Reducing the plate waste of families at hotel buffets – A quasi-experimental field study

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ABSTRACT

Twenty percent of all global greenhouse emissions are food-related. Tourism and hospitality contribute significantly, with food accounting for nearly half of the waste these sectors produce. One type of food waste – plate waste – could easily be avoided. Plate waste is the food people leave behind uneaten on their plates. It does not increase the enjoyment of the meal, yet costs the hotel money, and harms the environment. We develop and test – in a quasi-experimental field study – a game-based intervention that reduces plate waste by 34 percent, and is available for immediate adoption by hotels globally. Our study contributes to theory by demonstrating the power of increasing pleasure in pleasure-seeking contexts when aiming to change environmentally significant tourist behaviour. Our findings also challenge established behavioural theories, which postulate that people’s beliefs are the key drivers of pro-environmental behaviour.

1. Introduction

Food burdens the environment. It accounts for 20 percent of global greenhouse gas emissions (Hertwich & Peters, 2009) and 92 percent of the global water footprint (UNEP, 2012). Food waste includes waste generated during food production, storage, preparation and consumption. About a third of food waste is generated during consumption (Juvan, Grün, & Dolnicar, 2018, Filimonau and De Coteau, 2019). Between 78 percent and 92 percent of food waste is avoidable (Betz, Buchli, Göbel, & Müller, 2015).

Tourism and hospitality contribute significantly to this problem. These industries generate substantial amounts of waste, with nearly half being food waste (Curry, 2012). One sub-category of food waste generated in tourism and hospitality is plate waste: food left on a plate uneaten at the end of the meal. Because some 12 percent of served food is not eaten (Engström & Carlsson-Kanyama, 2004), plate waste accounts for about one third of food waste in tourism and hospitality (SustainableRestaurant Association, 2010).

Despite the general agreement that food waste is a major environmental problem, only a small number of studies identify specific factors that drive plate waste, and even fewer develop and test interventions to reduce plate waste. The aim of the present study is to fill this gap. We develop an intervention targeted specifically at reducing plate waste generated by families at hotel buffets. We test the effectiveness of this intervention using a quasi-experimental field study conducted in two hotels. The primary aim is to provide proof of principle of the effectiveness of the intervention. Results are of immediate value to hotel managers interested in reducing plate waste, although some variation in the effectiveness must be expected in dependence of hotel guest mix and other hotel-specific characteristics. The study also contributes to our theoretical understanding of pro-environmental behaviour as it points to theoretical constructs that can be used to trigger the desired behaviour in tourists, and to other constructs that – contrary to theoretical expectations – fail to increase responsible eating and reduce plate waste.

2. Prior research

2.1. The amount of plate waste

Food waste has a detrimental impact on the environment – by contributing to carbon emissions (Gössling, Garrod, Carlo, Hille, & Peeters, 2011; Rico et al., 2019), by using excessive amounts of water (Gössling, 2015), and by increasing the amount of waste (Kuo, Hsiao & Lan, 2005). Yet, food waste remains an under-investigated topic in
tourism and hospitality (Filimonau & de Coteau, 2019). Most work to date focuses on determining how much food waste the tourism and hospitality sector generates. In the European Union, for example, the catering industry is responsible for 14 percent of food waste (Aschermann-Witzel, de Hooge, Amani, & Bech-LarsenOostindjer, 2015). Food waste accounts for half of all hospitality waste in the US (Alexander, 2002). Restaurants generate a third of US food waste (BSR, 2012). These statistics are derived from a wide range of different methodological approaches (Betz et al., 2015), often representing “guestimates” rather than relying on actual measures of the food waste produced (Filimonau & de Coteau, 2019, p. 237).

A few studies have measured plate waste generated by guests in hotels and restaurants in grams. At a breakfast buffet in a four-star hotel at the seaside in Slovenia, for example, the amount of food left behind per person per day on average was 15.2 g (Juvan et al., 2018), with significant differences across a number of guest mix factors and buffet characteristics (to be discussed in the next section on drivers of plate waste). In a five-star hotel in Malaysia, the average guest left behind 300 g of food at the breakfast buffet, 100 g at the lunch buffet, and 400 g at the dinner buffet (Papargyropoulou et al., 2016), with 92 percent deemed to be avoidable. A study in China measured the plate waste generated at lunch and dinner on 3557 tables across 195 restaurants. On average, patrons generated 93 g of plate waste per person per meal. About one third of this plate waste consisted of vegetables. Meat accounted for 17 percent and rice for 14 percent.

This review of investigations of the amount of plate waste being generated in tourism and hospitality illustrates that there are substantial gaps in our knowledge relating to plate waste. National-level statistics rely primarily on estimates, and only a small number of studies have actually measured plate waste per person in hotels and restaurants. A second conclusion that can be drawn from this body of work is that plate waste data are highly inconsistent. This is likely the case because the amount of plate waste generated depends on a large number of factors. These drivers of plate waste must be understood to make plate waste data comparable.

