with restaurant and kitchen staff and identified 12 drivers of plate waste across seven themes. The present study builds on this framework to develop a comprehensive empirically supported model, using both qualitative and observational data on actual plate waste collected in hotels. The key contribution of the present paper lies in extending and empirically testing the propositions of the mini-theory of plate waste (Dolnicar & Juvan, 2019) which was built using observations and rich experiences of the kitchen and restaurant service staff at the same destination.

3. Method

We collected three quantitative observational data sets (plate waste measurements) during the peak summer season at multiple hotels at the Mediterranean seaside location of Portorož in Slovenia. Portorož is the most developed tourist destination in Slovenia, known primarily as a sun and sand destination, and for convention and casino tourism. This area is known for its traditional dishes made from local Istrian and Mediterranean ingredients.

The quantitative observational data (plate waste measurements) formed the core of the analysis. After the quantitative data was analysed, we also conducted interviews with hotel restaurant staff to gain deeper insights into the reasons for the observed phenomena. The participating hotels were chosen because they were typical for the destination, had the features required to answer our research questions, and because they expressed their interest to serve as an experimental fieldwork site. Active interest in participating in the study was critically important from the perspective of research ethics, to ensure data reliability, and to overcome the general reluctance of the industry to participate in food waste studies (Wang et al., 2020).

Measuring plate waste was a very involved and labour-intensive process. Research assistants sorted and weighed plate waste during the entire meal serving time. In one of the hotels, a second research assistant assisted with table clearing to ensure accuracy of hourly measurements. Research assistants were trained on how to collect and weigh plate waste to ensure minimum interference with normal hotel operations. Restaurant staff received detailed information about the procedure to ensure they knew what to expect during field experimentation.

We did not modify the existing plate waste collection process. For example, one restaurant collects plate waste from dining tables into plastic containers located on mobile service carts, then transfers them into the bins in the kitchen. We installed a floor scale and placed an additional bin on the scale. Plate waste delivered into the kitchen was weighted using this bin first, then transferred into the usual kitchen bin for plate waste.

Edible plate waste was recorded in hourly intervals. We chose to measure edible plate waste only because 94% of it is entirely avoidable (Papargyropoulou et al., 2016). Inedible plate waste, such as bones, banana peels, butter wrappers, cannot be avoided. In making this measurement decision, we also follow recommendations by experts in the field (Parfitt, Barthel, & Macnaughton, 2010; Wang et al., 2017). One of the authors checked the reporting sheets for potential discrepancies daily. If any such discrepancies occurred (e.g. typos, hard to read information, comments), the authors addressed them with research assistants.

We analysed the observational data, and reported findings back to hotel restaurant staff, asking them – in a very open and unstructured manner – if they have any explanations for those observations. We interviewed 14 staff members: eight waiters, two chefs from the four-star hotel, and four restaurant staff members from the budget hotel. Based on both the quantitative analysis of the actual plate waste data generated at hotel buffets, and the thematic analysis of the explanations offered by hotel restaurant staff, we develop a comprehensive conceptual model of drivers of plate waste.

3.1. Data set #1 – plate waste at the breakfast buffet of a four-star hotel

Data set #1 contains plate waste observations for 77 days from July 15th until September 30th (with one day missing, July 25th), collected at the breakfast buffet of a four-star hotel popular with families. Breakfast is included in the booking, and served between 7 am and 10 am. A restaurant staff member notes the room number as guests enter the dining room. Guests can choose any table in the dining room, and walk to self-service areas to get food and drinks. They can return to those areas as often as they wish to get more food and additional drinks. At the end of their meal, they leave the breakfast room, and service staff clear the table. Any food that is edible, but left behind on the plate when guests depart, is plate waste.

The breakfast buffet consists of a great variety of cold dishes (for example, salamis and similar cold cuts, cheeses, spreads, cereals, yogurts, fresh fruits, fruit salad, vegetables), a side range of warm dishes (for example, sausages, bacon, scrambled eggs, omelettes, baked beans, semolina) as well as cakes, croissants, and four kinds of bread.

Research assistants separated edible from non-edible foods in the kitchen, and recorded total plate waste in grams at 8:15 am, 9:15 am and 10:15 am. The number of people in the dining room at any given time can be derived from the receptionist's arrival sheet, assuming that guests stay in the breakfast area for about half an hour. Based on observations and staff reporting, this is an average guest party duration. Theoretically guests could arrive at 7 am and stay in the dining room until 10 am.

3.2. Data set #2 – plate waste at the dinner buffet of a four-star hotel

We collected plate waste at the dinner buffet at the same four-star hotel during July 3rd until September 30th. The dinner buffet is managed differently: guests can choose to dine in one of three different restaurants. For two of the restaurants, they choose either the 6 pm to 7:30 pm sitting or the 7:30 pm to 9 pm sitting. Dinner is included in bookings with half-board arrangement.

When guests arrive in the dining room for the first time, the receptionist notes their room number and assigns to them a table they use for their entire stay. Guests order drinks from the waiter assigned to their area of the dining room, with cost typically charged to the room. Guests get their food from the buffet. The dinner buffet consists of a starter area (typically containing cold meats, cheeses, and pasta dishes), a salad buffet, an area with three different main meals, and a dessert area offering fruit, cakes and ice cream. Starters, mains and desserts change daily. Hotel guests can return to the self-service area as often as they wish to get more food.

Plates are cleared during the meal, and at the end of the meal. Any food that is edible, but left behind on the plate when the plate is cleared, is plate waste. To accurately measure plate waste, research assistants took the plates as waiters brought them into the kitchen, separated out edible components, and placed them into a large bin, which was weighted at the end of each dinner service. This is the daily plate waste measure we use as dependent variable.

