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Modeling the intention and adoption of food waste prevention practices among Chinese households

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Considerable attention has been paid to the problem of food waste on a worldwide scale. Evidence demonstrates that food waste occurs mostly in private households, and that home food waste has been identified as the leading cause of global food waste. Home food waste poses a severe threat to food security and involves environmental and financial ramifications. While this is a global issue, most studies on what motivates people to make changes that would result in less food waste have been conducted in wealthy countries. Integrating the Theory of Interpersonal Behavior (TIB), this study fills this gap by investigating the factors influencing Chinese household consumers' intentions toward food waste reduction and their actual food waste behavior. This study used a cross-sectional survey approach to collect data from households using social media platforms. Partial least squares structural equation modeling was adopted to assess and evaluate the conceptual model. The empirical findings demonstrate that cognitive (perceived value of sustainability), environmental (awareness of consequences and ascription of responsibility), social (social norms), and emotional (anticipated guilt) aspects tend to have a positive influence on Chinese household consumers' intentions toward reducing food waste, suggesting that interpersonal behavior could reduce food consumption in developing countries like China. Furthermore, the findings show that the intention to decrease food waste serves as an intermediary variable that highlights another route of association between the TIB factors and actual food waste reduction behavior. The findings will be more informative to policymakers, marketers, and researchers in developing strategies to reduce food waste.

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Introduction

Food waste[1] (FW) is a serious impediment to effective environmental stewardship and global food security owing to its harmful ecological, economic, and societal impacts (Niu et al., 2022; Ogunmoroti et al., 2022). The Food and Agricultural Organization of the United Nations reported that on a global scale, there is a loss or wastage of 1.3 billion tons of food annually, which is equivalent to roughly one-third of the total production (Gustavsson et al., 2013). According to the "2021 Food Waste Index Report" published by the United Nations Environment Program (UNEP—United Nations Environment Program (2021)), an estimated 931 million tons of food was wasted by households, commercial kitchens, and other food service providers in 2019. This proportion was ~17% of the total food available for global consumption in 2019. The reports also highlighted that domestic food waste is notably significant, accounting for 11% of the food available to consumers, followed by the food services (5%) and retail segments (2%). Domestic food waste is a serious problem for every continent and economy, regardless of the high or low average income level. Additionally, it has been shown that 8–10% of the world's annual greenhouse gas emissions are caused by food waste (UNEP—United Nations Environment Program (2021)). This indicates the severity of the food waste problem. Stabilizing and enhancing the capacity of the food supply will help ensure global food security. If we want to reduce food waste at the consumption stage, we need a new way of thinking about reducing losses and increasing production. Hence, reducing food waste has become a topic of concern in academic circles worldwide as researchers have attempted to determine how to ensure a sustainable food supply for their inhabitants.

Household waste is the primary source of food waste. The 2021 Food Waste Index Report further details that, in 2019, the amount of food thrown away globally was 931 million tons, with 61% coming from households (UNEP—United Nations Environment Program (2021)). The reports show that food waste is a major problem in the United States and the United Kingdom. For example, household food waste accounts for much greater (40–70%) of consumer food loss and waste generation in industrialized nations (Xue et al., 2021). Furthermore, as a developing nation, China's per capita food waste is not among the highest in the world. However, given its size and population, the country produces approximately 18 million tons of food waste annually. Wastage at this scale will have a considerable impact on the overall quantity of food lost or wasted globally. In compliance with the Sustainable Development Goals (SDGs) outlined by the United Nations, the central government of China has prioritized encouraging eco-civilization, green consumption, and sustainable consumption patterns, including the reduction of food waste (Li et al., 2021). Hence, this study explored the factors influencing behavioral intentions to reduce food waste and actual food waste behavior at the household level in China.