2.2. Drivers of plate waste

A limited number of studies have identified potential drivers of plate waste – factors which are significantly associated with higher amounts of plate waste. The Slovenian breakfast buffet study (Juvan et al., 2018), for example, identified significant differences across a number of guest mix factors and buffet characteristics: families emerged as producing the most plate waste per person, as did tourists from Russia. Tourists from Austria, on the other hand, generated significantly less plate waste than the reference guest. The number of self-service buffet stations also affected plate waste. Usually the hotel has two sections where guests can serve themselves. Both areas offer the same foods. During peak season, the number of guests in the dining room increases, making it necessary to open a third self-service area. Opening this third buffet dramatically increases plate waste. The exact reason could not be derived from their study, but the authors hypothesize that either increased anonymity (reducing social pressure to eat up), or increased perception of abundance of food (which may induce the impression that the food is not precious) may have driven plate waste up.

A study conducted in the context of event catering in the United Arab Emirates found that buffet-style lunches generate more plate waste than a la carte lunches; that buffets with live cooking demonstrations generate more plate waste than traditional buffet settings; that meals during Ramadan generate less plate waste than meals during iftar; and that lunch buffets generate more plate waste than breakfast buffets (Pirani & Arafat, 2016). Overall, in this study, between four and 12 percent of the meal remained uneaten. In the Chinese context, plate waste was found to be higher in less populated cities, among tourists (as opposed to locals), in larger restaurants, and at social and business gatherings (as opposed to work or private dining experiences; Wang et al., 2017).

An initial attempt to develop a model of drivers of plate waste (Dolnicar & Juvan, 2019) identified no less than 12 drivers in one single context (the same hotel at dinner time only): cheap ingredients, pre-prepared foods rather than food prepared by the chef in the kitchen, food items which do not stay fresh when displayed at the buffet, patrons’ inexperience in choosing compatible food items, patrons’ lack of knowledge how to eat certain food items, food items which are genuinely hard to eat, the use of incorrect plates, lack of familiarity with certain foods, lack of familiarity with certain types of food preparation, as well as a number of psychological factors including the fear of missing out, people’s eyes being bigger than their bellies, and people’s unwillingness to go to the buffet many times – their laziness – which leads to the creation of mini-buffets at the dining table. Inevitably not all of this food ends up being consumed.

These findings highlight the many different factors that influence the amount of plate waste generated. The wide range of drivers of plate waste makes it difficult to derive reliable statistics on plate waste which are independent of context. The benefit of the existence of this large number of drivers, however, is that each one of them can serve as a target for interventions aimed at reducing plate waste.

2.3. Existing interventions to reduce plate waste

Only a small number of studies have developed interventions proven to reduce plate waste. Kallbekken (2013) identified two measures that reduce plate waste by about 20 percent each, independent of one another: the use of a table sign that invites guests to return to the buffet as often as they want and explains to them that this is much better than taking too much food at once. The second intervention involved reducing the plate size by 3 cm. Both approaches were highly effective, but used different avenues to change guest behaviour: the table sign appealed at social norms, and required cognitive processing from guests. Reducing plate size required no cognitive processing; it was a change in infrastructure. Despite the smaller plates, guests could return to the buffet as many times as they wanted, and they could leave as much plate waste as they wanted. Possibly as a consequence of the retained freedom, guest satisfaction was not negatively affected. This study is unique because the interventions are proven effective in the hotel context.

Most other intervention studies were conducted in staff or university cafeterias – in settings in which food is a necessity, rather than a pleasurable experience. As a consequence, findings about the effectiveness of the interventions are not easily transferrable to the hotel or restaurant context. At a university restaurant, for example, charging approximately $5 when students leave plate waste behind proved highly effective, reducing plate waste in this semi-buffet style eatery by 54 percent (Kuo & Shih, 2016). Interestingly, in the same study, educating students had no effect on plate waste, a finding that stands in direct contrast to the conclusions drawn by Kim and Freedman (2010) in a university canteen, where education reduced plate waste by 25 percent. Kim and Freedman (2010) also introduced tray-less dining, making it more difficult to carry a lot of food at once, which led to a decrease by 54 percent. In another university all-you-can-eat canteen, reducing the portion size of French fries from 88 g to 44 g reduced plate waste by 86 percent (Freedman & Brochado, 2010). This is interesting because students were able to go back to the buffet and get as many servings of French fries as the wanted; they consumed 82 percent of the French fries they took from the buffet, irrespective of portion size. In a staff canteen, rewarding employees who displayed the desired behaviour – not leaving plate waste behind – proved successful: a free chocolate at the end of the meal reduced plate waste by 60 percent (Windrum, 2014).

But the canteen context is very different in nature than the hotel or restaurant context. In a hotel or a restaurant, dining is a memorable experience; it is an activity people engage with in pursuit of pleasure. In a hotel or restaurant, patrons pay full price for their meals, food is
expensive, much in contrast to the canteen, where typically food is cheaper, and often subsidised. It is not reasonable to assume, therefore, that interventions proven to work in canteens will also work in hotel and restaurant buffet settings: it is difficult, potentially impossible, to charge a hotel guest a fine if they leave plate waste behind; it is impossible to reduce portion sizes to the point where hotel guests get frustrated; and getting a chocolate as an incentive does not work at a hotel buffet that has an entire section of delicious desserts.