For each day we recorded the plate waste generated in each of the three restaurants (per sitting for two of the restaurants), and the number of guests arriving in the dining area. Data on food waste and the number of guests is available for 90 days for two sittings in the main restaurant and for 60 days for two sittings and 26 days for one sitting in the second restaurant. Sixty-eight daily observations of food waste and guests are available for the third specialized restaurant, which serves dinner to guests at three-star serviced apartments. Half of the tables are located inside, half outside on a terrace.

3.3. Data set #3 – plate waste at the breakfast buffet of a budget hotel

Data set #3 is from a budget hotel at the same destination. This hotel is basic, with shared bathrooms for guests. The breakfast buffet – open from 8 am until 10 am – is also basic, offering two types of bread, two kinds of salamis, typical spreads (e.g. fresh cheese, meat pate, butter, jam), seasonal fruit, boiled eggs and yogurts, occasionally sponge cake or other simple desserts.

We collected plate waste data separately for each hotel room. Being a small hotel, the receptionists also service the breakfast buffet. They know the guest room numbers, enabling them to assign the plate waste to the room. One of the authors trained staff to ensure that the weight measurements were recorded correctly. Every night, before closing the front desk, the receptionists prepared a waste recording sheet with room numbers for recording plate waste the following day. After guests finished breakfast, staff cleared the tables, and weighed the edible plate waste. De-identified guest characteristics were included from the guest data base.

Data set #3 contains entries from July 1st until September 3rd. The final data set covers plate waste information from 495 guest parties. Because guests typically stay longer than one day, the number of observations (812 daily plate waste measurements) is higher than the number of guest parties. Of these daily plate waste measurements, 36% were for Slovenian guest parties; 22% for guest parties with children.

Table 2 contains the key features of each data set. We indicate for each data set the hotel type and meal-specific information, including the number of daily measurements (N) of the number of guests and plate waste per person (in grams), as well as the respective mean values and standard deviations (SD).

Data collection was approved by the university's human ethics committee (approval number 2015001101). We analysed all data sets quantitatively to derive insights into drivers of plate waste. Then we shared our findings with hotel restaurant staff, many of whom volunteered explanations and their own observations.

For breakfast data, we analysed plate waste per hour. For dinner, each sitting generated one plate waste measure per day. We calculated the daily average plate waste measurements per person and time slot, and the number of guests eating the respective meal. We fitted weighted linear models where the weights correspond to the number of guests. We compared models with and without a time slot effect using the *F*-test to assess statistical significance of differences of average waste per person. Similarly, we compared the daily measurements of plate waste per person between breakfast and dinner for the four-star hotel, and for breakfast between the four-star hotel and the budget hotel. The daily measurements of plate waste per person split by the different characteristics of interest are also visualised using box plots.

The waste measurements for breakfast at the budget hotel are available at guest party level, allowing the use of linear mixed effects models using waste per person per guest party and day as dependent variable, and using first day, last day, length of stay, being Slovenian and having children among the guest party as potential explanatory variables to account for differences in average waste per person per guest party while taking individual differences into account using a random effect. Relevant variables to account for differences are identified by comparing models with different covariates being included as fixed effects and fitted with maximum likelihood using a χ^2-test. The significance of the retained fixed effects is assessed based on standard asymptotic maximum likelihood theory.

4. Results, discussion and managerial implications

4.1. Differences in plate waste across breakfast times

Data set #1 contains plate waste measurements for three buffet breakfast time periods (7–8 am, 8–9 am and 9–10 am). The data are summarised

Table 2
Data set specifications. SD denotes standard deviation.

Data set	Hotel	Meal	Restaurant	N	Number of guests		Plate waste per person (in g)	
					Mean	SD	Mean	SD
# 1	Four-star	Breakfast	Main	77	941.6	173.6	14.3	4.1
# 2	Four-star	Dinner	Main	90	418.2	93.4	45.5	13.7
		Dinner	Second	86	195.2	53.4	58.1	19.4
		Dinner	Specialized	68	163.3	30.9	62.8	12.9
# 3	Budget	Breakfast		65	32.1	6.7	9.2	5.4

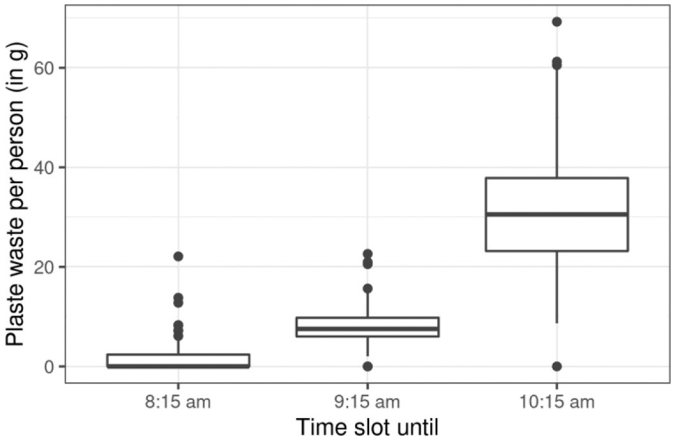

Fig. 1. Daily average breakfast plate waste per person per time slot (data set #1).

in Table 6 in the Appendix. Across the 77-day period, 203 hotel guests attended breakfast during the earliest time slot on average. The number of guests in the second and last time slot is very similar with on average 378 having breakfast between 8 am and 9 am and 361 after 9 am.

The difference in average plate waste per guest is material: substantially higher amounts of plate waste are generated in later time slots. The average amount of plate waste is 1.8 g per person between 7 and 8 am, 8.3 g per person between 8 and 9 am, and 31.8 g between 9 and 10 am, with an overall average of 14.3 g per person per day. The differences across time slots are statistically significant (F value = 290.4, p value <0.001).

