One needs to be reminded and motivated: Mediating role of digital nudging for food waste reduction.

Structured Abstract

Purpose - The global food waste and food scarcity paradox is steadfastly increasing. This study examined the effects of digital nudging as forms of positive and negative reinforcement to change food waste behavior and found that nudging positive reinforcement modifies this habit.

Design/methodology/approach - A field experiment was conducted on 628 diners randomly split into experiment (n=412) and control group (n=216) in 2 separate dining locations over 4 weeks. Out of these 412 diners were randomly subjected to tent cards with positive (n=228) and negative (n=184) reinforcement nudging and completed a questionnaire to ascertain if nudging affects their consumption behavior. Consumption waste per unit revenue (CWPUR) was calculated from all 628 diners individually to analyze the financial impact between control and experiment groups.

Findings - SEM analysis reveals that positive reinforcement mediates between external motivators (social media and restaurant service) and reduction of food waste behavior. Further analysis also reveals that nudging has a higher one -third effect on reducing food waste as compared with no nudging (control).

Social implications - Positive messaging encourages behavior change more effectively as compared to negative ones. Gentle reminders of how everyone can personally be a "warrior" or "hero" in the fight against global food waste increases the likelihood of altruistic motivation in tackling these issues.

Originality/value - This study demonstrates how positive reinforcement in the form of nudges acts as key mediator to support reduction of consumer food waste on site ultimately helping to reduce financial costs compared to those without nudges.

Keywords Food waste, Digital nudge, Socially responsible consumption, Social Marketing

Paper Type Research Paper

1.Introduction

Current global food disposal practices is unsustainable causing extensive ecological, social, and economic impact (Corrado, *et al.,* 2019). The entire food system accounts for 15-28% of total greenhouse gas (GHG) emissions (Lemaire and Limbourg, 2019), while food losses and wastes (FLW) cause indirect environmental impacts including soil erosion, deforestation, water, and air pollution (Read *et al.,* 2020). A total of 1.3. billion tonnes per year of food for consumption is wasted (Dou and Toth, 2021; Schanes *et al.,* 2018). In Malaysia, the estimated food waste has increased from 4.4 million (2005) to about 6.5 million tonnes (2020) and projected to reach up to about 41,035 tonnes per day by 2026, in which paradoxically this same amount could potentially feed around 12 million Malaysians a day (SWCorp, 2018). Restaurants and eateries are the main cause of food wastage mainly due to poor meal planning

(Yokokawa *et al.,* 2018) and studies (Annunziata *et al.,* 2020; Ahmed *et al.,* 2021; Naim and Rahman, 2020) show that poor knowledge and understanding about food wastage is prevalent, indicating the need for effective food waste educational programs.

Whilst consumers may have strong opinions on food waste, an uncomfortable gap exists between consumer's desire to avoid food waste and their actions which contradicts this intention (Pelt *et al.*, 2020). Food waste reduction efforts can benefit from activating the 8 benchmarks of social marketing (Andreasen, 2002) for it to be effective (Kim *et al.*, 2020) and ensure that any intervention introduced must be uniquely set apart from its competitors and its effectiveness is determined by the specific context and purpose (Schmidtke *et al.,* 2021). Kim *et al.* (2020) proposes a theory-marketing mix combination to promote behavior change, however, there are inadequate number of such studies on food waste to validate this impact. Whilst, a strong presence of behavioral objectives is found in change initiatives, consumer orientation strategy however is lacking to effectively drive such changes (Katt and Meixner, 2020; Kotler and Zaltman, 1971).