Previous studies investigated the root causes of food waste and proposed potential mitigation strategies (Vermeir & Verbeke, 2008; Teller et al., 2018). Policy recommendations for decreasing food waste have been developed by examining the causes of food waste on a small scale and determining the effectiveness of current initiatives for reducing food loss and preserving food. Hebrok and Boks (2017) found that the primary cause of food waste was related to human awareness. Moreover, individual demographic characteristics, such as cognition, habits, religious beliefs, and other internal elements, impact the relatively complex human decision-making process (Vermeir & Verbeke, 2008). Furthermore, extraneous factors, including family traits, food culture, and informational interventions, play a role in shaping food waste habits. However, these factors have varying effects in different settings and people. Prior studies have frequently employed the theory of planned behavior to capture food waste reduction behaviors impacted by a diverse range of unknown factors (Vermeir & Verbeke, 2008). Studies based on the theory of planned behavior have recently highlighted the emotional aspects of food waste, such as regret, guilt, and self-blame, and have found that emotions are directly associated with food waste behavior (Sirieix et al., 2017; Goh & Jie, 2019; Attiq et al., 2021a). These studies argue that consumers actively reduce food waste if they have a greater understanding of food conservation and a sense of shame when it is wasted. Concerning food waste, several other theories, such as the Comprehensive Model of Environmental Psychology and Interpersonal Behavior Theory, have been adopted relatively recently (Russell et al., 2017).

A review of existing literature on food waste in households revealed the following knowledge gaps: most of the previous studies have focused on determining the amount of food wasted and how it affects global food systems (Ericksen, 2008; Springmann et al., 2018). The quantification of factors that influence food waste has also been extensively researched (Thyberg et al., 2015; Damiani et al., 2021). Little emphasis has been placed on reducing food waste through household participation. Therefore, academics underline the necessity of examining the various factors that households can use to prevent FW. Furthermore, cognitive factors such as personal norms, a sense of community, our understanding of repercussions, and customers' intentions to avoid food waste have been the focus of earlier studies (Schanes et al., 2018; Soorani & Ahmadvand, 2019). However, there has not been much emphasis on non-cognitive factors, such as emotions. Stancu et al. (2016) showed a connection between consumer self-efficacy and FW. Real-world emotions play a significant role in influencing food consumption and behaviors that lead to FW. Attiq et al. (2021b) demonstrated that anticipated guilt can accurately predict whether consumers contribute to food waste. According to Schanes et al. (2018), people who feel guilty about food waste would take more proactive measures to reduce it. These negative emotions included expectation guilt. Consequently, customers' desire to engage in food waste behavior can be highly predicted by anticipatory guilt and other emotions. However, prior research on the connection between knowledge and food waste intentions has produced inconsistent results (Visschers et al., 2016), and these findings require further investigation and confirmation. Hence, it is essential to combine the emotional relevance with the crucial cognitive side to overcome the aforementioned drawbacks and understand households' food waste reduction behavior.

Therefore, the objective of this study was to better understand how cognitive (perceived value of sustainability), environmental (awareness of consequences and ascription of responsibility), social (social norms), and emotional (anticipatory guilt) factors impact intentions to reduce food loss and food waste. Food waste reduction intentions play a mediating role in food waste reduction behavior. The current study adopted the TIB to investigate the relationship between Chinese household customers' willingness to minimize food waste and their actual food waste reduction behavior to pinpoint pathways and potential policy objectives for decreasing food waste. The results showed that waste reduction behaviors and intentions were positively associated, and waste reduction goals encouraged food waste reduction. Therefore, the results of this study will aid scientists in understanding how consumers' intentions to reduce food waste are influenced by emotions and cognition. Policymakers, governments, and practitioners can use this research to inform the public, run advertising campaigns, and engage in social marketing to encourage consumers to engage in environmentally friendly

activities. The next section goes over the survey's theoretical underpinnings and develops the hypotheses. The methodology used in the study is discussed in the following sections. The acquired data were then used to inform earlier investigations. The consequences and limitations of this study are also examined.

Literature review

Food waste scenario in China. Food waste is a pressing global issue with economic, social, and environmental implications (Niu et al., 2022; Ogunmoroti et al., 2022). Understanding households' food waste behavior is essential for developing successful initiatives to reduce waste and encourage sustainable consumption (Principato et al., 2021). China's enormous population and evolving consumption patterns are a severe concern regarding food waste (Li et al., 2021). Research indicates that the amount of food waste in China is substantial, with millions of tons of food wasted annually. According to a countrywide survey, Song et al. (2018) reported that the average household food waste in China was approximately 17 kg/capita/year. Furthermore, the amount of food waste in developed cities of China was higher than the average value (Wu et al., 2023). For instance, Xu et al. (2016) and Gu et al. (2015) estimated food waste in households in Xiamen and Suzhou, respectively. According to their findings, the annual food waste per capita in Xiamen could be as high as 75 kg, while in Suzhou, it was reported to be 67.3 kg. These values were significantly higher than the national average of 17 kg/capita/year. Moreover, according to Wu et al., (2023), food waste accounts for a substantial 60% share of the solid waste generated by households in China. As a result, the country is observing financial losses, significant environmental pollution, and resource scarcity (Xue et al., 2021). Thus, the magnitude of food waste in China emphasizes the critical nature of handling it, especially at the household level. However, Li et al. (2021) stated that most household food waste research has been conducted in advanced countries other than China. According to the authors, the few published studies on Chinese household food waste are rarely supported by empirical evidence.