Different types of interventions are needed in the tourism and hospitality sector. This sector if defined by a pursuit of pleasure, and the all-inclusive nature of pricing makes it impossible to financially incentivise pro-environmental behaviour. For the present study we chose to develop an intervention targeted at families, because families have emerged in prior work as the segment which causes the most plate waste. We have designed the intervention in a way that it increases pleasure (i.e., game-based), rather than requesting from tourists a sacrifice in enjoyment for the greater good.

3. Methodology

We conducted a quasi-experimental field study, a guest survey and interviews with restaurant staff and research assistants during the peak summer season in two hotels: one four-star rated property operating 276 rooms, and one three-star rated property operating 216 rooms (ethics approval number 2018001325). Both hotels are located in the seaside town of Portoroz in Slovenia. They share the same beach, an indoor pool area, and the restaurant. Both hotels are popular with families because they are located very close to the beach, have access to a pool area with water slides, and provide good value for money.

The hotel restaurant hosts between 800 and 1200 diners within a 3 h timeframe, rotating 14 different menus fortnightly. A typical dinner menu includes four different cold starters, three different warm starters and three main courses consisting of two different kinds of meat, one type of fish and typically with one or two kinds of side dish for each type of meat or fish. A separate buffet station contains a variation of salads, desserts, cheeses and fruits or ice-cream.

3.1. Dependent variable

The key dependent variable was edible food waste left behind on plates. The unit of analysis is grams of plate waste generated per family member per day; we refer to this as plate waste throughout this article. Practically, measuring plate waste per table (per family) meant that research assistants were working alongside waiting staff during the 50-day fieldwork period. As the waiters delivered plates into the kitchen, the research assistant noted the table number, and placed all plate waste from the table in a container which was weighted. After the weighing procedure was completed, the plate waste was disposed off in the main food waste bin located in the kitchen.

We measured plate waste separately for each family. This was possible because each family is assigned a specific dinner table for their entire stay in the hotel. We were able to link this data with the de-identified hotel guest database. Linking the total table plate waste with the hotel database enabled us to determine the number of people in the room and calculate plate waste per family member per day. Note that isolating families is only required to enable the separate, attributable plate waste measurements required in this study. Once the effectiveness of the intervention is proven, there is no need for this anymore. All guests were informed at check-in of the study, without revealing any details that may affect their plate waste behaviour.

3.2. Experimental conditions

We measured plate waste for five different conditions; each condition was implemented for ten days. The field study follows a quasi-experimental design because hotel guests could not be randomly assigned to experimental conditions by the researchers. Given that our field experiment took place during normal hotel operations, experimental conditions were implemented sequentially. Guests staying at the hotels during the field experiment were assigned to experimental conditions depending on their check-in date.

The control group represented the status quo; we measured plate waste generated during regular hotel operations (n = 538 plate waste measurements from 185 families). Experimental group #1a involved guests receiving a flyer (see Appendix 2) asking them to help the hotel reduce food waste without presenting a pro-environmental appeal (n = 162 measurements from 54 families). Experimental group #1b involved guests receiving a flyer asking them to help the hotel reduce food waste, supported by a pro-environmental appeal (see Appendix 2, n = 268 measurements from 98 families). We included experimental groups #1a and #1b originally to be able to separate out any potential awareness effects of the main intervention: the stamp collection booklet for families.

Families checking in at the hotel reception during experimental group #2a condition received a stamp collection booklet (see Appendix 2, n = 667 measurements from 221 families). For every day the family did not leave any uneaten food behind on their plates, the waiter stamped the booklet for that day. If the family managed to collect one stamp for each day of their stay, they received a certificate and a prize (a waterproof mobile phone case or an inflatable ball) at check-out. Experimental group #2b was the same as #2a, except that a pro-environmental appeal was added to the booklet’s front page (see Appendix 2, n = 551 measurements from 219 families).

3.3. Voluntary guest survey and staff observations

In addition to collecting actual plate waste data, we also (1) asked staff and research assistants to observe guest reactions during the entire duration of the experiment, and (2) invited guests to participate in a voluntary guest survey at check-out to gain more insight about how people perceived the intervention. Those who agreed, answered the questions on a tablet. On days with large numbers of guests checking out, research assistants invited guests personally, and distributed tablelets. This approach reduced the burden on guests, and increased the response rate. The survey was deliberately designed to be as short as possible to increase the likelihood of guests completing it. The questionnaires asked hotel guests if they participated in the stamp collection game (yes/no), and if they returned the stamp collection booklet (yes/no). Those who did also indicated the level of pleasure associated with: the stamp collection game, the present they received, and the certificate they received. This was done to check whether the stamp collection book – as expected – added to holiday enjoyment of hotel guests.

