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What influences consumer food waste behaviour when ordering food online? An application of the extended theory of planned behaviour

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ABSTRACT

In the search to mitigate food waste in households and restaurants, consumer food waste behaviour has been the focus of many investigations. However, exploration of consumer food waste behaviour in online food delivery (OFD) settings has to receive limited attention. This study aims to understand the antecedents of food waste behaviour in OFD settings by applying the Theory of Planned Behaviour (TPB) with Food-related Factors as an additional construct. An online survey provided quantitative data from 520 participants representatively distributed in age and gender from 7 cities geographically spread across China. It was found (1) the average frequency for consumers wasting OFD food was 'rarely' to 'occasionally'; (2) the extended TPB model was useful in predicting consumer food waste behaviour in OFD settings; (3) an intention of not wasting food had a significant negative effect on food waste behaviour; (4) attitudes and perceived behavioural control positively affected the intention of not wasting food; and (5) Food-related Factors had a significant negative effect on intention of not wasting food. This is the first empirical study to apply the TPB to the OFD context in China and confirm its applicability. We conclude that measures to promote OFD food waste reduction behaviour may best take effect via education and campaigns to increase individuals' attitudes and intention of not wasting food and prominently displaying food-related information and portion sizes on OFD platforms.

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1. Introduction

With the rapid development of e-commerce and the fast pace of modern life, online food delivery (OFD) has gained vast popularity. Research on OFD has also increased over the past three years, mainly focused on the attributes and services of OFD platforms (Eu & Sameeha, 2021, Chandrasekhar et al., 2019), consumer's perceptions and behaviours for using food delivery services (Panse et al., 2019, Misra & Srivastava, 2021), and OFD business models (Meenakshi & Sinha, 2019, Chen et al., 2022). However, the environmental sustainability concerns of OFD cannot be overlooked (Li et al., 2020). Research have attempted to investigate the worldwide food and packaging waste associated with OFD. Using food delivery services instead of cooking at home increase household food and

plastic waste in Thailand (Liu et al., 2021). Moreover, studies in US and India found that OFD may drive consumer's over-ordering behaviour during the Covid-19 pandemic (Talwar et al., 2022, Shankar et al., 2022, Sharma et al., 2021). In response to sustainability concern, OFD platforms all around the world had also been making efforts to reduce FW and packaging waste such as using compostable boxes or low-carbon electronic powered deliveries, or asking consumer if cutlery is needed (Amicarelli et al., 2021).

China leads the way in the rise of the OFD market globally. The projected revenue for 2023 is estimated to be over \$395.90 billion, which is basically equivalent to the sum of the second to fifth places (US: \$269.8 billion; South Korea: 40.53 billion; UK: 40.17 billion; Japan: 33.97 billion) (STATISTA, 2023). There

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were approximately 460 million OFD users in China, accounting for 50.7% of permanent urban residents and generating 8.7 billion orders in 2019 (MEITUAN RESEARCH INSTITUTE, 2020). However, despite these financial highlights, the waste associated with OFD is significant. Zhang et al. (2022) found that the total food and packaging waste produced by OFD was 177.6kt in Wuhan, 2019, and more than two-thirds were food waste (FW). It was found almost half of the students (43.6%) at Jilin University surveyed wasted half or more of their OFD food in 2018 though the FW quantity has not been reported (Lin et al., 2018, Lin et al., 2019). Thus, OFD FW has also become a problem in China (Li et al., 2022).

However, the consumption of OFD food is different from other well-studied settings such as households or the hospitality sector. For example, people have more interactions with food in the household or restaurants than when ordering OFD food, because they have control over the grocery planning and food preparation and storage in the household, or they can smell and see the food on others' tables in the restaurant and communicate with the waiter for details about the food when ordering (Stroebele & DE Castro, 2004). A study investigating FW in a healthcare setting found that a change in food preparation method from cook-chill to cook hold catering could dramatically reduce FW, as the resulting food retained more of the sensory properties desired by the patients (Bux et al., 2023). Further a study investigating FW behaviours of Taiwanese hospitality students reported that changing food teaching practices could provide guidance on how to reduce FW waste associated with losses during food preparation, over seasoning or over cooking (Ko & Hong, 2023). When ordering food online, people's perceptions of the food varied due to the limited food-related information. i.e., consumers may waste some food because the ingredients or the portion sizes were not clearly displayed on the website (Trivedi et al., 2023).

Developing a theoretical understanding of factors influencing consumer FW behaviour in OFD settings will help mitigate FW. The theory of planned behaviour (TPB) is a model frequently used to investigate consumer FW behaviour (Ajzen, 1991). It has been extended to have better predictive capability in FW behaviour in the household (Soorani & Ahmadvand, 2019, Visschers et al., 2016) and hospitality sectors (Blešić et al., 2021, Coşkun & Yetkin Özbük, 2020, Moon, 2021). Researchers have made efforts to apply TPB in the Chinese context. The TPB model or an integrated model combining TPB and Lee's modified

Fishbein model were proved to be useful in explaining the pro-environmental behaviour of Chinese students and green consumers (Wu et al., 2019, Liao et al., 2020, Wang, 2016) and in-home and out-of-home leftover generation behaviour (Liao et al., 2018). Moreover, it was recently proved that the TPB could be used to explain consumers' over-ordering behaviour when using OFD during the Covid-19 pandemic (Shankar et al., 2022, Talwar et al., 2022). While these authors' novel application of the TPB to the OFD sector yielded some interesting insights into consumers' FW antecedents in the case study countries (US and India), further work is now needed. Not only is there value in applying the TPB to other case study countries where OFD is an important part of the economy, such as China, there is also value in taking a more critical look at some of the assumptions that underpinned the determined relationship between over-ordering and FW. In the abovementioned study (Shankar et al., 2022, Talwar et al., 2022), an intention to reuse leftovers was found to be positively associated with over-ordering behaviour, implying people who have a stronger intention to reuse leftovers tend to order more OFD food. However, without an understanding of the final destination for these leftovers (i.e., were they eaten as intended or were they subsequently wasted), it is not possible to infer a link between overordering and food waste behaviours.