Fig. 1 plots plate waste separately for the three breakfast serving times across the entire observation period. The daily measurements of average plate waste per person (in grams) for the three time slots are visualised with box plots. The box contains the middle 50% of the sorted observations with the black horizontal line in the box indicating the median. The black vertical lines (also referred to as whiskers) have a maximum length of up to 1.5 times the box length and stretch to the most extreme observation within this limit. Observations outside these limits are indicated as black dots. The box plot thus visualises the centre of the distribution based on the median and indicates variability with the box length as well as indicating the range of values observed. This graph illustrates the dramatic jump in plate waste from the early morning session to the middle session and, finally, to the latest breakfast buffet session of the day.

Results for the two dinner settings (data set #2, see Fig. 2 and Table 7 in the Appendix) in the same hotel confirm the findings above: The average plate waste for the earlier sitting was 26.6 g per person for the main restaurant, and 32.2 g per person for the second restaurant. The average plate waste for the later sitting was 70.8 g per person for the main restaurant, and 114 g per person for the second restaurant. This difference is statistically significant (F value = 189.41, p value <0.01 comparing the model with restaurant effect, time slot effect and interaction effect with the model including a restaurant effect only).

We reported these results to hotel staff, and asked them if they had any explanations for this substantial jump in plate waste in later meal time slots. Hotel staff shared a number of interesting observations which are summarised in Table 3. For each observation the context (breakfast or dinner, early or late time slots) is given and the observations are grouped by driver identified.

Hotel staff indicate that guests in the early time slots have a different personality than those in the late time slots, e.g., they are more calm. Hotel staff also suggest that having a structured day schedule with already something planned after breakfast or dinner reduces the plate waste. By contrast for the late time slots, guests were characterised as being lazy, trying to avoid the need to get back to the buffet. Furthermore, guests are suggested to be unconsciously overserving in the late time slots. Hotel staff also mention dining room features as contributing to higher plate waste for breakfast at late time slots. For dinner at late time slots, hotel staff indicate that the purpose of meal and lack of control increase plate waste.

Given these empirical insights, the difference in the amount of plate waste generated across time slots can be explained by both contextual factors (e.g. differences in food availability, length of queues at the buffet) and factors related to guest characteristics (e.g. fear of missing out, viewing the hotel dinner as the main evening event or not).

From a managerial perspective, the most relevant insight is the dramatic jump in plate waste from the early morning session to the latest breakfast buffet session. This finding has immediate and important managerial implications. Restaurant procedures need to be reviewed, and promising modifications adopted, including live preparation of foods instead of buffet display of food items cooked in the kitchen. This change would demonstrate to guests the freshness of foods at all times and may also lead to pre-portioning of those items that are cooked live by a chef. This service model is also likely to increase, rather than decrease guests' enjoyment of the meal, while reducing food waste and food cost for the hotel.

Other practical solutions hotels could implement, that would address the psychological factors identified in this study, are to assign set tables for breakfast also (preventing fear of not finding a table to sit on), and opening up more buffet stations (to prevent the fear of missing out as well as long queues at one single buffet serving station).

An entirely novel finding that emerged from this analysis is the role of having activities planned during the day of plate waste generation. This insight can inform modifications in hotel procedures. For example, guests could be pro-actively informed about activities that are on offer on any given day at breakfast, thus refocusing their attention from food to the activities they may wish to engage in.

4.2. Differences in breakfast plate waste across hotels of different standard

The plate waste generated at the breakfast buffet of a very basic hostel is significantly lower (9.2 g per day) than that of the four-star rated hotel

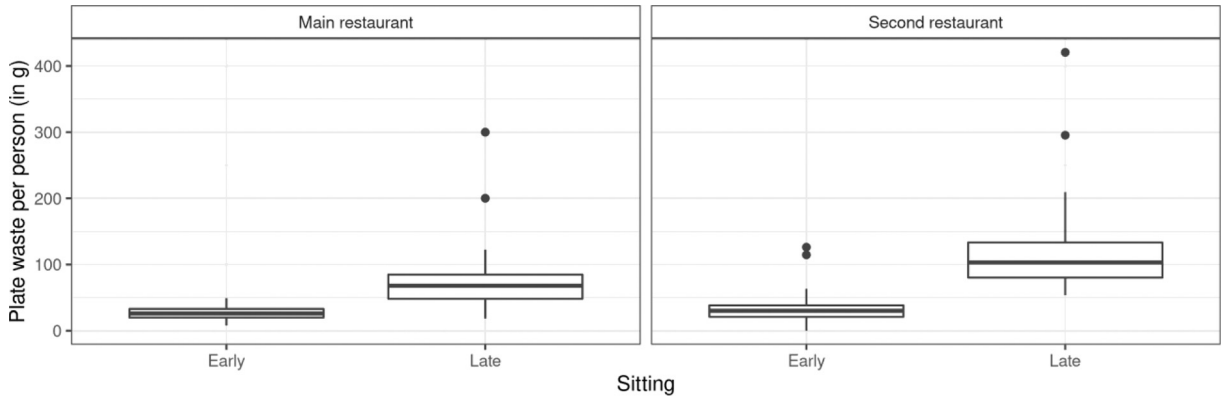

Fig. 2. Daily average plate waste per person by dinner serving period for the two restaurants (data set #2).

Table 3
Staff observations with context (breakfast/dinner, earlier or later time slots) and identified drivers of plate waste.