One of the most valuable sources of insight during this study was hotel staff. Most of the staff have worked in the hotel for many years, and have been continuously observing guest behaviour. Their observation of guest behaviour during the study, therefore, was invaluable. We conducted interviews with six chefs, 12 restaurant service staff members, two receptionists and five research assistants at the hotel (25 people in total). We asked all staff who had direct personal contact with guests to describe how families reacted to the booklets, how children and adults reacted to collecting the stamps, how they actually collected stamps, how guests behaved when returning the stamp collection booklets to reception and how they reacted when they received their reward. We also presented chefs and restaurant service staff with two of the menus (1 and 14) and asked them why they thought these two menus resulted in more plate waste. A number of clear themes emerged from the staff interviews, both with respect to drivers of plate waste and guest reactions to the stamp collection game.

3.4. Data analysis

Before testing the effect of the interventions, we checked for
4. Results and discussion

4.1. Average plate waste

Fig. 1 shows the distribution of average plate waste per family member across experimental conditions. The visualisation used in Fig. 1 is a so-called violin plot. It determines a kernel density estimate and draws it twice, once rotated by 90° to the left, and once rotated by 90° to the right. The area inside of each violin corresponds to two times the standard deviation of the data. If the data follow a normal distribution, the violin plot shows two bell-shaped, symmetric curves. Kernel density estimation is a non-parametric way of estimating the probability density function of a continuous random variable. The area below a density is scaled to be one, and the area below the density for a given interval represents the probability of the random variable falling into this interval. Kernel density estimate areas with high values indicate that many observations fall into this area. Compared to other ways of characterising a distribution – such as a box plot – the kernel density estimate flexibly adapts to different shapes and thus highlights subtle differences in the shape of the compared distributions.

Among the experimental conditions, we visualised the average plate waste per family member using a violin plot to enable comparison of the distribution across experimental conditions. We then fitted linear mixed-effects regression models to test how the average plate waste per family member varies across experimental conditions, while accounting for other sources of heterogeneity by including socio-demographic characteristics of the guest parties as control variables and a random intercept for each guest party. We fitted logistic mixed-effects regression models to test how the likelihood of having a zero daily plate waste measure for a guest party depends on the experimental conditions (while again accounting for other sources of heterogeneity by including socio-demographic characteristics of the guest parties as control variables and a random intercept for each guest party). We use maximum-likelihood estimation to fit all models and report regression coefficients along with standard errors (Bates, Mächler, Bolker, & Walker, 2015). 95 percent confidence intervals for the regression coefficients are determined using the profile likelihood for the linear and standard asymptotic theory for the logistic mixed-effects regression model.

Fig. 1. Violin plot of average plate waste across experimental conditions.
average plate waste. It has to be assumed, therefore, that the information alone, the drawing of guest attention to plate waste, has led to some behavioural change. This may be due to the message of eating everything that is on one’s plate resonating with traditional parental messages in the central European context.

The average plate waste per family increases with the number of members in the family. However, for each additional person in the family the average food waste per person decreases. Average plate waste per family member is lower for Slovenian families and for families staying at the hotel for a longer period of time, and average plate waste per family member is affected by the menu.

Two of the 14 menus (details of those two menus are provided in Table 4 in Appendix 1) generate significantly more plate waste. Both menus contain a higher proportion of lower quality food items, and items which are unusual in taste or serving style. Specific dishes of such nature include: fish terrine, Idrian style pasta with fish stuffing, pasta salads, and yogurt panna cotta with herbs or meatballs. The two menus also contain dishes that are not particularly suitable for buffet-style meals. Roasted and grilled beef, for example, should be served directly out of the oven or from the grill. Sitting in a buffet tray waiting to be served reduces the tenderness of the beef. Guests take these items because they look nice, but ultimately do not eat them because the texture or flavour do not meet their expectation.

4.2. Zero plate waste

Because the stamp collection booklets required families to leave absolutely no plate waste behind at all in order to get a stamp, we also study zero plate waste as a secondary dependent variable. Fig. 3 contains results from the logistic regression analysis (numerical details are included in Table 3 in Appendix 1). As can be seen, the likelihood of leaving absolutely no plate waste behind increases significantly when there are fewer people in the family, when the family is Slovenian, when the family gets the booklet (Experimental groups #2a and #2b), and when the family is staying at the hotel for a longer time period. The likelihood of leaving absolutely no plate waste behind is not improved by the flyer or by adding a pro-environmental appeal. This is in line with our theoretical expectations about the likely effect of the stamp collection booklet. Again, findings contradict currently dominant theory which postulates that beliefs drive pro-environmental behaviour: using the exact kinds of beliefs assumed to drive behaviour in the theory of environmentally significant behaviour (Stern, 2000) had no effect on zero plate waste.

4.3. Guest reactions

In total, 101 guests staying at the hotel during experimental conditions #2a and #2b completed the voluntary survey at check-out. Of those, 21 percent indicated they had collected stamps and returned the booklet at the end of their stay. On a visual analogue scale with end-points labelled as 0 and 100, they evaluated the pleasure associated with collecting stamps as a family at 72, on average (standard deviation: 24). The 17 respondents who redeemed the certificate and the gift at the end of their stay, indicated the pleasure of their children receiving a certificate at 65, on average (standard deviation: 25), and the pleasure of the gift at 80, on average (standard deviation: 20). These evaluations from
hotel guests suggest that, indeed, the stamp collection booklet, as well as the gift families received for handing in the complete booklet, did increase their vacation pleasure, supporting the theoretical explanation of increased utility being associated with the stamp collection booklet intervention.