Thus, the current study aimed to build on these earlier studies exploring consumer FW behaviour in OFD settings using an extended TPB model with Food-related Factors (FrF) as an additional predictor. FrF refers to the overall performance of food to fulfil consumer needs and covers several aspects of the food characteristics, such as food variety, visual appearance, portion size, temperature (adapted from Blešić et al. (2021)). The original TPB was first tested to explain consumer FW behaviour when consuming OFD food, then FrF was incorporated into the original TPB model to test the variance of the extended model. This study contributes to the current knowledge by adding the antecedents of consumer FW behaviour to the TPB model in the OFD context. Then, the original TPB's predictive capability was increased by including FrF, which suggests food taste and quality is still the major concern for consumers when consuming OFD food.

Furthermore, the results obtained by this study could assist in the management of OFD food waste in China, specifically by identifying suitable areas in which reasonable interventions could be designed and implemented. It has previously been reported

that interventions underpinned by theories work better (Casonato et al., 2023). TPB and a revised Motivation Opportunity Ability (MOA) framework have already been used to analyze the drivers and levers for behavioural change of consumers to reduce food waste at household level (Vittuari et al., 2023). Findings of a review that systematizes the most recent evidence on FW at the consumer level highlighted the need for further research that aides practitioners in designing and targeting appropriate message and intervention for more effective interventions (Candeal et al., 2023). Thus, the current study applies a sound theoretical basis to understand FW behaviour in the OFD settings, with the aim of aiding with future intervention design.

2. Theoretical background

The TPB has long been used as a behavioural model to predict and explain human behaviour in various contexts (Ajzen, 1991). It has also been proposed to be a sound theoretical framework for investigating FW behaviour in the household and hospitality sectors (Lorenz et al., 2017, Visschers et al., 2020, Stancu et al., 2016, Stefan et al., 2013, Yuriev et al., 2020).

Subjective norm is the social pressure an individual perceives when performing a certain behaviour. For example, if people feel pressure when wasting food, their intention not to waste food increases (Aktas et al., 2018, Barone et al., 2019). However, studies have also reported that subjective norms have a relatively insignificant impact on the intention of not wasting food (Stefan et al., 2013, Visschers et al., 2016). For the current study the following hypothesis was developed:

H₁: Subjective norms positively affect intentions of not wasting food.

In predicting consumers' intention not to waste food, attitudes refer to the favourable or unfavourable evaluation of FW behaviour. People's intention to reduce FW will increase if they have unfavourable evaluations of FW behaviour (Barone et al., 2019, Graham-Rowe et al., 2015, Visschers et al., 2016). Based on earlier studies, consumers generally have negative attitudes toward FW; that is they feel bad if they waste food (Stancu et al., 2016, Evans, 2012, Watson & Meah, 2012), and they show concern if they have wasted food (Abeliotis et al., 2014). For Chinese consumers, feelings of guilt about throwing food away and a belief that saving food is the right thing to do are critical contributors to preventing FW (Wang et al., 2018a, Wu et al., 2019, Wang et al.,

2019, Wang et al., 2018b). Hence the following hypothesis was developed:

H₂: Attitudes towards FW positively affect intentions of not wasting food.

Perceived behaviour control (PBC) is a person's perception of control over a particular behaviour. If people perceive they have control over the factors causing FW, their intention not to waste food increases, and they are less likely to waste food (Mondéjar-Jiménez et al., 2016, Soorani & Ahmadvand, 2019). Based on the literature review, the following hypotheses were developed:

H₃: PBC positively affects intentions of not wasting food.

H₄: PBC negatively affects FW behaviour.

The TPB is an expectancy value model that states that behaviour is a consequence of person's behavioural intention. It was found that intention to reduce FW negatively impacts on FW behavior in restaurants and households (Barone et al., 2019; Coşkun & Yetkin Özbük, 2020), which means, if an individual intends not to waste food, they will behave that way. Hence the following hypothesis was developed:

H₅: The intention of not wasting food negatively affects FW behaviour.

The TPB is open to the inclusion of additional predictors if they are developed on certain behaviours or various contexts (Ajzen, 1991). The current research included FrF to investigate its effect on intention and FW behaviour. FrF was adapted to include some food-related features influencing people's consumption willingness, such as the meal's portion size, ingredients and the temperature. It has been proved that food-related experience is a critical factor affecting food consumption status in hotels (Itthiphakorn, 2021; Tekin & Ilyasov, 2017), canteens (Lorenz et al., 2017) and restaurants (Beretta et al., 2013; Blešić et al., 2021). Researchers have also found that vagueness in plate size information contributed to consumer FW when ordering food online (Trivedi et al., 2023). Considering the fact that FrF influences people's food choices when using OFD service (Liu & Chen, 2019; Suhartanto et al., 2019; Trivedi et al., 2023), it was assumed that people who care more about the food-related experience would have less intention of not wasting food. Thus, the food they ordered online might be wasted if the FrF does not satisfy their needs, such as the inclusion of disliked

ingredients, food being at the wrong temperatures, big portion size or the food not looking very appealing. Therefore, it was hypothesised that:

H₆: FrF negatively affects the intention of not wasting food.