However, few empirical studies have identified the factors influencing food waste reduction intentions, emphasizing the Chinese setting. Based on the norm activation model, Obuobi et al. (2023) examined the effects of benefits awareness, lack of concern, and personal norms on households' food waste reduction intention. However, the authors ignored the integration of actual behavior into the research model. Using the direct-weighing method, a case study by Li et al. (2021) explored the characteristics and enabling factors of household food waste generation in Chinese rural areas. However, this study was restricted by a lack of theoretical foundations and hypothetical assumptions. Liao et al. (2022) identified the perspective of consumer concerns and values while investigating their impact on food waste reduction intention in the context of advent food consumption. Nevertheless, theoretical integration was missing in this study. Based on a qualitative study, Zhang et al. (2020) found that consumer perceptions significantly influence household food waste reduction behavior in urban areas. Nonetheless, the study failed to integrate any theory and demonstrate how these factors affect intentions to reduce food waste. Thus, the lack of empirical studies on Chinese household food waste further emphasizes the significance and originality of this study, utilizing the theoretical framework of TIB.

Theoretical foundation. The theoretical foundation of this study was based on the TIB developed by Triandis (1979). TIB is a comprehensive model that posits behavior as a function of emotional, cognitive, social, and environmental dimensions to explain the impact of key determinants on the intention to reduce food waste (Attiq et al., 2021a). TIB provides an exhaustive rationale for modifying behavior. TIB is more appropriate than other theories for explaining food waste behavior (Attiq et al., 2021b). However, as human behavior is complex and challenging to predict, Schanes et al. (2018) indicated that cognitive components such as attitudes and beliefs alone do not fully explain food waste reduction practices. TIB meets this need by representing many facets of the phenomenon, including the development of behavioral responses and considering the complexity of behavior. TIB also addresses ethical, social, and cultural issues. It integrates habits and favorable situations as behavioral factors (Jabeen et al., 2023).

In the existing literature, researchers have integrated TIB to explore the factors and dynamics influencing individuals' food waste reduction intentions and behaviors. For instance, integrating TIB, Attiq et al. (2021b) revealed that emotional (anticipated guilt), social (sense of community), and cognitive (awareness of consequences and environmental knowledge) factors were positively associated with food waste reduction behavior. However, the study did not find a significant association between a sense of community and reuse intention. This suggests that while social factors play a role in food waste reduction, they may not equally impact all aspects of food waste reduction behavior, such as reuse intentions. In another study, Attiq et al. (2021a) examined the impact of emotional (anticipated guilt), social (sense of community), cognitive (perceived busyness), and environmental (awareness of consequences) factors on food waste reduction behavior based on the foundation of TIB. Similarly, Mumtaz et al. (2022) investigated the influence of anticipated positive emotions, awareness of consequences, environmental knowledge, and social norms on consumers' waste reduction behavior in restaurants incorporating TIB. However, none of these studies consider the perceived value of sustainability and ascription of responsibility as predictors, which can further enrich the understanding of food waste reduction behavior. Thus, the inclusion of these factors can provide a more comprehensive model that encompasses both personal and environmental influences on behavior. Thus, based on the theoretical basis of TIB and the relevant research gaps, this study integrated perceived values on sustainability as a cognitive factor (Han et al., 2016), awareness of consequences (Klöckner, 2015), and ascription of responsibility (Kim et al., 2022) as environmental, social norms as social (Han et al., 2016), and anticipated guilt (Klöckner, 2015) as emotional factor and investigated the impact of these factors on food waste reduction intention to develop actual behavior.