Kim et al.'s (2019) systematic review highlights the various programs initiated to reduce food waste using nudging within the specific contextual setting (Hamerman *et al.,* 2018; Giaccherini *et al.,* 2021; Vidal *et al.,* 2022; Qi, *et al.,* 2022) however none centered around using digital nudging in public spaces. Hence this study hopes to fill the gap in analysing how digital nudging can be used to affect positive behavioral change in food waste reduction. This paper fills this gap by empirically examining how essential information on food waste supported by nudge theory, social media intervention and social marketing concepts can trigger and sustain behavioral change to reduce food waste. The messages and graphics were crafted around the use of positive and negative reinforcement and nudge theory (Thaler and Sunstein, 2008; Fogg *et al.*, 2007), while social marketing principles (Kotler and Zaltman,1971) were practically applied. Hence this study aims to answer the following research questions:

RQ1: Does digital nudging affect positive behavioral change (reduce food waste)?

RQ2: Which is more effective (positive or negative reinforcement messaging) at positive behavioral change (reduce food waste)?

2. Literature review and hypotheses development
2.1. Factors influencing food consumption behavior

Given that current food consumption and disposal practices are increasingly detrimental to the global eco-system (van den Bos Verma *et al.,* 2020), effective solutions are therefore urgently needed to resolve this problem. For example, GHG emissions from decomposing food not only contributes 25 times greater global warming potency than carbon dioxide but also triggers toxic landfill emission leaks (Thyberg and Tonjes, 2016). Food waste prevention and surplus management are found to mitigate food waste in the restaurant industry (Papargyropoulou *et.al.*, 2019). In their analysis of 3557 tables in 195 restaurants in China, Wang, *et. al.,* (2017) found 93 g of food waste per capita per meal, equivalent to approximately 11 kg/cap/year. Additionally, McAdams *et al.,* (2019) and Thyberg and Tonjes (2016) found restaurant plate waste was a major contributor of food waste.

Unfortunately, to date modifying poor food consumption behavior remains challenging due its complex nature and no clear indication of what factors likely influences it (Falasconi *et al.,* 2019;

Wharton *et al.,* 2021). On a positive note, food waste habits can be modified and resolved for the better (Kim *et al.,* 2019; Ravandi, and Jovanovic, 2019) employing the discipline of Social Marketing as a tool to promote positive consumer driven behavior for the good of society (Kotler and Zaltman,1971). Previous studies (Carins and Rundle-Thiele, 2014; Kim, *et al.*, 2020; Kim, *et al.*, 2019; Kubacki *et al.,* 2015) show how motives behind food behavior can be uncovered whilst at the same time provide workable solutions to tackle food waste.

However, despite keen efforts to introduce food waste mitigation programs, it has not garnered significant positive outcomes thus far (Kymäläinen *et al.,* 2021; Sharma, 2021). This complexity of food consumption behavior has caused vast disparity of understanding amongst practitioners resulting in limited workable solutions (Falasconi *et al.,* 2019; Lefebvre 2011). As such experts (Kotler and Zaltman, 1971; Lefebvre, 2011), suggest applying an integrated approach in which relevant information from researchers and other agencies can be utilized to develop practical solutions. Additionally, scholars (Fogg *et al.*, 2007; Thaler and Sunstein, 2008) propose a holistic research approach encompassing the combined analysis of intrinsic and extrinsic factors to better understand consumption behavior.

Many definitions of food waste (e.g., leftovers, food loss and unconsumed foods) challenges the quantification of the phenomenon (Betz *et al.,* 2015), which also means that each type of food waste may require specific effective interventions (de Oliveira Pontes *et al.,* 2022). Specifically, limited studies on plate waste in a restaurant setting (Dolnicar *et al.,* 2020) shows that there is a need to address waste from dining out spurred by busy lifestyles of urban population (Huang and Tseng, 2020). Hence, this study is timely in its focus on investigating commercial plate waste in restaurants to address this growing environmental threat. Numerous studies (Cerrah and Yigitoglu, 2022; Juvan *et al.,* 2021) have shown that plate waste modification initiatives for both private and business consumption have shown significant improvement in food waste habits hence key theories (i.e., Fogg *et al.*, 2007; Thaler and Sunstein, 2008) were applied to develop a workable model (See Figure 2) in a practical setting (See Figure 3*)* for effective social marketing initiatives for the benefit of society, and the environment.