H₇: FrF positively affects OFD FW behaviour.

Figure 1 shows the hypothesised relationships based on the aforementioned theoretical foundations.

3. Methodology

The current study focused on the factors influencing consumers' FW behaviours associated with OFD. This included an investigation of factors such as the number of times OFD food was ordered per week, if there was a fridge available in the setting where the food was consumed (office/home), the common mealtimes and places where people consumed OFD

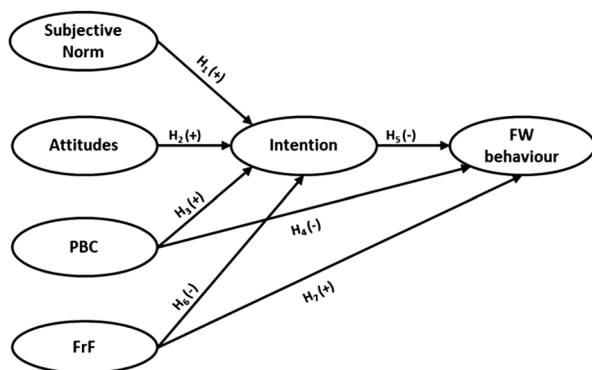


Figure 1. Conceptual model.

food, and if they ate alone or in the company of others (family or friends, etc.). The data was collected via an online questionnaire in target Chinese cities, and then analyzed using SPSS AMOS as the following sections detail.

3.1. Designing of the questionnaire

The questionnaire included three sections: The first part contained a series of questions about the OFD food consumption routines. The second part presented the research constructs of the study model for which most of the questions were adapted from existing literature (Table 1). The third section recorded the participants' sociodemographic characteristics, including age, gender, marital status, educational level, income, awareness of FW campaigns etc. The questionnaire was developed in English and translated into Chinese by the first author. Two other scholars checked the Chinese questionnaire to ensure content validity.

In the questionnaire, OFD food was defined as 'Ready-to-eat food delivered by OFD riders (i.e. packed meals, drinks and dessert from Meituan and Eleme (two of the leading OFD platforms in China holding 94% market share in 2020), excluding bulk fruit, boxed yoghurt, fresh meat/poultry/fish/vegetables/flowers, medicines, life necessities)'. The self-reported OFD FW behaviour questions were measured with four items that a previous study indicated were commonly wasted in the OFD context in China (Zhang et al., 2022). The items required respondents to estimate how frequently they throw away

Table 1. The sources of constructs and the items.

Constructs	Items	Sources
OFD-food waste behaviour (FW behaviour)	How likely are you to throw away some portion of the following OFD food? (e.g., NOT fruit peel and cores, eggshells, and bones) Meat (e.g., chicken, duck, fish, pork, and beef) Vegetables Staple food (e.g., rice, porridge, noodles, and bread) Soups and drinks	(Blešić et al., 2021; Zhang et al., 2022)
Intentions of not wasting food	I intend not to throw OFD food away My goal is to not throw OFD food away I will try not to throw OFD food away	(Stancu et al., 2016)
Subjective norms	People who are important to me would disapprove of me throwing food out People who are important to me would find my attempts to reduce the amount of food I waste unnecessary (R) People who are important to me would think it's normal if I tried to reduce my food waste	(Stefan et al., 2013; Visschers et al., 2016)
Attitudes	Wasting OFD food is negative (D) Wasting OFD food is foolish Loading the environment with my OFD food waste is harmful Loading the environment with my OFD food waste is negative	(Stancu et al., 2016)
Perceived behavioural control (PBC)	Wasting my OFD food is avoidable Loading the environment with my wasted OFD food is avoidable	(Stancu et al., 2016)
Food-related factors (FrF)	Not throwing out my OFD food is easy If the OFD food is not at the right temperature (e.g. hot drink is too cold), I don't consume it. If I order more OFD food than I should eat, I don't consume it. If I do not like some of the OFD food or ingredients, I don't consume it. If I find the look of the OFD food is not as attractive as the demo picture, I don't consume it.	(Blešić et al., 2021)

some of their OFD food (in general), ranging from never (1) to every time (7). Other constructs were adapted from earlier studies by applying a seven-point Likert-type scale—ranging from strongly disagree (1) to strongly agree (7) (Table 1).

3.2. Sample and data collection

Before finalising the questionnaire, a pilot trial was conducted to guarantee the readability and clarity of the items with senior academics and Chinese OFD users ($n=10$). According to the feedback and recommendations received from the pilot trial participants, minor adjustments were made to the wording, phrasing, formatting, and overall visual construct of the survey tool.

Shanghai (East of China), Beijing (North of China), Guangzhou and Shenzhen (South of China), Chengdu and Chongqing (West of China) and Wuhan (Middle of China) were chosen as target cities because (1) 64.7% of total OFD orders were placed in Tier 1 and new Tier1 cities (MEITUAN RESEARCH INSTITUTE, 2020) and (2) these cities have also been selected to represent the OFD industry situation nationwide using hierarchical k-means clustering by Zhang and Wen (2022). The chosen cities rank high in both income and education level in China (Global Times, 2023; STATISTA, 2022), this was important because consumer have more disposable income in big cities, and are also more likely to be able to complete a smartphone based questionnaire (Kim et al., 2015). The selection of the age group of participants was also based on data from the MEITUAN RESEARCH INSTITUTE (2020). According to Meituan, which is the leading OFD platform in China, the age distribution of users is around: 18–25 years (38%), 26–30 years (24%), 31–35 years (18%), 36–40 years (10%), 41–45 years (6%), 46–50 years (3%), 50 years above (2%). Hence this percentage of age distribution was applied to the sample selection for the current study. Participants were recruited using online panel of a market research company based in China. Quota sampling was implemented, first divided their population database into subgroups (based on the geographic regions and age), then recruited participants from each group until the predetermined quota was reached. The raw data collected was subsequently supplied to the research team to analyse. The survey was conducted from January to March 2022 in accordance with the [University of Otago's] [blinded for review] code of research ethics (reference number: D21/082). The average time needed by the participants for the completion of the questionnaire was 15 min.