Perceived values on sustainability align with the cognitive dimension of TIB, precisely attitudes and beliefs (Ojo & Fauzi, 2020). These values reflect individuals' evaluations and the importance placed on sustainability concerning food waste prevention. This study analyzes the role of cognitive processes in determining individuals' intentions and behaviors by including perceived values on sustainability. Understanding individuals' cognitive stimuli of sustainability can shed light on their motivations, priorities, and decision-making processes regarding food waste prevention (Talwar et al., 2022). Additionally, the understanding of the external factors influencing food waste behavior is broadened by incorporating awareness of consequences and ascription of responsibility into the environmental dimension of TIB. In this regard, Liao & Li (2019) showed that environmental knowledge and attitudes encourage individuals' intention to separate solid waste. Di Talia et al. (2019) indicated that the awareness of consequences might increase moral obligation and lead to constructive actions. However, Attiq et al. (2021a) classified awareness of consequences as an

environmental factor, assuming that an individual's awareness of the environmental consequences of their actions can be influenced by external factors. Conversely, Attiq et al. (2021b) categorized awareness of consequences as a cognitive factor based on the idea that an individual's understanding of the consequences of their actions is inherently related to their cognitive processes. Nonetheless, the purpose of the current study is to examine the full range of consequences of awareness, taking into account both its cognitive foundations and the external factors that influence its development. By considering awareness of consequences as an environmental factor, we aim to demonstrate its susceptibility to external interventions and policy measures, making it a practical target for modification. In addition, Heidari et al. (2020) revealed that the ascription of responsibility enhances individuals' perceptions of their role and accountability in preventing food waste. Bai et al. (2022) revealed that consumers who perceive responsibility as important may be more socially conscious and less likely to waste food detrimental to their environment. It has been established that motivation to reduce food waste and perception of individuals' responsibilities are positively correlated (Parizeau et al., 2015). By including awareness of consequences and ascription of responsibility as environmental factors, this study recognizes the significance of individuals' recognition of the environmental consequences of their behavior and their sense of responsibility in mitigating food waste.

Moreover, this study recognizes the role of emotions by integrating anticipated guilt as an emotional factor that influences individuals' behavior within the emotional dimension of TIB. Researchers have addressed the fact that the influence of emotions is largely disregarded in the existing literature (Russell et al., 2017). TIB suggests that emotion has a significant effect on consumer behavior and discusses individuals' attitudes toward food waste reduction practices (Graham-Rowe et al., 2015). TIB theory focuses on comprehending and reducing food waste behavior, as well as the social and emotional aspects of people (Attiq et al., 2021b). By incorporating anticipated guilt into the framework, this study addressed the emotional components and individual experiences associated with food waste prevention intentions. Anticipated guilt can motivate individuals to engage in behaviors that align with their moral values and desires to avoid adverse emotional outcomes (van Geffen et al., 2020). This integration recognizes the significance of emotional factors in driving food waste prevention behaviors among individuals.

Thus, this study broadens the theoretical framework of TIB by including a wide range of factors such as perceived values on sustainability, awareness of consequences, ascription of responsibility, social norms, and anticipated guilt affecting food waste prevention practices among Chinese households. By recognizing the cognitive, environmental, social, and emotional dimensions of behavior, this integration paves the way for a more comprehensive understanding of the factors influencing individuals' intentions and behavior in relation to food waste prevention. It also enables the development of measures and approaches that consider these multidimensional factors, eventually leading to more effective initiatives to reduce food waste at the household level.

Development of hypotheses
Cognitive factors perceived values on sustainability. Self-efficacy, goals, outcome expectations, and socio-structural factors are the core determinants of Social Cognitive Theory", which has either a direct or indirect effect on human behavior. Kortright and Wakefield (2010) showed that household food waste is a growing barrier to society's ability to thrive sustainably. In these cases, the topic of sustainable development is complex. This means meeting people's demands today without compromising the capacity of future generations to obtain what they need. People are gradually becoming more conscious of the need for environmental preservation and understanding its significance for current and future growth. Hebrok and Boks (2017) found that perceived values are directly linked to consumers' beliefs about decreasing food waste. Environmental awareness has a significant impact on how green customers feel regarding ecological, social, and environmental benefits (Lin & Guan, 2021). People's environmental attitudes toward decreasing food waste are significantly influenced by sustainability values. Stancu et al. (2016) demonstrated that attitudes toward sustainability have a substantial impact on one's social and cultural standards as well as their intent to reduce food waste.