In addition to the survey based self-reports by guests, hotel staff as well as research assistants involved in the project were asked to provide their evaluation in relation to how families reacted to the stamp collection booklets. Staff and research assistants reported that families, especially children, appeared to enjoy the game and took great pride in collecting their stamps. On a number of occasions, the children informed the head waiter (who welcomes guests as they get to their table), the table waiter (who serves the drinks) or the assistant waiter (who clears the table) in advance that they have a booklet, and that they will make sure they receive a stamp for today. A few comments by waiters illustrate this:

"Before even welcoming guests …, the kids would waive their booklets and smilingly say: I will get the stamp today!" (Waiter, 25 years of work experience)

"Sometimes kids would run over to me, to another section of my part of restaurant, and kindly ask if they can get the stamp … kids were excited during our walk to their table saying that they ate it all." (Waitress, 8 years of work experience)

"Oh man, you should see their faces after getting the stamp! It was like earning a million Euros or the best toy. They would show the stamp in the booklet to their parents or siblings feeling really proud. Sometimes, they even asked me if I can give them another smiley (stamp) on their hand." (Waiter, 13 years of work experience)

Parents were also proud when the family managed to finish dinner without leaving behind plate waste. The "successful" parents, especially mothers, smiled when research assistants or waiters approached to stamp the book, because the table was clean:

"Moms were especially cute. You could tell how proud they were of their kids and sometimes even of themselves, because they managed to motivate kids being more mindful of the food." (Waiter, 8 years of work experience)

"I remember one grandmother rewarding her grandson with a big kiss, saying ‘You’re a good boy I am very proud of you. I think you also deserve a scoop of ice tomorrow.’" (Waiter, 5 years of work experience)

The pleasure of playing the stamp collection game was also evident at check-in and check-out at the hotel reception. Children suddenly became interested in being actively involved in the check-in and check-out process, which is typically not the case. Children even started asking questions of the receptionists, much to their surprise:

"Being a front desk manager for many years now, I haven’t seen kids being so interested in waiting in lines for the check-out. They would stand in line, holding the booklet and talking with their parent, with a big smile on their face. After approaching the first thing was that kids returned the booklet and asked what they will get for the stamps." (Front desk manager, 10 years of work experience)

"Sometimes kids would run to the reception ahead of their parents and return the booklet. You could tell how proud they were and of course excited about the reward. They typically picked the ball and instantly wanted their dad to blow it up so they can start playing." (Receptionist, 12 years of work experience)

"I remember two siblings having collected all the stamps. They had a chat about what to take. You know we offered two kinds of gifts. And after a
short conversation they agreed to take each kind of gift so that they can share afterwards.” (Receptionist, 3 years of work experience).

“Parents being used to a typical check-in process were not really interested in short explanations about the booklets, but once we mentioned a reward they became interested. We could tell from the expression on their faces (like a smile) or responses (like this is cute and nice). We could tell that a reward opportunity improved their engagement and actually made them happy.” (Receptionist, 8 years of work experience)

The booklets were a serious project for families and children. While it was a game, they appeared determined to “win” at any cost:

“There was this cute little girl, about 7–9 years old, asking me if I can give her another stamp because one day the family did not arrive to dinner and now she has a missing spot and would really, really, really like to achieve the goal of getting a reward and being successful.” (Waitress, 2 years of work experience).

“One morning, a young lady approached me asking if I can see her son at that table. I asked why and she explained that he needs to ask me something. When at the table, the boy asked me for a stamp, because last night he forgot his booklet and could not get the stamp. But his family really did not leave any food waste.” (Waiter, 25 years of work experience).

“Sometimes you could overhear a serious advice from the parents to kids when they learned about the booklets at the check-in. Parents would say things like ‘you see, if we all behave well, you get something special’ or ‘yes, you can get a reward, but we all need to help you, and we will’.” (Receptionist, 14 years of work experience).

“It was not rare observing families being ready to leave the restaurant, but you could overhear a conversation about who will take the last piece of food from the plate, so that they can get the stamp.” (Waiter, 6 months of work experience).

Overall, guest responses to the voluntary check-out questionnaire as well as the observations by receptionists, waiters and research assistants suggest that families, and children in specific, enjoyed the stamp collection process (rather than feeling burdened by it), viewed it as a game they wanted to win, wanted to get the prize at the end of their stay, and took pride in getting all stamps. Parents frequently took the opportunity to leverage the game to convey their own views about the need to eat up what is on the plate. These results indicate that the pleasure derived from collecting stamps likely was higher than the effort of having to eat up, leading to an overall increase in pleasure. The behavioural change observed, therefore, is in line with classic utility theory of human behaviour.