3.3. Data analysis

Consistent with many earlier studies (Stefan et al., 2013, Soorani & Ahmadvand, 2019, Sharma et al., 2021) that have used TPB to explore the intention and food waste behavior, data analysis was conducted in two stages in SPSS AMOS® (Arbuckle, 2013). First, a Confirmatory Factor Analysis (CFA) was tested to ensure construct validity and reliability. Second, Structural Equation Modelling (SEM) was conducted to investigate the best fitting model for the casual relationship and to test the hypothesised relationships in the conceptual model. This approach was considered to be suitable because the proposed model is grounded in a well-established theory with latent constructs.

4. Results

4.1. Study sample characteristics and OFD food consumption routines

The survey targeted Chinese adults aged 18 years and older in target cities who had use of the OFD mobile phone applications (Meituan or Eleme) to order food online at least once per week during the past month so that the most recent OFD occasion remained relatively fresh in their memory. Around 3000–3500 people were sent invitation by the market research company to participate. Of these people, 1000–1100 people accepted the invitation and the eligibility screening started. Of those, 520 people met the eligibility criteria and then completed the survey (response rate around 50%). The participants were geographically spread across China and representatively distributed in their age and gender according to current OFD users' profiles within each city (MEITUAN RESEARCH INSTITUTE, 2020). The detailed sociodemographic characteristics of the participants are presented in Table 2.

The average per person before tax income was generally higher in Tier 1 cities such as Shanghai, Beijing, Guangzhou and Shenzhen with 57%, 54% and 59% of participants in these cities having a monthly income between 7000 and 10,000 RMB (around 1000–1430 USD). While in the new Tier 1 cities such as Chengdu and Chongqing, 58% of participants earned 4000–7000 RMB (around 570–1000 USD) per month. This number was 75% in Wuhan, which somehow indicate Wuhan is relatively less developed compared with other cities studied. This result was in line with the data released by the National Bureau of Statistics (Global Times, 2023)

Table 2. Sociodemographic characteristics of the participants ($N=520$).

	<i>N</i>	Sample (%)
<i>Gender</i>		
Male	260	50
Female	260	50
<i>City</i>		
Shanghai (East)	130	25
Beijing (North)	130	25
Guangzhou & Shenzhen (South)	130	25
Chengdu & Chongqing (West)	78	15
Wuhan (Middle)	52	10
<i>Age</i>		
18–25 years	197	38
26–30 years	126	24
31–35 years	91	18
36–40 years	54	10
41–45 years	29	6
46–50 years	13	3
50 years above	10	2
<i>Marital status</i>		
Single	217	41.7
Married	226	43.5
Not married but has a partner	77	14.8
<i>Living situation</i>		
One-person household	68	13.1
Couple only	92	17.7
Couple/Single with children aged under 16 years	143	27.5
Adults living with parent/s	162	31.2
Flatting/ Dormitories	53	10.2
Parent, spouse and kid	1	0.2
Spouse with kid (16 years above)	1	0.2
<i>Education</i>		
Secondary school	15	2.9
Vocational School*	8	1.5
University degree	483	92.9
Postgraduate degree	14	2.7
<i>Per Person Income Before Tax Per Month (CNY)</i>		
Less than 4000	59	11.3
4000–6999	81	15.6
7000–9999	140	26.9
10,000–14,999	141	27.1
15,000–19,999	68	13.1
20,000–29,999	21	4.0
30,000 and above	2	0.4
Prefer not to say	8	1.5

*Notes: Vocational school is a school offering instruction in one or more skilled or semiskilled trades or occupations, such as carpentry or plumbing.

which showed the per capita disposable income of first-tier cities such as Beijing and Shanghai inched closer to 80,000 Yuan (11,795 USD) in 2022, and 36,883 Yuan nationwide.

Frequency analysis revealed that 68.3% ($n=355$) of the participants ordered OFD on average 3–5 times per week. The most common meal and place people consumed their OFD food was 'lunch in the office' (449 times), followed by 'dinner at home' (246 times). More than half of the OFD orders (53.8%) were consumed alone, followed by dining with colleagues. Most of the participants (72.5%) had seen or heard of information on concerns around FW over the last two

years. Interestingly, the average frequency of consumers wasting their OFD food was around 2.55 ± 1.38 (Table 2). On the seven-point Likert scale, it means 'rarely, in less than 10% of my OFD orders' to 'occasionally, in about 30% of my orders'.