H_1: *Perceived values on sustainability are related to increased intention toward reducing food waste.*

Environmental factors-awareness of consequence. The term 'awareness of consequences' refers to a person's knowledge that their actions or inactions may have adverse outcomes for other individuals (Attiq et al., 2021b). People must be conscious of the consequences of their behavior. Consumer intent must be determined by examining customer behavior and its effects. People often develop and maintain a positive attitude toward certain activities that can lead to good results or outcomes (Bhattacharya & Sen, 2004). Schanes et al. (2018) stated that people may waste less food if they are aware of its negative repercussions on the environment. Knowledge of the effects of waste influences decisions on how to behave regarding food waste. Consumers will become more conscious of the negative economic, social, and environmental effects of food waste as their knowledge of its effects increases (Burlea-Schiopoiu et al., 2021). Ekanem (1998) demonstrated that consumer education initiatives encourage people to practice better food stewardship by increasing their awareness of food waste. The public's understanding of the importance of reducing food waste, internalizing it as a component of corporate social responsibility, establishing social agreement on this matter at the awareness level, and fostering a culture that typically rejects food waste is essential.

H_2. *Awareness of consequences is related to increased intentions toward reducing food waste.*

Environmental factors—ascription of responsibility. Ascription of responsibility is described as a compulsory effect toward unfavorable results or the consequences of not acting in a prosocial manner (Steg & Groot, 2010). Individuals' internalized values are linked to their moral need to participate in prosocial activities because people take moral responsibility for their actions. Customers who were conscientious and felt bad about wasting food were less likely to do the same. A responsible person will actively explore the subject and put it into practice, in addition to devoting more time and effort to waste reduction (Kollikkathara et al., 2009). Overbuying is a leading cause of food waste. Food waste prevention initiatives are less effective when consumers lack the knowledge and skills necessary to shop and prepare food. Those who consider the effects of their decisions may also consider how those decisions impact the environment, which may spark personal environmental intent. Similarly, individuals concerned with climate change have a sense of human responsibility to curb global warming (Bouman et al., 2020). Food preservation is encouraged by environmental concerns and food shortages. Considering these findings, we predict that consumers willing to be accountable for their actions will handle leftovers more responsibly.

H[3]: *Ascription of responsibility is related to increased intentions toward reducing food waste.*

Social factor—social norms. Social norms are the standards and requirements that group members must fulfill to accomplish group objectives and maintain group activities. To obtain approval or integration into a certain group, people imitate the actions of other group members by adhering to accepted norms. Stancu et al. (2016) showed that individuals are easily influenced by social norms because they feel like members of a group and care more about them than their own opinions. Behavioral intentions, which have some predictive ability for behaviors displayed by people, are cognitive propensity and behavioral motivation before individual activities. Social norms effectively promote socially useful conduct. Individual residents will set behavioral intentions based on an assessment of their food waste tendencies, and behavioral intentions will further influence individual behaviors depending on the call or pressure of social norms (Lehner et al., 2016). Social norms play a significant role in preventing food waste, suggesting that future studies should examine the effects of this motivational predictor (Russell et al., 2017). ElHaffar et al. (2020) revealed that social norms represent commonly acceptable behaviors in a particular setting and have the power to influence attitudes, intentions, preferences, and behaviors. The creation of anti-waste societal norms can influence people's willingness to decrease waste and assist in lowering waste levels.

H[4]: *Social norms are related to increased intentions toward reducing food waste.*