5. Conclusions, managerial implications and future research

This quasi-experimental field study makes a number of key contributions to knowledge: It develops a new intervention aimed at reducing plate waste, and proves its effectiveness using a causal research design and actual behaviour as a dependent variable. This proof of principle of intervention effectiveness represents the primary aim of the study. It represents a major contribution, because – despite general agreement on the importance for the tourism industry to become more environmentally friendly – few studies to date have proposed tangible measures to achieve this. The study therefore lays the foundation for practical impact on reducing plate waste and, with it, the negative impact of tourism on the environment.

The research design also allows key theoretical insights to be gained. First of all: increasing pleasure through the stamp collection booklet in an inherently pleasure-focused context (vacations) – in line with classic utility theory of human behaviour – represents a promising strategy to making tourists behave more environmentally friendly. This is in line with prior findings in the context of drink vouchers increasing voluntary opt-out of room cleaning in hotels (Dolnicar, Knezecv Cvelbar & Grün, 2019), which can also be explained by additional pleasure, or utility, being generated by the reward obtained for displaying the desired behaviour.

Secondly, the study provides additional empirical evidence for an observation that has been made in two prior quasi-experimental studies in the hotel context (Dolnicar, Knezecv Cvelbar & Grün, 2017; 2019): that pro-environmental appeals do not trigger the desired pro-environmental behaviour. Within conventional theories of human behaviour, therefore, social norms remain as the only leverage point for interventions, as illustrated in the quasi-experimental study by Kallbekken(2013).

Our study also provides some insights about the potential effectiveness of awareness-raising only, especially when the message is in line with parental principles likely enforced in the home context. The fly condition, originally designed to control for the awareness-raising component of the stamp collection booklet, significantly reduced average plate waste at much lower cost than the stamp collection booklet. While flyers were not effective in terms of zero plate waste, they worked remarkably well in reducing average plate waste, making flyers a highly attractive low-cost intervention in the fight against plate waste at hotel dinner buffets.

5.1. Managerial implications

Plate waste comes at high cost to the hotel. Hotel managers are motivated to reduce plate waste to save money. The interventions tested in this study performed well in terms of operational savings for the hotel in which the study was conducted. The intervention reduced plate waste per family member by 13 g. An average dinner consists of 250g–300g of food, and costs 3.5–4.8 Euro (an equivalent of 0.014–0.016 Euro per gram of food). The hotel also pays 0.00024 Euro for the disposal of 1 g of food waste. If all families (36,428 family members) had participated in the stamp collection game during July and August, plate waste would have been reduced by 474 kg, saving the hotel between 6636 and 7584 Euro in food purchasing cost and another 114 Euro in disposal fees. The cost of producing all distributed flyers (105 Euro) and the cost of producing the stamp booklets and paying extra time to waiters to check plate waste and stamp the booklet (473 Euro) were substantially lower.

Importantly, there is no indication of the intervention reducing hotel guests’ enjoyment of their stay. Staff and research assistants report from their observations that they have received no complaints or negative comments about the flyers or stamp collection game, and that those who chose to play, enjoyed doing so. It is likely that specific circumstances of the hotel will lead to the effectiveness of the intervention being affected. Obviously the intervention is unlikely to work if families do not represent a substantial fraction of the guest mix. It is also likely that the country of origin, and with it the cultural background of families will affect plate waste reduction by the intervention. We expect that the intervention will be most effective when the cultural background reinforces the positive societal perception of not leaving uneaten food behind.

5.2. Limitations and future work

This study provides proof of principle that a simple and cost-effective intervention can lead to a substantial reduction in plate waste in hotels. The study is limited in that it was conducted in hotels with a high proportion of families in the guest mix and where the potential of the intervention to make a difference was assumed to be high. Many of the families in the guest mix have a cultural background where children are taught not to leave uneaten food behind on their plates. As such, the intervention was well aligned with the educational principles of parents. In addition, the intervention may be expected to be less effective if the families are highly familiar with the foods offered (either because they
Tourism Management 80 (2020) 104103

are domestic tourists or because they are repeat visitors). As a consequence, the initial level of plate waste may be lower, reducing the potential of the intervention to make a difference. Unclear is the effect of potentially different parenting styles, and this was not a focus of the present study. It could be argued that children whose parents do not manage their children as tightly would be less reactive to the intervention because they would not be receiving parental reinforcement to engage in collecting stamps. Also, the hotels – during the time when the study was conducted – are almost entirely booked by holiday guests, as opposed to business guests. The variability in effectiveness of the intervention we have tested should be assessed in replication studies in hotels which vary systematically in the cultural background of families. It would be of particular interest to replicate the study in all-inclusive contexts (resorts or cruise ships) where the inclination of guests to maximise on their booking entitlements is even higher. Also, it is critically important to develop similar interventions not targeted at families only, as families represent only a fraction of tourists staying at hotels and eating at buffets.

A number of additional opportunities for future work emerge from the results of this study: First of all, the low number of completed stamp booklets returned (44 across both experimental groups #2a and #2b) suggest that two variations could be implemented to further increase the effectiveness of the interventions: (1) the prize received for collecting all stamps could be of higher value, and (2) a system could be set in place to allow families to miss one stamp to avoid demotivation if, for example, the stamp booklet gets forgotten once. Another obvious modification is to avoid using paper to produce flyers and stamp booklets and, instead developing a visually more appealing and engaging app that can be installed on the parents’ and older children’s mobile telephones, thus preventing issues of families forgetting booklets in the room.