4.2 Background variables

Consistent with past research which has utilised demographic variables as background variables to improve the robustness of their findings (Bravi et al., 2020; Cho et al., 2019; Shankar et al., 2022; Sharma et al., 2021; Talwar et al., 2022), we also included several sociodemographic variables such as gender, age, marital status, living situation, income etc., into our model as control variables. However, no correlation between OFD FW behaviour and participants' age, marital status, living situation, income, times of order/week, eating companions and awareness of FW campaigns was found. Interestingly, some variables correlated positively with OFD FW behaviour, such as female ($r=0.095$, $p=0.027$) and fridge availability in the office ($r=0.113$, $p=0.008$). Additionally, people who had a postgraduate degree were more likely to waste OFD food than people with only a secondary school education ($r=0.107$, $p=0.013$). People in Beijing were more likely to waste OFD food than people in Wuhan ($r=0.198$, $p<0.001$). Nevertheless, as the coefficients of correlation were relatively low, and including these covariates did not significantly improve the fit of the model to the data, these variables were not included in the final structural model.

4.3. Reliability and validity assessment

By applying the necessary modifications, the fit of the measurement model was acceptable for the sample ($n=520$) ($\chi^2 = 466.514$, $df=155$, $\chi^2/df=3.010$; CFI = 0.942; GFI = 0.917; AGFI = 0.887; TLI = 0.929; SRMR = 0.0614, RMSEA = 0.062; $p<0.05$). All the items in the measurement model had significant loadings ($p<0.001$) on their respective factors with values greater than 0.50, thus confirming convergent validity. Item convergence was also assessed through Average Variance Extracted (AVE) and Construct Reliability (CR). Using the thresholds suggested by Fornell and Larcker (1981), the CR of the constructs was acceptable (ranging from 0.788 to 0.906, above the suggested minimum value of 0.70). The AVE of each construct was acceptable (above 0.50) (Hair et al., 2010). Table 3 presents the final CFA results. The discriminant validity of the constructs showed

Table 3. Factor loadings from Confirmatory Factor Analysis (CFA) and construct reliability.

Items and factors	Mean (SD)	β	t-Values	α	CR	AVE
OFD food waste behaviour (FW behaviour)				0.904	0.906	0.708
<i>Instruction: How likely are you to throw away some portion of the following OFD food? (e.g., NOT fruit peel and cores, eggshells, and bones).</i>						
Meat (e.g., chicken, duck, fish, pork, and beef)	2.28 (1.456)	0.842	*			
Vegetables	2.49 (1.603)	0.894	25.614			
Staple food (e.g., rice, porridge, noodles, and bread)	2.72 (1.550)	0.844	23.102			
Soups and drinks	2.73 (1.659)	0.781	20.478			
<i>Scale: Never (1) to Every time (7)^Δ</i>						
Intentions of not wasting food				0.827	0.829	0.618
<i>Instruction: Please indicate your level of agreement with the following statements</i>						
I intend not to throw food away	4.87 (1.423)	0.785	*			
My goal is to not throw food away	4.94 (1.412)	0.833	18.003			
I will try not to throw food away	4.88 (1.411)	0.737	16.172			
<i>Scale: Strongly disagree (1) to Strongly agree (7)</i>						
Subjective Norms				0.809	0.817	0.602
<i>Instruction: Please indicate your level of agreement with the following statements</i>						
People who are important to me would disapprove of me throwing food out	5.75 (1.108)	0.868	14.043			
People who are important to me would find my attempts to reduce the amount of food I waste unnecessary (R)	2.44 (1.226)	0.807	14.339			
People who are important to me would think it's normal if I tried to reduce my food waste	5.52 (1.185)	0.634	*			
<i>Scale: strongly disagree (1) to strongly agree (7)</i>						
Attitudes				0.857	0.871	0.697
<i>Instruction: Please indicate your level of agreement with the following statements</i>						
Wasting OFD food is negative**	5.56 (1.192)					
Wasting OFD food is foolish	4.79 (1.456)	0.637	*			
Loading the environment with my OFD food waste is harmful	5.03 (1.427)	0.917	16.618			
Loading the environment with my OFD food waste is negative	5.11 (1.362)	0.919	16.373			
<i>Scale: strongly disagree (1) to strongly agree (7)</i>						
Perceived Behavioural Control (PBC)				0.780	0.788	0.554
<i>Instruction: Please indicate your level of agreement with the following statements</i>						
Wasting my OFD food is avoidable	5.26 (1.254)	0.722	12.834			
Loading the environment with my wasted OFD food is avoidable	5.43 (1.122)	0.805	13.349			
Not throwing out my OFD food is easy	5.19 (1.188)	0.701	*			
<i>Scale: strongly disagree (1) to strongly agree (7)</i>						
Food-related factors (FrF)				0.815	0.817	0.530
<i>Instruction: Please indicate your level of agreement with the following statements</i>						
If the OFD food is not at the right temperature (e.g., hot drink is too cold), I don't consume it.	4.02 (1.356)	0.602	*			
If I order more OFD food than I should eat, I don't consume it.	4.27 (1.352)	0.761	12.785			
If I do not like some of the OFD food or ingredients, I don't consume it.	4.37 (1.406)	0.820	12.775			
If I find the look of the OFD food is not as attractive as the demo picture, I don't consume it.	3.53 (1.374)	0.711	12.375			
<i>Scale: strongly disagree (1) to strongly agree (7)</i>						

Notes: R-item was reversed; *Items fixed to 1 in CFA; **item removed from CFA; β -Std. Regression weights; α -Cronbach's alpha; CR-composite reliability; AVE: average variance expected.

^ΔNever; Rarely, in less than 10% of my OFD orders; Occasionally, in about 30% of my OFD orders; Sometimes, in about 50% of my OFD orders; Frequently, in about 70% of my OFD orders; Usually, in about 90% of my OFD orders; Every time.

that the square roots of the AVE of constructs (bolded) were all higher than the off-diagonal correlation values, which supports the discriminant validity (Table 4). Therefore, consistent with the preliminary confirmatory factor analysis, a satisfactory measurement model was achieved.