2.2. Socially Responsible Behavior (SRC)

Socially Responsible Consumption (SRC) is defined as "purchasing products and services which are perceived to have a positive or less negative impact on the physical environment and/or the use of purchasing power to express social concerns" (Francois-Lecompte and Roberts, 2006, p. 52). Antil (1984) suggests that socially responsible consumption must be continuously practised to instil ingrained behavior who are often practiced by those who live in modern cities and are more exposed to community activities. Consumers in this category, generally portray themselves as being environmentally conscious and are willing to help with environmental problems (Antil, 1984).

With the growing depletion and scarcity of natural food resources (Paužuolienė *et al.,* 2022 ; Read, *et al.*, 2020), interventions to promote SRC within the food domain is therefore important to attract, retain and motivate positive SRC to promote mindful food consumption habits in restaurants. At the same time given the propensity for socially responsible consumers to be engaged with community activities (Antil. 1984), they could act as advocates for promoting responsible food consumption practices. Studies (Jenkins *et al.,* 2022; Teoh *et al.,* 2022) show that socially responsible consumers can influence this behavior in their communities through word

of mouth, social media platforms and other such communication channels. Hence, the inclusion of SRC in this study test the effectiveness of the plate waste campaign in a restaurant setting with the aim of sustaining this behavior whilst encouraging individuals to be ambassadors for change in their own communities.

2.3 Fogg Behavior Model (FBM)

The FBM model (Fogg *et al.,* 2007) asserts that three factors namely: (1) motivation, (2) ability and (3) triggers must occur at the same time for any targeted behavior to take place (See Figure 1). Additionally, Thaler and Sunstein (2008) suggests that positive behavioral change is most effective when motivation, ability and triggers work in tandem with external influences. Therefore, the combined use of the FBM Model (Fogg *et al.,* 2007), Nudge Theory (Thaler and Sunstein, 2008) and reinforcement techniques (Skinner,1963) were applied in this research, with the aim to promote mindful food consumption behavior and to mitigate food wastage practices.

[INSERT]: Figure 1. Fogg Behavior Model: Adapted from BJ Fogg (Fogg, 2009)

2.4 Nudge theory and digital nudging

The Behavioral Economics (Thaler and Sunstein, 2009) perspective postulates that individuals should not be forced to act in a prescribed manner but rather gently encouraged to act in ways that are most beneficial to them. Within the broad concept of Behavioral Economics, the Nudge Theory (Thaler and Sunstein, 2009) was developed wherein its basic premise states that (1) individuals are not inclined to act in their own best interest from an economic standpoint and (2) that individuals can be "nudged" to change their choice environment (i.e., choice architecture). Specifically, food choice architecture incorporates elements of how a food choice is framed, and its impact on subsequent food related behavior (Ensaff, *et al.* 2015). Working on this premise, this research applied key nudging techniques (i.e., tent cards and digital nudges) within the chosen choice architecture environment of within a specified setting (Jagau and Vyrastekova, 2017), in this case a restaurant setting.

Numerous nudging initiatives have been used to direct people into making better choices and judgments [e.g., addictive behaviors (Newall, 2019), healthy eating (van Rookhuijzen and de Vet 2021), disease prevention (Misawa *et al,* 2020) and food waste behavior (Leverenz *et al.,* 2019)]. Recent successful examples of nudging have been used to help reduce public dining food waste initiating takeaway leftovers (Hamerman *et al.,* 2018), asking for doggy bags in eateries (Giaccherini *et al.,* 2021), understanding portion sizes in school canteens (Vidal *et al.,* 2022), and displaying larger plate size (Qi *et al.,* 2022).