Context	Driver	Observation
Breakfast, early time slots	Guest personality / Structured day schedule	*"… people are more calm and … on a mission to feed themselves and then head out … they have something planned just after breakfast."* *"Early arrivals … usually sit quietly, read something or chat with their spouses. They do not eat much, and also leave nothing behind. Those are the ones everybody likes."* *"… early guests are politer, better organised and responsible."* *"The later they come worse … it gets … Everyone [is] calm earlier, everybody [is] crazy later."*
Breakfast, late time slots	Guest personality / Laziness	*"Late breakfasts … are a battle. Everybody is looking for something … people just make sure to get enough food once at the buffet, so no need to get back to the buffet through that entire crowd."* *"Some [buffet serving] trays are less full or even empty at the later hour … people … fish for anything left, to make sure they will get their share."*
	Unconscious overserving	*"… they tend to sit longer. They visit the buffet many times and I can easily say that food after the third serving will stay untouched or just barely touched. This all goes to waste."* *"Families … typically come around 9. Quite often you can spot a family sitting at the table…. Kids get whatever is there at the buffet table and parents, well it looks like they just need their coffee time. Guys frequently eat, but mums, well they enjoy the moment without hassle. No one really cares if kids play table soccer with bread buns."* *"Those coming in later, tend to sit longer."* *"Often I see guests serving too much food from the buffet, making sure that they will have something to eat after the buffet closes."* *"Guest … just wish to grab as much as possible before the buffet is closed. It is silly, as we would never throw them out of the restaurant, so they could just simply serve more responsibly and enjoyably."*
	Dining room features	*"It is definitely warmer in the last hour; hot would be a better word … It could be that more plate waste is generated [because it is] too hot in the restaurant. Who can eat when it is 30 plus degrees."*
Dinner, late time slots	Unconscious overserving	*"Those coming in later, tend to sit longer."* *"Often I see guests serving too much food from the buffet, making sure that they will have something to eat after the buffet closes."* *"Guest … just wish to grab as much as possible before the buffet is closed. It is silly, as we would never throw them out of the restaurant, so they could just simply serve more responsibly and enjoyably."*
	Guest personality /Structured day schedule	*"The early sitting typically includes guests with plans for the evening … they come to eat and not to enjoy."*
	Purpose of meal	*"Later guests are dressed up more fancy, and they tend to browse the buffet for a longer period … the later ones come for enjoyment of dinner. They take more plates, are slower eaters and socialise more."*
	Lack of control	*"Some foods are not as … nice in the later hours. Most … was prepared earlier, so definitely not so tasty anymore."*

(14.3 g; F value = 6.88, p value = 0.01). Fig. 3 visualises the distribution of the daily average plate waste per person at breakfast for the two hotels using box plots.

Table 4 summarises the different explanations for plate waste in each of the hotels given by hotel staff. Again the context (breakfast, lower / higher standard) is given as well as the identified driver together with the observations made by hotel staff.

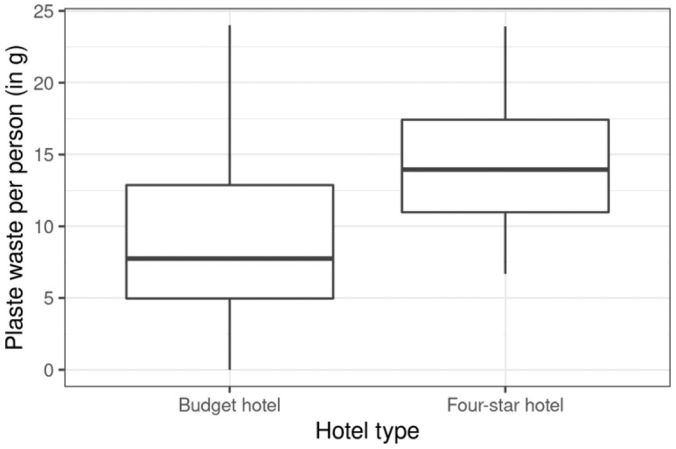

Fig. 3. Daily average plate waste per person for breakfast for the two hotels (data set #1 and #3).

The aspects contributing to reduced plate waste in the budget hotel are associated with the quality of the food, the dining room features and the purpose of the meal. For the higher standard hotel, the lack of familiarity with the food items offered is suggested as a source of increased plate waste by hotel staff.

The findings have important managerial implications. While hotels of higher star categories are not in the position to reduce the variety of foods they offer, they can take measures that may reduce plate waste production. Findings from this study, for example, point to the importance of knowing the food items well, not experiencing surprises. Two practical measures that can address this include offering small portions of uncommon dishes on tasting plates, allowing guests to taste these items before serving themselves a large amount. A second measure would be to offer verbal descriptions of the uncommon food items. Both measures assist in managing expectations and, as a consequence, have the potential to reduce plate waste. Both measures are also likely to improve, rather than reduce, guest satisfaction. A third possible measure is to reduce portion sizes for items where this is possible. Smaller portions imply less wasted food if the guest tries the food item and does not like the taste of it.

4.3. Differences in plate waste across types of meals

The average plate waste generated at the breakfast buffets depends on the standard of the hotel, but ranges from about 9 g to 15 g per person per day. The average plate waste generated at the dinner buffet at a four-star hotel is 50.2 g. This is significantly higher than the waste produced at

Table 4
Staff observations with context (breakfast, lower or higher standard) and identified drivers of plate waste.

Context	Driver	Observation
Breakfast, lower standard	Low food quality	*"There isn't much to waste, there? We offer basic food, of a good quality, but guests know what it is."*
	Dining room features	*"[Guests] can take as much as they want. They do not need to wait to get food. Our buffet is simple, easily accessible – so no need to fill up plates too much, just to save time waiting in lines or to make sure you will get [enough]."*
	Purpose of meal	*"They come [to breakfast] to get full and then off to the city, beach. Not rocket science … just simple, plain but good food, why would you waste any of it."*
Breakfast, higher standard	Lack of familiarity	*"As a four-star hotel, we need an international cuisine corner. Guests simply expect that. But we need to adapt the recipes to accommodate all international guests. For example, Asian guests dislike their traditional dishes being adapted. But if we use the original recipe, guests from other countries don't like it."*