4.4. Structural model: goodness of fit statistic and hypothesis testing

The overall fit of the original TPB model was acceptable ($\chi^2/df = 3.545$; CFI = 0.946; GFI = 0.925; AGFI = 0.893;

TLI = 0.932; SRMR = 0.0662; RMSEA = 0.070; $p < 0.05$). However, the additional variable (FrF) was added to improve the explanatory power. This extended model showed a satisfactory fit ($\chi^2/df = 2.972$; CFI = 0.942; GFI = 0.917; AGFI = 0.889; TLI = 0.930; SRMR = 0.0618; RMSEA = 0.062; $p < 0.05$) (Table 5).

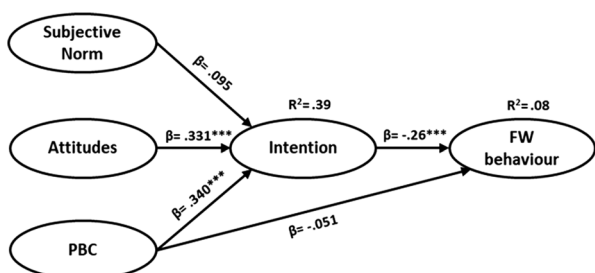
The addition of the FrF variable to the conceptual framework explained the greater variance in intention and behaviour. As shown in Figures 2 and 3, the explained variance ($R^2 = 0.39$) for the intention of not wasting food in the original model was increased (to $R^2 = 0.45$) in the extended model and the

Table 4. Discriminant validity assessment ($n=520$).

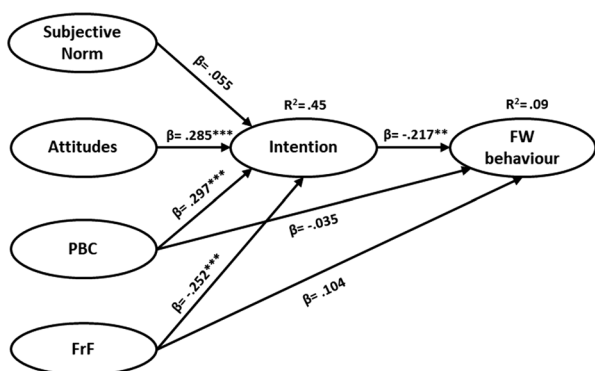
	Food	Attitudes	PBC	Subjective norms	Intention of not wasting food	FW behaviour
Food	0.728					
Attitudes	-0.316	0.835				
Subjective norms	-0.348	0.430	0.744			
PBC	-0.327	0.388	0.567	0.776		
Intentions of not wasting food	-0.464	0.514	0.538	0.416	0.786	
FW behaviour	0.217	-0.159	-0.188	-0.144	-0.284	0.841

Table 5. The explanatory power of the original and the extended TPB model.

Fit indices	Original model (TPB)	Extended model
χ^2	340.334	466.663
df	96	157
χ^2/df	3.545	2.972
CFI	0.946	0.942
GFI	0.925	0.917
AGFI	0.893	0.889
TLI	0.932	0.930
SRMR	0.0662	0.0618
RMSEA	0.070	0.062
R ²	0.08	0.09

**Figure 2.** The original structural model of food waste behaviour.

Note: The model allows covariation between Subjective norms, Attitudes, and PBC. Goodness of fit indices: $\chi^2/df = 3.545$; CFI = 0.946; GFI = 0.925; AGFI = 0.893; TLI = 0.932; SRMR = 0.0662; RMSEA = 0.070; $p < 0.05$. *** $p < 0.001$. $N=520$. R²: squared multiple correlations.

**Figure 3.** The extended structural model of food waste behaviour.

Note: The model allows covariation between Subjective norms, Attitudes, PBC and FrF. Goodness of fit indices: $\chi^2/df = 2.972$; CFI = 0.942; GFI = 0.917; AGFI = 0.889; TLI = 0.930; SRMR = 0.0618; RMSEA = 0.062; $p < 0.05$. *** $p < 0.001$; ** $p < 0.01$. $N=520$. R² = squared multiple correlations.

explained variance for the FW behaviour also increased from 0.08 to 0.09 which is quite acceptable for consumer behaviour studies (Hair et al., 2011).

In the original and extended model, the impact of subjective norms on intention was not significant. Although the impacts of attitudes and PBC on the intention of not wasting food decreased in the extended model compared to the original model (Figures 2 and 3), they both showed a positive and significant effect. In the extended model, PBC had the highest contribution in predicting the intention ($\beta=0.297$), followed by attitudes ($\beta=0.285$). Therefore, people who perceive themselves as having more control over their FW behaviour or have a negative attitude toward FW show a higher intention of not wasting food. OFD FW behaviour could be predicted by intention but not by PBC in both models. In the extended model, FrF was a predictor of the intention of not wasting food ($\beta = -0.252$) but not of behaviour. Therefore, if an individual cared more about FrF, the intention of not wasting food decreased.