Message framing has to be appropriate for the intended audience for any campaign to be successful (Pearson and Perera, 2020) and for today's tech-savvy audience, the nudging messages should be relayed quickly, effectively and widely (Soma and Maclaren, 2020) through digital platforms (Mullick *et al.,* 2021). Social media can help highlight the issue of food waste

(Sutinen and Närvänen, 2022; Jenkins *et al.,* 2022) and posting about the issue can act as a form of nudge to encourage food waste prevention (Teoh *et al.,* 2022). However, to date, the effectiveness of digital nudges on food waste habits is still not clear (Farr-Wharton *et al.,* 2017; Lazell, 2016), therefore, its application was examined in this study amongst restaurant patrons with the following hypotheses (H1):

H1: Social media postings positively effects socially responsible consumption behavior

2.5 Consumer Food Exploratory Behaviors

The tendency to explore variety and trying out advertised novel products (Raju, 1980) dictates how consumer exploratory behaviors provide insights on the effectiveness of environmentally focused food services and messaging at restaurants to encourage repeat patronage (Chang, 2022; Ha, 2020). Consumers tend to gravitate towards businesses that matches their altruistic environmentally friendly needs (Lentz *et al.,* 2021), but there are still uncertainties in its significance and impact on commercial plate waste. For example, monetary incentives and morally persuasive messages can discourage plate waste (Chang, 2022) whilst other studies (Coşkun and Filimonau, 2021; Matzembacher, *et al.,* 2020) indicate uncertain outcomes. In this case, individual perceptions, attitudes and restaurant services may influence these diverse outcomes (Chang, 2022; Matzembacher, *et al.,* 2020). Therefore, this study analyses the relationship between restaurant service (during the campaign) to confirm its impact on plate waste with the aim to develop targeted plate waste awareness campaigns for social good.

In view of this, hypothesis (H2) was postulated.

H2: Restaurant service positively influences socially responsible consumption behavior.

2.6 Digital Nudge (Positive and Negative) Reinforcement as Mediators

Positive reinforcement is a technique to elicit and/or strengthen behavior change by including rewards and incentives rather than removing benefits thereby making the targeted behavior more likely to happen in the future (Catania, 2001). Negative reinforcement on the other hand is a response or behavior that is strengthened by removing and/or avoiding a negative outcome or aversive stimulus (Skinner,1963). Studies (Abrahamse, 2020; Filimonau *et al.,* 2020) show that reinforcement using nudges and other such interventions can act as mediators to sustainable related behaviors.

In this research, nudging in terms of digital nudge before (digital tent card positive and negative messaging) and after (social media posting) was applied to understand both the positive and neagtive reinforcement relationships between attitudes and socially responsible consumption behavior. The reinforcement messages and social media posting are tested to see if they are likely to influence self-control to minimize food waste.

Therefore, the following hypotheses were postulated.

H3: Positive reinforcement messages mediates the relationship between social media posting and socially responsible consumption behavior

H4: Negative reinforcement messages mediates the relationship between social media posting and socially responsible consumption behavior

H5: Positive reinforcement messages mediates the relationship between restaurant service and and socially responsible consumption behavior

H6: Negative reinforcement messages mediates the relationship between restaurant and socially responsible consumption behavior.

The key theories in this study (Fogg *et al.,* 2007; Thaler and Sunstein, 2009) provides the framework to understand the role of individual behavior in decision making on positive food behavior modification (Chang, 2022). Whilst many intrinsic and extrinsic factors (Matzembacher, *et al.,* 2020) may hinder plate waste, evidence (Chang, 2022; Kim, *et al.,* 2020) show that interventions and other support mechanisms can modify poor food practices. Hence, this study tested a combination of support tools such as digital nudges (Thaler and Sunstein, 2009) reinforcement techniques (Skinner, 1963) and social marketing principles (Andreasen 2002; Kotler and Zaltman, 1971) to examine its impact on restaurant plate waste. Overall, the application and testing of these theories and concepts on site provides the opportunity for practical implementation and further expansion in the sustainable food domain.