CRediT authorship contribution statement

Sara Dolnicar: Conceptualization, Methodology, Writing - original draft. Emil Juvan: Conceptualization, Data curation, Investigation, Methodology, Writing - original draft. Bettina Grün: Formal analysis, Methodology, Writing - original draft.

Acknowledgements

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Appendix 1

Table 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Statistic</th>
<th>Control</th>
<th>Experimental group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>#1a</td>
<td>#1b</td>
</tr>
<tr>
<td>Guest parties</td>
<td>Count</td>
<td>185</td>
<td>54</td>
</tr>
<tr>
<td>Number of adults</td>
<td>Mean</td>
<td>2.38</td>
<td>2.28</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>1.06</td>
<td>0.87</td>
</tr>
<tr>
<td>Number of children</td>
<td>Mean</td>
<td>1.60</td>
<td>1.52</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>0.83</td>
<td>0.78</td>
</tr>
<tr>
<td>Length of stay (in days)</td>
<td>Mean</td>
<td>5.98</td>
<td>6.83</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>2.25</td>
<td>2.87</td>
</tr>
<tr>
<td>Being Slovenian</td>
<td>Percentage</td>
<td>25%</td>
<td>28%</td>
</tr>
<tr>
<td>Plate waste measurements</td>
<td>Count</td>
<td>538</td>
<td>162</td>
</tr>
<tr>
<td>Plate waste (in g) per family member</td>
<td>Mean</td>
<td>44.8</td>
<td>29.5</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>51.6</td>
<td>36.4</td>
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</table>

Table 2

Linear mixed-effects regression results.

<table>
<thead>
<tr>
<th>Estimate</th>
<th>Std. Error</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower bound</td>
</tr>
<tr>
<td>Baseline</td>
<td>54.6</td>
<td>4.1</td>
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<tr>
<td>Experiment: Flyer versus Control</td>
<td>–13.4</td>
<td>4.0</td>
</tr>
<tr>
<td>Experiment: Booklet versus Flyer</td>
<td>0.3</td>
<td>3.1</td>
</tr>
<tr>
<td>Environmental</td>
<td>–3.9</td>
<td>2.8</td>
</tr>
<tr>
<td>Number of family party members</td>
<td>–11.2</td>
<td>2.9</td>
</tr>
<tr>
<td>Being Slovenian</td>
<td>–1.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Length of stay (in days)</td>
<td>8.1</td>
<td>2.7</td>
</tr>
<tr>
<td>Menu 1</td>
<td>–6.1</td>
<td>3.3</td>
</tr>
<tr>
<td>Menu 2</td>
<td>1.4</td>
<td>3.0</td>
</tr>
<tr>
<td>Menu 3</td>
<td>0.0</td>
<td>2.8</td>
</tr>
<tr>
<td>Menu 4</td>
<td>–3.2</td>
<td>3.1</td>
</tr>
<tr>
<td>Menu 5</td>
<td>1.1</td>
<td>2.8</td>
</tr>
<tr>
<td>Menu 6</td>
<td>–2.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Menu 7</td>
<td>–3.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Menu 8</td>
<td>–2.7</td>
<td>3.0</td>
</tr>
<tr>
<td>Menu 9</td>
<td>0.7</td>
<td>3.1</td>
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<tr>
<td>Menu 10</td>
<td>–2.6</td>
<td>3.2</td>
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</table>

(continued on next page)
### Table 2 (continued)

<table>
<thead>
<tr>
<th>Menu</th>
<th>Estimate</th>
<th>Std. Error</th>
<th>95% confidence interval</th>
<th>Lower bound</th>
<th>Upper bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>0.4</td>
<td>3.1</td>
<td>-5.6</td>
<td>6.4</td>
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<td>13</td>
<td>-1.7</td>
<td>3.5</td>
<td>-8.5</td>
<td>5.3</td>
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<td>14</td>
<td>10.6</td>
<td>2.9</td>
<td>5.0</td>
<td>16.3</td>
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</table>

The baseline represents the average plate waste per family member for a family with zero members, which is not Slovenian, which is in the control group, has received no environmental message, has a length of stay of zero days and has dinner for an average menu composed of the 14 different menus.

### Table 3

Logistic mixed-effects regression results.