Emotional factor—anticipated guilt. Emotions serve as a driving force behind behavior and can be classified according to their valence or directionality as either positive or negative. Negative emotions like guilt are a person's subjective assessment, which is distinct from the "crime" as defined by straightforward legal regulations. The personality trait of guilt is the general anticipation of self-punishment for transgressing, potentially transgressing, or failing to uphold moral norms. Guilt is an important predictor of behavioral intentions. Individuals frequently experience the negative emotions of anticipating guilt. Punishment is carried out through painful inner sentiments to prevent wasteful behavior. This sense of impending guilt enhances personal growth and ultimately results in behavioral modifications. Previous studies have demonstrated that guilt encourages people to engage in actions that reduce the impact of perceived infractions (Stefan et al., 2013). According to previous studies, consumers may adapt or alter their behavior toward food waste because they feel bad about their wasteful conduct (Soorani & Ahmadvand, 2019). Thus, anticipating guilt encourages people to conform to ideals and standards that they believe others should hold to limit food waste. A study on the impulsive eating habits of Chinese visitors discovered that tourists feel bad about terrible food waste because it costs money and harms the environment (Mkono & Hughes, 2020). Experience has shown that anticipatory remorse about food waste causes people to cut back on their food waste, thereby reducing unpleasant emotions.

H[5]. *Anticipated guilt is related to increased intentions toward reducing food waste.*

Food waste reduction intention and behavior. The probability that a person will perform a specific activity in the future is referred to as intention. People's intention to behave in a certain manner results in positive and significant changes in their behavior because intentions can result in actions, and behavioral intentions have a strong predictive influence on behavior (Webb & Sheeran, 2006). Intention has a good predictive and decisive effect on individual behavior. Visschers et al. (2016) noted a positive and significant correlation between individuals' intentions to reduce food waste and their actual behavior to do so. With regard to household food waste, academics have undertaken motivational and source studies and discovered that finding a purpose for minimizing food waste is the key to achieving it (Graham-Rowe et al., 2015). Russell et al. (2017), who examined the elements that reduce household food waste inferred that the stronger the intention to reduce food waste, the lesser is the frequency of food waste behavior. Intentions significantly influence how Iranian households manage their household garbage, as well as their waste from fruits and vegetables (Soorani & Ahmadvand, 2019). Hence, one of the key factors influencing the decrease in food waste is its purpose to do so. Additionally, food waste may involve more than just internalized patterns and behaviors. For instance, some health-conscious shoppers frequently use their desire to eat well as justification for purchasing a variety of fresh foods, which ultimately leads to food waste.

H[6]. *Food waste reduction intention is positively related to food waste reduction behavior.*

Mediating effects of food waste reduction intention. The role of several elements is connected to food waste reduction behavior in mediating the goal of minimizing food waste and similar behaviors. The relationship between food waste reduction behaviors and the desire to reduce food waste may be tempered (Graham-Rowe et al., 2015). In particular, the desire to reduce food waste can mediate the link between consumer selection and food waste. For instance, customers motivated to decrease food waste are more likely to select items with minimal packaging, buy only what they require, and consume leftovers. The intention to reduce food waste serves as a mediator between social norms and waste-reducing behavior (Graham-Rowe et al., 2015). Strong social norms improve a person's likelihood of intention to reduce food waste, which can increase the possibility that they will act (Fischer et al., 2011). Overall, the intention to reduce food waste was a key factor mediating the relationship between the other variables and effective food waste reduction.

H[M1-5]. *The link between perceived values on sustainability, awareness of consequences, ascription of responsibility, social norms, anticipated guilt, and food waste reduction behavior is mediated by food waste reduction intention.*

Based on the discussions in the previous section, the research framework depicted in Fig. 1 highlights the hypothesized associations between food waste reduction intentions and food-wasteful behavior. These associations included perceived values on sustainability, awareness of consequences, ascription of responsibility, social norms, and anticipated guilt.