[INSERT]: Figure 2. Research Model developed for the study

3. Methodology
The methodology of this research was carried out after due process in ethics approval has been sought. We acknowledge that the project is entirely self-funded and is part of a Master of Business Administration Research Project for the completion of the Lancaster-Sunway Master of Business Administration Degree. The Ethical approval for the project was sought on 13th August 2019 (approval no: SUBS-REC-2019/MBA/006) from the Sunway University Research Ethics Committee, with the title: "Cash on plate, let's not waste: A field experiment in assessing the change in consumer behavior towards food wastage".

3.1 Instrument development

The questionnaire consists of three major sections: (1) an introduction which stated the purpose and importance of the research along with the researcher information; (2) research instrument, with pre-tested adapted scales (each with 5 items): Socially-responsible-consumption behavior for *behavioral outcome* (Antil and Bennett, 1979); Attitudes Influencing Monetary Donations to Charitable Organizations for *positive reinforcement* (Webb *et al.,* 2000); General Self Control for *negative reinforcement* (Tangney *et al.,* 2004); Trait Aspect of Vanity for *social media posting* (Netemeyer *et al.,* 1995); Exploratory Tendencies in Consumer Behavior for *restaurant service* (Raju, 1980) and; (3) demographic information. All constructs were measured in a response

format of a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). All scales are presented in Appendix 1. Behavioral outcome, social media posting, and restaurant service were modelled as reflective constructs. Positive and negative reinforcements were modelled as formative constructs to show the items that causes the constructs and hence items were not interchangeable (Rossiter, 2002; Jarvis *et al.,* 2003) and removing any of the items would change the essence of the construct (Hair *et al.,* 2017).

3.2 Data Collection

Field experiment conducted at a casual dining franchise (Manhattan Fish Market) was randomized from two different locations (Sunway Pyramid Mall and Wangsa Walk Mall) and they were chosen due to their high traffic based on the strategic locations. The study was conducted in two levels.

3.2.1 Level One: Weighing leftovers and consumption waste per unit revenue

A total of 628 respondents participated in the process during both lunch and dinner periods with experiment group receiving nudges (n=412) and control group without nudge (n=216). Level one measured (weighed in grammes) all 628 respondents' leftovers (if there were any) and recorded it alongside with their purchase receipt amount (which indirectly gives us our consumption waste per unit revenue (CWPUR)).

3.2.2 Level Two: Digital nudge, questionnaire and social media posting

Level two involved administering questionnaire to the randomised experiment group (n=412) consisting of both influence exposure groups receiving either positive (n= 184) or negative (n=228) reinforcement (nudges). The number of respondents for the randomization of the field experiment is detailed in Table 1. Participants who consented to be part of the experiment had to acknowledge a message on their phone and fill in a questionnaire before they pay. Once consented, they were asked to scan a QR code to order their food. A digital tent card would appear before they would see the menu and they were asked to acknowledge that they have read it before ordering. They were given randomized tent-cards used (different across 4 weeks) for the different groups (pictured in Figure 3).

Positive reinforcement message was written as "Finish your food today, become a ZERO waste warrior, leave a positive legacy tomorrow" while the negative reinforcement message was written as "waste your food, create more hunger today, starve the world tomorrow". These tent cards were then placed on their table once their food came to serve as a support to the digital nudge. Upon payment, they would then be given a link to a short questionnaire after which they were encouraged to post a picture of their after-meal plate on social media with the hashtag #finishedfoodMahattanFishMarket. The social media post allows the participants to be in the running for a meal voucher on their next visit. The data from the questionnaires were then analysed to compare the effectiveness of positive and negative reinforcement nudges on socially responsible consumption.