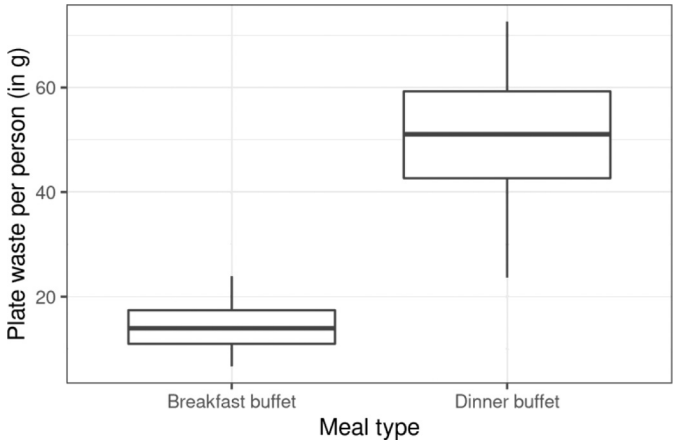

Fig. 4. Daily average plate waste per person for breakfast and dinner for the four-star hotel (data set #1 and #2).

breakfast (with an average of 14.3 g; F value = 859.71, p value <0.01; see Fig. 4).

Table 5 summarises the observations made by hotel staff about drivers of plate waste when asked about reasons for this difference in daily average plate waste per person between breakfast and dinner. Again the observations are separated by context and grouped by driver identified.

Comparing dinner with breakfast, unconscious overserving is suggested as a potential driver increasing plate waste for dinner, as dinner is more lavish than breakfast and less straight forward. In addition, for dinner, the dining room features as well as guest personality and laziness were identified as sources for increased plate waste.

The findings relating to breakfast versus dinner buffets again point to the variety of and familiarity with dishes served, and the guests' desire to try different food items, as a key source of plate waste. Possible measures hotels could adopt in an attempt to reduce plate waste, while still ensuring a wide range of interesting food items for guests to taste is to reorganise the presentation of meals in a way that separates common food items from unusual food items. The unusual food items could come with a description and tasting plates; they could also be presented in smaller trays. All of these measures would ensure that people who prefer familiar foods would not even approach that section and that those guests who approach that section understand that they may wish to taste those food items before serving themselves a larger amount. Alternatively, special items could be presented on a menu on the table, and ordered in set portions from the waiter, likely further reducing demand, while signalling a more exclusive meal experience to guests.

Table 5
Staff observations with context (breakfast or dinner) and identified drivers of plate waste.

Context	Driver	*Observation*
Dinner	Unconscious overserving	*"Dinner is more lavish than breakfast, hence more opportunity to try and leave behind."*
		"Many guests come hungry for breakfast, but not necessarily for dinner … they come to dinner less needy of food and just take too much."
	Dining room features	*"Could be the plates … for breakfast guests typically use smaller plates, but for dinner we always offer large plates … large plates allow taking … too much … the hungry eyes effect."*
	Guest personality / Laziness	*"Guests arrive for dinner in pretty much the same time, so the buffet area gets crowded … they want to take more just to avoid waiting too much time … more than they can finish."*
Breakfast	Unconscious overserving	*"Breakfasts are pretty straight forward … but dinner menus are different every day … more chances to taste different dishes … and just not like them."*

4.4. Differences in plate waste across guest segments and first meal and subsequent meals

We analyse the average plate waste generated per guest for breakfast at the budget hotel in dependence of them having breakfast for the first time, for the last time, accounting for their length of stay, them being Slovenian and having children among their party. These covariates were selected because they are associated with direct drivers of buffet food waste such as being unfamiliar with the food offered, unconscious overserving or guest characteristics. We fit linear mixed effects models with a random effect for guest party to account for repeated measurements using maximum likelihood estimation, excluding non-significant covariates with the final model only including a first day effect, children being among the guest party and being Slovenian. Dropping the other covariates does not significantly deteriorate model fit according to a χ^2-test (χ^2 = 1.16, p value = 0.56). Fig. 5 visualises the estimated effects of the final model. Table 8 in the Appendix contains numeric details.

The average waste per person is 7.8 g for a non-Slovenian guest party without children at their second or subsequent breakfast. Plate waste increases on average by 3 g on the first day of coming to the breakfast buffet, and by 3.5 g if children are present. Being Slovenian decreases the plate waste generated per person by 3 g, on average.

These novel findings are important to hotels as they direct attention to people's first day at the buffet. The first day is different from subsequent days because people are not familiar with the selection available at the buffet yet, and are more likely to try items they may not enjoy. Possible modifications to the buffet serving style that have the potential to reduce plate waste include tasting plates, a menu at the table guiding guests through the buffet and explaining which dishes are available, descriptions of dishes, and separation of unusual food items.

While the finding about children increasing plate waste is not new (Dolnicar et al., 2020; Juvan et al., 2018), it confirms the need for specific design features that cater to that guest segment. One option to reduce plate waste generated by children is to set up a separate buffet area for children which contains only items generally liked by children. This avoids children feeling visually attracted to some of the other items which, upon tasting them, they do not enjoy.

5. Conceptual model

Fig. 6 integrates the new insights derived from both the qualitative and observational research of this study into the model proposed by Dolnicar and Juvan (2019). Buffet plate waste drivers that have previously been identified are depicted in white. Newly identified factors are depicted in colour. Where possible, individual drivers were combined into themes.