The effect of subjective norms on the intention of not wasting food was not significant, thus rejecting H₁ ($\beta=0.055$, t -value = 0.941, $p = 0.347$) (Table 6, Figure 3). Attitudes towards FW were positively affected the intention of not wasting food supporting H₂ ($\beta=0.285$, t -value = 5.576, $p < 0.001$). H₃ was supported indicating PBC had a significant positive effect on the intention of not wasting food ($\beta=0.297$, t -value = 4.663, $p < 0.001$), however, H₄ was rejected because PBC had insignificant effect on OFD FW behaviour ($\beta = -0.035$, t -value = -0.560 , $p = 0.575$). The intention of not wasting food had a significant negative effect on FW behaviour, supporting H₅ ($\beta = -0.217$, t -value = -3.212 , $p = 0.001$). Although FrF had a negative effect on the intention of not wasting food as hypothesised (H₆) ($\beta = -0.252$, t -value = -4.888 , $p < 0.001$), its effect on FW behaviour was not significant, thus rejecting H₇ ($\beta=0.104$, t -value = 1.780, $p = 0.075$).

5. Discussion

This study tested the original TPB model and an extended model by including an FrF construct to explain FW behaviour when people consume OFD food. It was

Table 6. Structural model results.

Hypothesised paths	Coefficients	t-Values	p-Value	Hypothesis
H ₁ : Subjective norm → Intention (+)	0.055	0.941	0.347	Not supported
H ₂ : Attitudes → Intention (+)	0.285	5.576	***	Supported
H ₃ : PBC → Intention (+)	0.297	4.663	***	Supported
H ₄ : PBC → FW behaviour (-)	-0.035	-0.560	0.575	Not supported
H ₅ : Intention → FW behaviour (-)	-0.217	-3.212	0.001	Supported
H ₆ : FrF → Intention (-)	-0.252	-4.888	***	Supported
H ₇ : FrF → FW behaviour (+)	0.104	1.780	0.075	Not supported

hypothesised that subjective norms, attitudes towards FW and PBC would predict the intention of not wasting food. Moreover, the intention of not wasting food and PBC were expected to predict FW behaviour. It was also hypothesised that FrF would be a significant determinant of the intention of not wasting food and FW behaviour when people consume OFD food. The explanatory power of the extended model was increased by adding FrF to the original TPB model. The results verified the role of the primary TPB constructs in explaining FW behaviour consuming OFD food. Except for the effects of subjective norms on the intention of not wasting food, PBC and FrF on FW behaviour, the hypothesised paths were significant in explaining FW behaviour when people consume OFD food.

The effect of subjective norms on the intention of not wasting food (H₁) was not significant. Subjective norms refer to the social pressure that the individual may feel in engaging or not engaging in a specific behaviour. This finding indicated that subjective norms had a limited effect on arousing consumers' intention of not wasting food when consuming OFD food. In previous studies, this effect was controversial. For example, in some public areas like restaurants, Sirieix et al. (2017) found it was significant, while Coşkun and Yetkin Özbük (2020) reported it as being insignificant. While in private settings like households, the effects of subjective norms on intentions were proved to be significant (Russell et al., 2017, Soorani & Ahmadvand, 2019), while Visschers et al. (2016) and Mondéjar-Jiménez et al. (2016) reported the opposite result. In an OFD context, Shankar et al. (2022) and Troise et al. (2021) found that subjective norms strongly affect the intention to use OFD applications but not to reduce food waste. Understandably, people are more likely to be influenced by the action of others, e.g. eat more food if their companion eats more (Hermans et al., 2012). Also, developing social norms was used to encourage students' behaviour to reduce FW in university canteens in China (Lin et al., 2018; Wang, 2016; Wang et al., 2018b). However, in our study, more than half (53.8%) of the OFD food was consumed alone, meaning there were no others around. In such a private situation, social pressure may play a less critical role in people's performing the

act of saving food even if they feel others would disapprove of them wasting food.

Attitudes toward FW showed a medium-sized positive effect in predicting the intention of not wasting food (H₂). This aligns with findings from previous studies (Barone et al., 2019; Soorani & Ahmadvand, 2019; Stancu et al., 2016). In addition, a survey of Chinese consumers showed that attitude had the most significant impact on the intention to reduce FW (Liao et al., 2020). This indicates that the more individual's disapproval of FW, the more likely they will be not to waste food. The current study found that PBC is the most important predictor of intention, which is consistent with others' findings (Mondéjar-Jiménez et al., 2016; Russell et al., 2017). Participants who had higher levels of PBC had greater intentions of not wasting food (H₃), which also aligned with previous studies. Therefore, if consumers believe they can control their behaviour by not throwing OFD food away, their intention of not wasting OFD food would increase. However, the impact of PBC on the OFD FW behaviour is insignificant, although it shows a negative correlation, thus rejecting H₄. This finding is in line with previous studies (Barone et al., 2019; Blešić et al., 2021). A plausible explanation is that the consumer may end up wasting their OFD food due to factors which are not under their control. This has been proved in households as people waste food because they have no control over large portion sizes (Williams et al., 2012), with similar results being reported for restaurants (Blešić et al., 2021). This is particularly the case when people order food online as they have very limited control over or understanding of the portion size (Pal et al., 2022; Trivedi et al., 2023; Yang et al., 2021).

The intention of not wasting food was a significant predictor of FW behaviour when people consume OFD food as hypothesised (H₅). This result aligns with previous research (Barone et al., 2019; Russell et al., 2017) which indicates people who have a stronger intention of not wasting food generate lower OFD FW. Also, it corresponds well with results from a previous study among Chinese consumers that showed that the intention to reduce FW significantly decreased FW behaviours (Liao et al., 2020).