[INSERT]: Figure 3. Tent Cards Design - Social Marketing Reinforcement Messaging

[INSERT]: Table 1. Intervention Schedule Developed for This Study

3.3 Data Analysis

Structural Equation Modelling (SEM) (Chin, 1998a; Hair *et al.,* 2010) using the SMART PLS 3.0 software (Ringle *et al.*, 2015) where a two-stage analytical process, measurement and structural was employed (Anderson and Gerbing, 1988). Common method variance bias (Conway and Lance, 2010) was checked using the Harman's single unrotated factor test (Podsakoff and Organ,1986; Yeap *et al.,* 2016). All constructs were modelled as reflective except for positive and negative reinforcement (formative) (Anderson and Gerbing, 1991).

3.4 Results

The respondents' demographic breakdown was almost evenly represented by both males (42%) and females (58%) with a good mix of Malay (59.7%), Chinese (29.9%), Indian (6.8%) and other ethnicities (3.6%); whilst a majority of the respondents were aged 30-49 (76.4%).

3.4.1 Measurement Model:

Table 2 and Figure 4 shows the measurement model analysis (n=412). Reflective indicators loadings less than 0.5 were removed retained all others showing indicator reliability (Hulland, 1999, p. 198). Average Variance Extracted (AVE) shows all latent variables achieved adequate convergent reliability (AVE>0.5) (Bagozzi and Yi, 1988; Fornell and Larcker, 1981). The Dhillon-Goldstein Rho for Composite Reliability (CR), ρ shows values of 0.7 and above indicating adequate convergence or internal consistency (Gefen et al., 2000). Further indicator loadings were removed to ensure AVE, CR meet minimum requirements. Discriminant Validity of the reflective constructs was assessed using Fornell and Larcker criterion (1991) and Cross Loading (Chin, 1988a) shown in Table 3 and Table 4 respectively. Further assessment using heterotrait-monotrait (HTMT) (Table 5) (Henseler *et al.,* 2015) shows the ratio of correlations reinforces discriminant validity for both $HTMT_{.85}$, (Kline, 2011), and the $HTMT_{.90}$, (Gold *et al.,* 2001). For formative measures, standardized beta weights (Diamantopoulos and Winklhofer, 2001), T-Values (Peng and Lai, 2012), and variance inflation factor (Cassel *et al.,* 1999) are taken into consideration for the measurement model, in this case for indicators of Positive Reinforcement and Negative Reinforcement.

[INSERT]: Figure 4. Measurement Model

[INSERT]: Table 2. Full Measurement Model

[INSERT]: Table 3. Discriminant Validity Using the Fornell and Larcker (1981) criterion

[INSERT]: Table 4. Discriminant Validity Using the Cross Loading Criterion (Chin, 1988a)

[INSERT]: Table 5. Discriminant Validity Using the Heterotrait-Monotrait criterion

3.4.2 Structural Model: Direct Hypothesis

The structural model assessed both the *substantive significance* (effect size, f^2) and *statistical significance* (p-value) of the hypothesis relationships (Sullivan and Feinn, 2012). A bootstrapping

of 5000 samples was employed for ensure precision (Hair *et al.,*2014) while effect size assessment follows Cohen's (1988) guidelines. Both Social Media Posting (H1: β=-0.006; p>0.05) and Restaurant Service (H2: β=0.001; p>0.05) are not significant direct effects on Behavioral Outcome (Table 6 and Figure 5).

==[INSERT]: **Figure 5.** Structural Model==

==[INSERT]: **Table 6.** Structural Model Hypothesis Testing for Direct Relationships==

3.4.3 Structural Model: Mediation Effect

The Hayes and Preacher (2014) calculation on the indirect effects is employed using the bootstrapping of 5000 samples to ascertain mediating effect (Sobel, 1982; Baron and Kenny, 1986; James and Brett, 1984; Shadish and Sweeny, 1991) of Positive and Negative Reinforcement in the relationship between the predictors of Social Media Posting, Restaurant Service and Behavioral Outcome. Only the Positive Reinforcement shows significant mediation effect between H3: Social Media Posting (β=0.163; p<0.01), H5: Restaurant Service (β=0.113; p<0.01) and Behavioral Outcome (Table 7). This could mean, that restaurant patrons are more highly receptive to positive nudges of behavioral change as compared to negative ones.