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>95% confidence interval</th>
<th>Lower bound</th>
<th>Upper bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
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<td>-1.63</td>
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<tr>
<td>Experiment: Flyer versus Control</td>
<td>0.15</td>
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<td>-0.31</td>
<td>0.61</td>
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<tr>
<td>Experiment: Booklet versus Flyer</td>
<td>0.77</td>
<td>0.18</td>
<td>0.42</td>
<td>1.13</td>
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</tr>
<tr>
<td>Environmental</td>
<td>0.19</td>
<td>0.16</td>
<td>-0.12</td>
<td>0.49</td>
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</tr>
<tr>
<td>Number of family party members</td>
<td>-0.28</td>
<td>0.06</td>
<td>-0.39</td>
<td>-0.16</td>
<td></td>
</tr>
<tr>
<td>Being Slovenian</td>
<td>0.66</td>
<td>0.16</td>
<td>0.35</td>
<td>0.97</td>
<td></td>
</tr>
<tr>
<td>Length of stay (in days)</td>
<td>0.10</td>
<td>0.03</td>
<td>0.05</td>
<td>0.16</td>
<td></td>
</tr>
<tr>
<td>Menu 1</td>
<td>-0.12</td>
<td>0.18</td>
<td>-0.47</td>
<td>0.24</td>
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</tr>
<tr>
<td>Menu 2</td>
<td>0.02</td>
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<tr>
<td>Menu 3</td>
<td>0.30</td>
<td>0.19</td>
<td>-0.07</td>
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<tr>
<td>Menu 4</td>
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<td>-0.58</td>
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<td>Menu 5</td>
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<td>0.19</td>
<td>0.00</td>
<td>0.76</td>
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<tr>
<td>Menu 6</td>
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<td>0.19</td>
<td>-0.68</td>
<td>0.06</td>
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<tr>
<td>Menu 7</td>
<td>0.36</td>
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<td>Menu 8</td>
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<td>Menu 9</td>
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<td>0.18</td>
<td>0.04</td>
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<tr>
<td>Menu 10</td>
<td>0.00</td>
<td>0.20</td>
<td>-0.39</td>
<td>0.39</td>
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<td>Menu 11</td>
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<td>0.17</td>
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<td>Menu 12</td>
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<td>-0.26</td>
<td>0.53</td>
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<tr>
<td>Menu 13</td>
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<td>0.23</td>
<td>-0.57</td>
<td>0.33</td>
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</tr>
<tr>
<td>Menu 14</td>
<td>-0.51</td>
<td>0.20</td>
<td>-0.90</td>
<td>-0.11</td>
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</tr>
</tbody>
</table>

The baseline represents the log odds for zero plate waste for a family with zero members, which is not Slovenian, which is in the control group, has received no environmental message, has a length of stay of zero days and has dinner for an average menu composed of the 14 different menus.

### Table 4

High plate waste menus (* foods mentioned by chefs as high plate waste items).

#### MENU 1

**COLD STARTERS**
- Chickpea in a salad with vegetables
- Meat cold cuts
- Beef salad
- Fish "terrine" (minced fish with herbs roll)*

**WARM STARTERS**
- Idrian "zlikrofi" (traditional Slovenian pasta) with fish stuffing*
- Pasta with pancetta, olives, artichokes and asparagus
- Pasta with black mussels and vegetables*

**MAIN COURSE**
- Beef steak*
- Oven fried chicken*
- Pork roast with sweet onions
- Sea bass with spinach and mushrooms*
- Grilled calamari with Mediterranean dressing
- Mediterranean style baked potatoes with vegetables
- Cheese rolls with rocket
- Ancient wheat with vegetables*
- Spinach with Muscat blossom
- Cooked garden vegetables

#### MENU 14

**COLD STARTERS**
- Small shrimps (Gamberi) and vegetables salad
- Cooked prosciutto on a French salad
- Yogurt panna cotta with herbs*
- Grilled vegetables with pesto

**WARM STARTERS**
- Shell shaped pasta with smoked 4 cheeses, basil pesto and parmigiana cheese
- Ravioli with tomato sauce, capers and black olives
- Rocket and shrimps pasta

**MAIN COURSE**
- Roast beef in pepper sauce*
- Meat balls*
- Baked chicken tights in curry sauce and grilled pineapple
- Scorpion fish with olives and baby potatoes*
- Mashed potatoes

*(continued on next page)*
Appendix 2. Intervention materials

Flyer – no environmental appeal (Experimental group # 1a)

[Image of flyer]

Flyer – environmental appeal (Experimental group # 1b)

[Image of flyer]

Booklet – no environmental appeal (Experimental group # 2a)

[Image of booklet]
Declarations of interest

None.

References


Sara Dolnicar Sara is a Professor in Tourism at The University of Queensland in Australia. Sara’s core research interests are the improvement of market segmentation methodology and the testing and refinement of measures used in social science research. She has investigated a range of different applied research areas, including sustainable tourism and tourism marketing, environmental volunteering, foster caring and public acceptance of water alternatives and water conservation measures.

Emil Juvan Emil Juvan is an Assistant Professor and a Head of the Department for Sustainable Destination Development at University of Primorska in Slovenia, Faculty of Tourism Studies (Turistica). Emil’s research focuses on measuring actual environmental impacts of tourism and finding effective and easy-to-implement managerial solutions to reduce this impact.

Bettina Grün Bettina is an Associate Professor at the Department of Applied Statistics of the Johannes Kepler University Linz in Austria. Bettina’s core research interests include finite mixture models and their application in model-based clustering including estimation as well as implementation in statistical software; and quantitative methods in economics, marketing and tourism.