The current research shows that including food performance factors can expand the TPB in relation to OFD FW and make it a more comprehensive theory. The result showed that individuals with higher expectations about the food (FrF in our case), tend to have a lower intention of not wasting food (H_6). This is consistent with other studies in different settings. For example, big portion size, poor quality and less attractive appearance were reported to be some reasons for not fulfilling the consumers' needs, determining food leftovers in the food service industry (Betz et al., 2015; Freedman & Brochado, 2010; Itthiphakorn, 2021). In addition, it is reasonable to assume that OFD food will be wasted when FrF does not meet a consumer's expectations or generates concern around its safety. However, FrF failed to significantly affect FW behaviour, although it shows a positive correlation (H_7). This means although the OFD food does not have a good performance, it will not be likely to be wasted. Considering the fact that most meals are consumed alone as lunch in the office in our study, it is understandable that even though the food is less satisfying, it could still be used as a convenient meal for hungry workers.

The results obtained in this study could assist in building interventions to reduce OFD food waste in China. Measures such as public education and social campaigns can be used to influence individuals' attitudes toward FW and to increase their intention of not wasting food. Also, displaying food-related information such as portion sizes and taste on OFD platforms could also promote OFD food waste reduction behaviour.

6. Conclusion

This study demonstrates that FrF can be incorporated into the TPB to expand the understanding of OFD FW intentions and behaviours. It is the first theory-based paper to explore Chinese consumers' OFD FW behaviour across a range of geographical locations (seven cities in China) and ages.

PBC and attitudes toward FW were shown to have an impact on the intention of not wasting food. FrF also served as a reliable predictor of intention. Interestingly, although FrF and PBC showed significant effects on intention, their effect on the OFD FW behaviour was not significant as hypothesised. Therefore, consumers' OFD FW behaviour can only be predicted by intention. There are several possible explanations for this. First, the consumers' control over OFD food is limited, even if people perceive they can avoid their OFD food from being wasted, some unpredicted factors like portion size,

unexpected ingredients in the meal, or the appearance and the taste of the food could influence their final action. Second, even if people manage to order the right amount of food with favourable ingredients, the delivery process is not under their control (Cheng et al., 2021; Suhartanto et al., 2019). Most OFD users have experienced a long waiting time so the food might not be at their favourable consuming temperature (being cold or warmed up) or status (leakage due to indifferent handling of restaurant staff or delivery person) (Li et al., 2020) which could result in FW. Third, the cost of the food may be an important factor to consider. Restaurants sometimes use complimentary drinks or snacks to attract online consumers (Frederick & Parappagoudar, 2021), and consumers may not finish such add-on because they are free of charge (Heikkilä et al., 2016). So even if consumers' PBC is high, their final act of throwing the OFD food away or not might still be unpredictable.

The findings of this study have practical implications for managing consumer OFD FW. Firstly, the high impact of PBC on the intention of not wasting food suggests that if OFD platforms and restaurateurs had well-displayed information on their websites about the food, consumers would have more confidence in controlling the food they order. For example, OFD platforms should encourage restaurateurs to offer multiple portion sizes or recommended serving size as a nudge to increase people's intention of not wasting food. Secondly, the effect of attitudes suggests forming or strengthening the positive attitudes via policy guidance, social media and public campaigns among a broader range of the population could be helpful in affecting the intention of not wasting food (i.e., 'clean your plate' campaigns could be adapted to include OFD, e.g., 'clean your OFD boxes'). Thirdly, the effect of FrF suggests several actions for mitigating OFD FW. For instance, OFD platforms could encourage restaurateurs to display more detailed information about ingredients, which in turn could inform consumers to choose the meal they like and decrease the likelihood of the consumer not finishing the food.

7. Limitations and future research directions

7.1. Limitations

It is difficult for researchers to observe consumers' behaviour and collect OFD food waste data directly because most OFD food is consumed in private settings like offices or homes, so we relied on self-reported food waste behaviour in this study.

People tend to underreport their food waste quantities or frequencies because they want to be seen to be socially acceptable (Giordano et al., 2018; Jörissen et al., 2015). To reduce the deviation and obtain a more accurate amount of waste, future researchers should consider measuring the actual amount or adjusting this food waste behaviour construct into other measurable items such as shopping/ordering routine, reusing leftover routine, food storage routine and reduction of portioning (Amato et al., 2021; Soorani & Ahmadvand, 2019). In addition, the results should also be interpreted as indicative in view of the limited sample size until a larger sample can be collected as part of further work.

7.2. Future research directions

This study is the first to apply the TPB model to the OFD context worldwide. It confirmed the applicability of the TPB model with an additional predictor (FrF) to explain consumer OFD food waste behaviour. Therefore, it can be used as a baseline for future research to enhance the understanding of consumer OFD food waste behaviour.

Potential research will be needed to develop a deeper understanding of consumers' OFD food waste behaviour. First, there are other predictors specific to OFD features, such as the delivery service, the food package, and the food price despite food-related factors. For instance, the cost and the time of delivery and the attitude of a delivery person are considered to be affecting the success of OFD service (Ahmed Tausif, 2021). Thus, it would be helpful to examine the impact of delivery service on consumers' food waste behaviour. Second, thriftiness has long been considered a good virtue in Chinese traditional culture, which requires one not to spend more than necessary (Liao et al., 2018; Liu et al., 2019). With the improving living standards in the modern city (Li et al., 2019), would people still regard 'dining thriftiness' as a good virtue and its role in OFD food waste behaviour? This will be a point worth further looking into. Finally, many parties are involved in the food delivery process, and they are all responsible for different causes of OFD food waste. In this respect, the actions of restaurants, OFD platforms and delivery people from the OFD platforms or third parties affect consumers' OFD food consumption experience, hence these opinions and experiences should be investigated in future studies.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability statement

The data that support the findings of this study are available from the corresponding author, M.M., upon reasonable request.

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