==[INSERT]: **Table 7.** Structural Model Hypothesis Testing for Mediation Relationships==

3.4.4 Model Fit

The Standardised Root Mean Residuals (SRMR) of the model (0.076) further indicates that the theoretical model application is appropriate for this research as well as the data and the model for this research is a good fit (Henseler *et al,* 2015).

3.4.5 Independent t-test analysis

An independent t-test analysis was conducted to ascertain whether the different stimulus (nudges) influenced the waste (in grams), receipt value (in RM), financial aid generated (in RM) and CWPUR in RM. Only a significant difference in receipt value (t= 2.927, F=3.821, p-value = 0.02) between positive (n=228, Mean= RM 70.50, SD= 43.62) and negative reinforcement (n=184, Mean = RM 58.87, SD= RM 36.37) was shown. This further strengthens the results in the SEM that positive reinforcement nudges encourage respondents to support altruistic motivation causes like helping to feed the hungry.

3.4.6 Consumption waste per unit revenue (CWPUR)

The total amount of food wasted from all 628 diners was tallied calculating the CWPUR (the mean value of food waste in RM terms tabulated from their receipt amount). The experiment group showed a lower average of CWPUR (RM 0.45) compared to the control group (RM 1.44) approximating 1:3 difference in waste consumption (Refer to Table 8). This shows that nudge effects and intervention influences reduction in consumption waste. This influence is further strengthened by positive reinforcement messages stated before.

==[INSERT]: **Table 8.** Food Waste Collected from Field Experiment==

4. Discussion and Implications

Results from this study revealed that digital nudging (digital tent card) does not directly promote positive socially responsible consumption (RQ1) unless mediated through positive reinforcement messaging for restaurant service and social media posting (RQ2). The practical calculation of CWPUR in this experiment shows how businesses can save costs and the reduce the potential of effects of food waste. Results show that tangible influences do not directly influence behavioral change (Table 6) but require the mediating effect of positive reinforcement between social media posting (H3: β=0.163; p<0.01) and restaurant service (H5: β = 0.113; p<0.01) and on behavioral change (Table 7). This suggests a multi-pronged approach rather than a single influencing factor is required for any significant positive outcomes in behavior modification initiatives as proposed by theory (Fogg *et al.,* 2007); Thaler and Sunstein, 2008). The comparison of CWPUR between experiment (RM 0.45) and control (RM 1.44) respondents reveals approximately 1:3 difference in waste supporting digital nudge effect and intervention reduces consumption waste (Omeonu *et al.,* 2020; Reisch *et al.,* 2017) and that positive reinforcement messaging is a significant tool to improve behavior change as proposed by scholars (Fogg, 2009; Kim *et., al.* 2019).

Overall, the outcome of this study indicates that the combination of digital nudges, positive reinforcement, and restaurant service significantly modifies food wastage among restaurant patrons, showing a holistic approach is key to improving this behavior as proposed by theory (Thaler and Sunstein, 2008; Fogg *et al.,* 2007) and other studies (Rundle-Thiele, 2019; Schmidtke *et al.,* 2021).

Given the detrimental impact of restaurant food waste on the environment and economy (Schanes *et al.,* 2018: van den Bos Verma *et al.,* 2020), this study is timely and provides practical solutions to this problem. Evidence (Berezan and Raab, 2021; Ha, 2020; Lentz *et al.,* 2021) show a growing number of consumers choice in purchasing sustainable products and promote their own sustainable journey on social media platforms (Jain, *et al.,* 2020). As such, from a business perspective, digital nudging, positive reinforcements, and social media platforms presented in this study can be applied to increase restaurant patronage and profits.