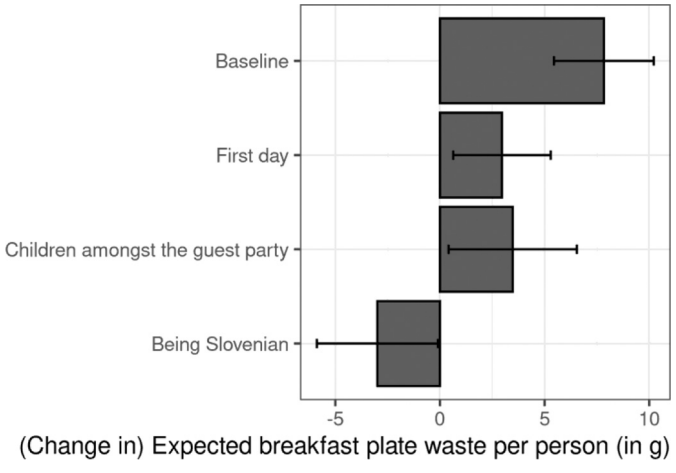

Fig. 5. Regression coefficient estimates (with 95% confidence intervals).

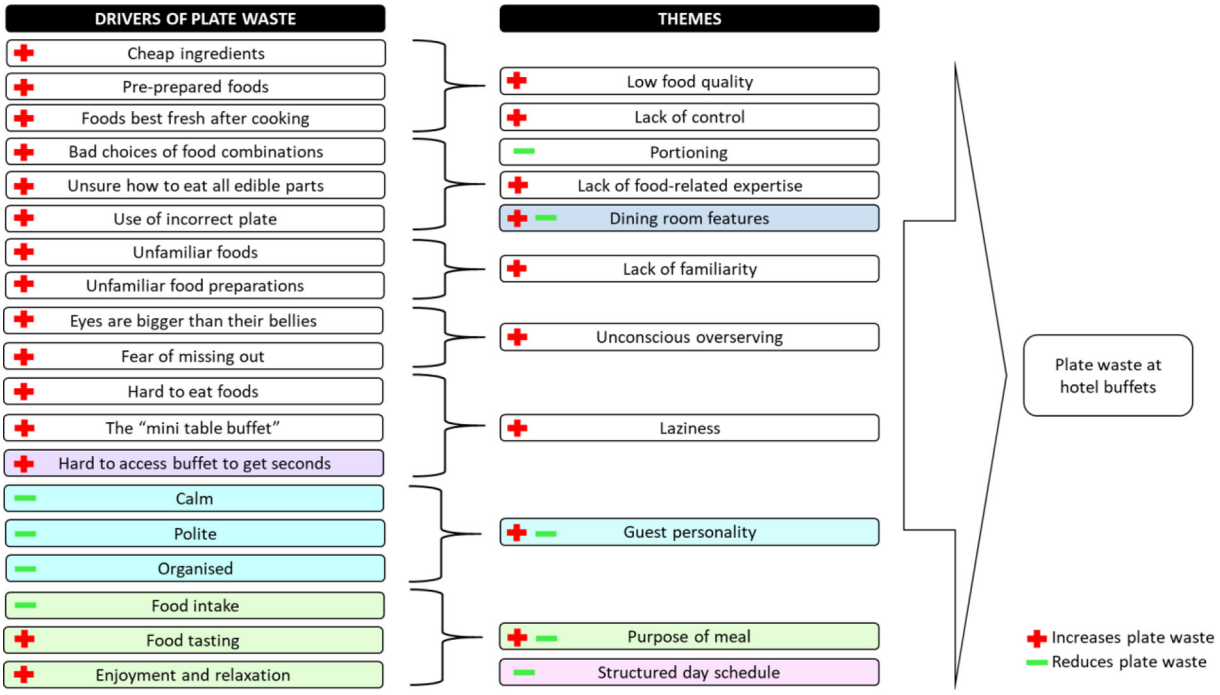

Fig. 6. Conceptual model of drivers of buffet plate waste.

Fig. 6 also indicates for each driver and theme whether its hypothesized effect on plate waste is positive or negative.

Here, only the new drivers are discussed. Among these newly identified factors affecting the amount of plate waste that is being generated are dining room features. Most striking in the current study was the difference between a very basic budget hotel buffet and a more extensive buffet offered by a high-end hotel. But even smaller variations in the dining room features may manifest in differences in plate waste. For example, for the three restaurants at the four-star hotel, the daily average waste per person at dinner was 46.8 g for the main restaurant, 58.2 g for the second restaurant, and 63.0 g for the specialized restaurant (F value $= 25.1$, p value < 0.001).

One aspect that is linked with both the themes of dining room features and guest laziness is access to the buffet from the table. At the dining room design end, tables could be too far from the buffet, or obstacles in the room may make it difficult to access the buffet. This, combined with guests being lazy, is likely to lead to more plate waste because guests take as much food as possible from the buffet to avoid having to return.

An entirely new theme that emerged from the present study is that of guest personality. Interestingly, this insight resulted from the analysis of plate waste across different times. This analysis showed that – irrespective of the meal – people who arrive later waste more food. Restaurant staff unanimously attribute this observation to different types of guests systematically dining at different times. Restaurant staff describe guests dining early as calm, polite and organised. Another driver of higher plate waste in later times is the fact that more people eat at the later time slots. The buffet is not refilled as much. This may cause guests to overserve to ensure getting everything that is on offer.

The purpose of meals for patrons also emerges as an influential aspect. Some guests come to the hotel dining room with the primary purpose of eating. At breakfast, for example, people may have a clear activity plan for the day. They come to breakfast to eat, then swiftly move on to start their activities. Similarly, in the evenings, people may attend the early sitting of dinner to eat, enabling them to explore evening activities at the destination, such as going to the theatre or a show. These guests leave very little plate waste. The meal is functional to them. They probably choose familiar foods, estimate accurately how much they need to eat, take that amount, eat it and leave. For other guests the meal is the main event at that time of day. At breakfast they may have slept in and arrive late. They make themselves comfortable, relax and slowly taste as many foods as possible from the wide range of options available at the buffet. When the buffet is about to close, they serve themselves one last time – an extra-large plate – to ensure they do not miss out and extend their enjoyable meal experience. These guests do not finish food items they do not like. And much of that last plate of food they got just before the buffet closed is likely to remain uneaten; they produce a lot of plate waste. Another key finding is that more structured plans for the day lead to reduced plate waste.