From a social marketing viewpoint, strategies presented in this study can help support relevant agencies and the public to actively participate and improve food waste management. Given the poor knowledge and understanding about food waste amongst consumers (Ahmed *et al.,* 2021; Naim and Rahman, 2020), the importance of social marketing application (Carins & Rundle-Thiele, 2014); Kim, *et al.,* 2020), via proper messaging, targeted campaigns and community support can be introduced to sustain pro-social behavior.

5.Conclusion

This study has shown that positive socially consumption behaviour can be encouraged through the activation of positive reinforcement bolstered by digital nudging and restaurant service. While food waste is an ongoing global problem that requires comprehensive solutions, we propose that the smallest reminders using digital means and nudging can help serve a greater purpose in the long run which can address tackling this large problem in small, sizable and practical ways (Falasconi *et. al.,* 2019; Wharton *et al.,* 2021).

Experts (Thaler and Sunstein, 2008; Fogg *et al.,* 2007; Rundle-Thiele, 2019; Schmidtke *et al.,* 2021) have advised that a holistic multi-pronged approach should be applied to further understand

this complex behavior. Hence, the idea of theory integration has been mooted by scholars (Lefebvre, 2011; Mayer and Sparrowe, 2013) as an effective strategy to develop workable solutions to a problem. This research has therefore demonstrated that the integration of the Fogg Behavioral Model (Fogg *et al.,* 2007) and nudge theory (Thaler and Sunstein, 2008) can activate positive behavior change in food related practices. This study demonstrated the high potential of choice architecture within the nudging technique activating (i.e., positive reinforcement) transformation of unconscious decisions into conscious actions for social good.

The food consumption reduction activity in this study is shown to be most cost-effective in yielding significant social and environmental impacts relative to other activities (See Table 3). By addressing food waste behavior, this research has also targeted the largest cumulative impact consumption has on the food value chain. Every 1kg of food waste at consumption has a significantly higher environmental impact than 1kg of food waste at farms, processors, supermarkets, or groceries (i.e., any upstream value chain activities) (Lipinski *et al.,* 2013).

Soliciting cooperation from diners to demonstrate socially responsible consumption through positive reinforcement can prove to be an effective strategy for the food industry in its sustainable business model as shown in the result of this study. Given the growing support of sustainable businesses by consumers today (Ha, 2020; Lentz *et al.,* 2021), food service businesses who incorporate clear and visible sustainable business practices will ultimately reap greater financial gains in the long run (Budzinski *et al.,* 2022) (refer to Table 8 on CWPUR and section 3.4.6). Whilst the application of positive social marketing messaging and digital nudging techniques in this study have shown to be vital tools to improve food waste practices in restaurants, it also has the potential to be adopted in other wider social settings.

One limitation the current study present is the bolstering of 'delusional altruism' as a potential side-effect (Putnam-Walkerly, 2020). As a suggestion, future similar research could inform respondents of the consequence of their actions either in real (how much have they wasted) or in hypothetical terms (how many people could have been fed). This reminder could help them reassess their choices in future similar situations. Informing participants that not all digital post will be picked up and highlighted by the restaurant as a caveat could help ascertain if the respondents will still want to be part of the process to avoid 'delusional altruism'. The use of narrower set of questionnaires during the field experiment with a more objective focus on the nudging effects could further reduce the tiresome effect for respondents.

In conclusion, this study applied a holistic, multiple theory and on-site research to deliver a workable solution for this global wicked problem study is in tandem with previous experts (Carins and Rundle-Thiele, 2014; Kotler and Zaltman, 1971; Lefebvre, 2011). Finally, as the 2030 United Nations urgent call to reduce food wastage i.e., UN Sustainable Development Goals fast approaches (FAO, 2018), this study can be an important contributor towards helping to reach this crucial milestone.

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