6. Conclusions

The empirical measurements collected in this study suggest that the amount of food unnecessarily wasted by tourists is substantial, and that it varies significantly across different types of meals, different quality levels of hotels, different types of guests, and even different times at which people come to the dining room to eat. Restaurant staff, who are immersed in tourists' dining experiences at the restaurant, offer consistent explanations for these observations, which provide key insights into the drivers of plate waste. From these insights, clear managerial implications and a conceptual model of plate waste are derived, both offering a systematic starting point for the development of practical initiatives to reduce plate waste in tourism and hospitality (Dolnicar, 2020b).

In many instances, the conceptual model resulting from this study is already sufficient for the development of initiatives. For example, hotels could schedule activities for tourists starting in the final hour of breakfast, or could provide ideas for activities on an information sheet at the breakfast table to direct guest attention away from food towards thinking of the activities of the day. This may give those guests who have no plans for the day something to look forward to, decreasing the focus on the breakfast experience. Other initiatives emerging as promising from the present study include separate children's buffet areas, verbal descriptions of meals, tasting plates for meals, and separating out or serving a la carte unusual food items. Such interventions need to be developed based on the drivers of edible plate waste identified in this study, and then experimentally tested to determine whether they are effective in reducing plate waste.

The present study contributes to the literature on plate waste in a number of ways: (1) by providing additional measurements of plate waste for new contexts; (2) by providing new – critically important – empirical

insights about variation in plate waste over time within the meal window, and (3) by offering the most comprehensive model of drivers of plate waste. This model is of immediate use to researchers and industry as a starting point for the development of interventions aimed at reducing plate waste.

This study also extends our knowledge on plate waste by empirically proving the existing variation of plate waste generation across different cultural contexts. Slovene hotel guests produce between 1.8 g and 50.2 g plate waste, whereas hotel guests in Malaysia produce between 100 g and 1400 g of plate waste. These findings mean that the role of culture in plate waste generation warrants further investigation in future, and that practical interventions aiming at reducing hospitality and tourism plate waste should consider the cultural background of guests.

With respect to other drivers of plate waste identified in this study, more detailed experimental studies are required to derive practical measures likely to be effective, for example, the exact nature of dining room features. Dining room features play a key role in how guests perceive crowdedness, waiting time, and availability of food. The present study cannot provide guidance on the optimal setup. This will require future experimental work in which the dining room setup must be altered in systematic ways, and the effect on plate waste tested. Aspects that are likely to influence plate waste include distance from dining tables to the buffet, the size of tables, the comfort of chairs, the room temperature, the brightness, perceived food abundance, perceived anonymity, etc.

The present study is limited by having been conducted in a small number of hotels with a specific guest mix. Replication studies in other geographical areas and including different hotels with distinctly different meal serving styles would be of great value.

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Appendix. Additional tables

Table 6
Number of measurements (N), mean and standard deviation (SD) of number of guests and average plate waste per person by breakfast serving period (data set #1).

Time slot	N	Number of guests		Plaste waste per person (in g)	
		Mean	SD	Mean	SD
8:15	77	203.4	74.1	1.8	3.7
9:15	77	377.6	105.2	8.3	4.1
10:15	77	360.5	157.9	31.8	13.5

Table 7
Number of measurements (N), mean and standard deviation (SD) of number of guests and average plate waste per person by restaurant and dinner serving period (data set #2).

			Number of guests		Plate waste per person (in g)	
Restaurant	Time	N	Mean	SD	Mean	SD
Main	Early	90	217.8	38.5	26.6	8.9
	Late	90	200.5	66.7	70.8	36.6
Second	Early	60	128.9	39.4	32.2	21.1
	Late	60	87.1	22.8	114	57.7

Table 8
Regression coefficient estimates of the linear mixed-effects model (data set #3).

	Estimate	Std. Error	*z* value	*p* value
Baseline	7.83	1.22	6.45	< 0.01
First day	2.96	1.19	2.49	0.01
Children among the guest party	3.48	1.56	2.22	0.03
Being Slovenian	−2.99	1.48	−2.02	0.04

References

ARSO (2018). *Odpadki – Poročila.* Accessed 14.12.2019 online https://www.arso.gov.si/varstvo%20okolja/odpadki/poro%c4%8dila%20in%20publikacije/.

Beretta, C., & Hellweg, S. (2019). Potential environmental benefits from food waste prevention in the food service sector. *Resources, Conservation and Recycling, 147*, 169–178.

Beretta, C., Stucki, M., & Hellweg, S. (2017). Environmental impacts and hotspots of food losses: Value chain analysis of Swiss food consumption. *Environmental Science & Technology, 51*(19), 11165–11173.

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

BIO Intelligence (2010). *Preparatory study on food waste across EU27.* Accessed 18.11.2019 online https://ec.europa.eu/environment/eussd/pdf/bio_foodwaste_report.pdf.

Björk, P., & Kauppinen-Räisänen, H. (2017). Interested in eating and drinking? How food affects travel satisfaction and the overall holiday experience. *Scandinavian Journal of Hospitality and Tourism, 17*(1), 9–26.

Dolnicar, S. (2020a). Eat up! Prevention of plate waste in tourism and hospitality: A perspective paper. *Tourism Review*. https://doi.org/10.1108/TR-05-2019-0199.

Dolnicar, S. (2020b). Designing for more environmentally friendly tourism. *Annals of Tourism Research, 84*, 102933.

Dolnicar, S., & Juvan, E. (2019). Drivers of plate waste: A mini theory of action based on staff observations. *Annals of Tourism Research*, 78.

Dolnicar, S., Juvan, E., & Grün, B. (2020). Reducing the plate waste of families at hotel buffets – A quasi-experimental field study. *Tourism Management, 80*, 104103.

Engström, R., & Carlsson-Kanyama, A. (2004). Food losses in food service institutions examples from Sweden. *Food Policy, 29*, 203–2013.

FAO (2019). Food wastage footprint & Climate Change: Accessed 18.11.2019 online: http://www.fao.org/fileadmin/templates/nr/sustainability_pathways/docs/FWF_and_climate_change.pdf.

Filimonau, V., & de Coteau, D. A. (2019). Food waste management in hospitality operations: A critical review. *Tourism Management, 71*, 243–245.

Filimonau, V., Nghiem, V. N., & Wang, L. (2021). Food waste management in ethnic food restaurants. *International Journal of Hospitality Management, 92*, 102731.

Foley, J. A., Ramankutty, N., Brauman, K. A., et al. (2011). Solutions for a cultivated planet. *Nature*, *478*, 337.
Freedman, M. R., & Brochado, C. (2010). Reducing portion size reduces food intake and plate waste. *Obesity*, *18*, 1864–1868.
Gössling, S. (2015). New performance indicators for water management in tourism. *Tourism Management*, *46*, 233–244.
Gössling, S., & Buckley, R. (2016). Carbon labels in tourism: Persuasive communication? *Journal of Cleaner Production*, *111*(B), 358–369.
Gössling, S., & Peeters, P. (2015). Assessing tourism's global environmental impact 1900–2050. *Journal of Sustainable Tourism*, *23*, 639–659.
Gössling, S., Peeters, P., Hall, C. M., Ceron, J. P., Dubois, G., Lehmann, L., & Scott, D. (2012). Tourism and water use: Supply, demand, and security. An international review. *Tourism Management*, *33*(1), 1–15.
Grey, C. E., & Dubois, R. A. A. (1947). A study of plate waste in the college dining room. *Journal of the American Dietetic Association*, *23*, 330–332.
Gunder, D. (2012). *Wasted: How America is losing up to 40 percent of its food from farm to fork to landfill.* Retrieved 07.09.2020 from https://www.nrdc.org/sites/default/files/wasted-food-IP.pdf.
Hamerman, E. J., Rudell, F., & Martins, C. M. (2018). Factors that predict taking restaurant leftovers: Strategies for reducing food waste. *Journal of Consumer Behaviour*, *17*, 94–104.
Juvan, E., Grün, B., & Dolnicar, S. (2018). Biting off more than they can chew: Food waste at hotel breakfast buffets. *Journal of Travel Research*, *57*(2), 232–242.
Kallbekken, S., & Sælen, H. (2013). "Nudging" hotel guests to reduce food waste as a win–win environmental measure. *Economics Letters*, *119*(3), 325–327.
Kantor, L. S., Lipton, K., Manchester, A., & Oliveira, V. (1997). Estimating and addressing America's food losses. *Food Review/National Food Review*, *20*(1), 1–11.
Katajajuuri, J. M., Hartikainen, H., Jalkanen, L., Koivupuro, H. -K., Silvennoinen, K., & Reinikainen, A. (2011). *Reduction of food waste in Finnish food production chain as part of life cycle management.* Retrieved 04.09.2020, from http://www.lcm2011.org/papers.html.
Kuo, C. F., & Shih, Y. (2016). Gender differences in the effects of education and coercion on reducing buffet plate waste. *Journal of Foodservice Business Research*, *19*(3), 223–235.
Li, Y. Y., Wang, L. E., & Cheng, S. K. (2019). Tourists' food consumption characteristics and influencing factors in tourism cities on the plateau: An empirical study of Lhasa. *Resources Science*, *41*(3), 494–508.
Mekonnen, M. M., & Hoekstra, A. Y. (2010). The green, blue and grey water footprint of farm animals and animal products. *Value of water research report series. Vol. 48.*. Delft (NDL): UNESO.
Papargyropoulou, E., Wright, N., Lozano, R., Steinberger, J., Padfield, R., & Ujang, Z. (2016). Conceptual framework for study of food waste generation and prevention in hospitality sector. *Waste Management*, *49*, 326–336.
Parfitt, J., Barthel, M., & Macnaughton, S. (2010). Food waste within food supply chains: Quantification and potential for change to 2050. *Philosophical Transactions of the Royal Society B*, *365*, 3065–3081.
PATA (2018). *Buffett toolkit – Building and understanding for food excess in tourism.* Bangkok: Pacific Asia Travel Association (PATA).
Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. *Science*, *360*(6392), 987–992.
Ravandi, B., & Jovanovic, N. (2019). Impact of plate size on food waste: Agent-based simulation of food consumption. *Resources, Conservation and Recycling*, *149*, 550–565.
Scherhaufer, S., Moates, G., Hartikainen, H., Waldron, K., & Obersteiner, G. (2018). Environmental impacts of food waste in Europe. *Waste Management*, *77*, 98–113.
Scholz, K., Eriksson, M., & Strid, I. (2015). Carbon footprint of supermarket food waste. *Resources, Conservation and Recycling*, *94*, 56–65.
Wang, L., Filimonau, V., & Li, Y. (2020). Exploring the patterns of food waste generation by tourists in a popular destination. *Journal of Cleaner Production*, *79*, 123890.
Wang, L., Liu, G., Liu, X., Liu, Y., Gao, J., Zhou, B., ... Cheng, S. (2017). The weight of unfinished plate: A survey based characterization of restaurant food waste in Chinese cities. *Waste Management*, *66*, 3–12.
WWF (2017). *Hotel kitchen: Fighting food waste in hotels.* Accessed 19.11.2019 online: https://www.worldwildlife.org/publications/hotel-kitchen-fighting-food-waste-in-hotels/.

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