Methodology
Data collection. The correlation between variables was examined using quantitative analysis. Data were collected using a self-administered questionnaire and cross-sectional research design. Target respondents were surveyed in an organized manner to gather information. All research constructs were modified and conceptualized using well-known scales. The WJX issued and collected the surveys from March 15 to June 22, 2022. A set of screening questions were used to reduce the pool of potential participants. This study concentrated on households in China with at least one adult over the age of 18, accounting for more than 63.35% of all Chinese people. The sample size was computed using GPower 3.1. The minimum number of participants required for a study was 153, with an effect size of 0.15, a power of 0.95, and seven predictors (Faul et al., 2009). In this event, we successfully collected 1090 acceptable responses for the investigation.
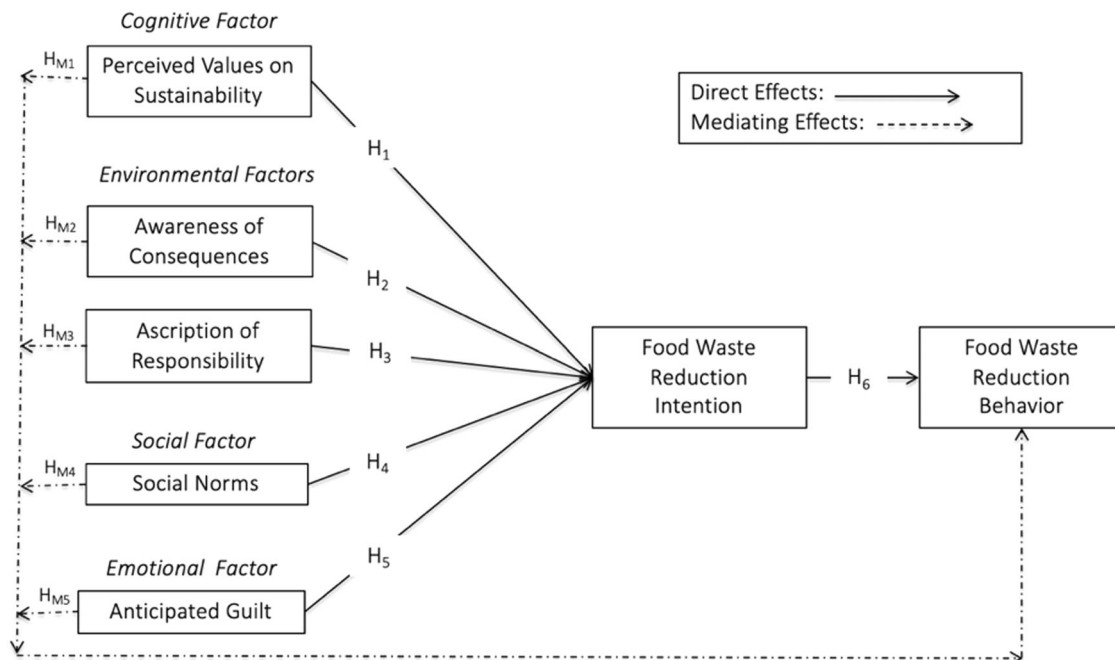
Fig. 1 Research framework. Research Framework, Highlighting each of the hypothesized associations in this study.

Instrument. The questionnaire was divided into two sections. The demographic profiles of the respondents were covered in Section A, including gender, age, work position, educational attainment, household size, frequency of eating outside, and meals eaten outside. Section B focused on measuring perceived values on sustainability (five items adopted from Oviedo-García et al., 2016; Kim et al., 2019; Han et al. 2016), awareness of consequences (five items adopted from Attiq et al., 2021a), ascription of responsibility (five items adopted from Kim et al., 2022), social norms (five items adopted from Kim, et al., 2016), anticipated guilt (five items adopted from Attiq et al., 2021a), food waste reduction intentions (five items adopted from Aktas et al., 2018) and food waste reduction behavior (five items adopted from Attiq et al., 2021a).

The objective of the study was to examine the actions and behaviors of households in China to reduce food waste. To evaluate these behaviors, the measurement items were taken from Attiq et al. (2021a) and modified to capture specific actions related to food waste reduction in households. This approach provides a comprehensive understanding of the strategies and behaviors that individuals use to reduce food waste in their homes. The primary goal of this study is to investigate patterns of behavior related to reducing household food waste while also including tools to assess waste reduction intentions in non-household contexts. As this study is exploratory, its aim was to gain a deeper understanding of the relationship between house-hold and non-household waste reduction intentions. By incor-porating the items of intention from non-household contexts, we can conduct a comparative analysis and gain valuable insights into the factors that influence intentions across different waste reduction scenarios. It should be acknowledged that individuals' intentions and behaviors concerning food waste can be affected by various factors in a variety of settings. Consequently, our objective was to offer a more comprehensive viewpoint by examining intentions both within and outside the household.

In addition, the measurement items of food waste reduction behavior in this study were not directly aligned with the 3 Rs framework used in Attiq et al. (2021a, 2021b). Thus, the dimensions of reuse, reduce, and recycle were not integrated.

This is because the focus of this study is on food waste reduction behavior among Chinese consumers. This study has considered various ways of reducing food waste and designed the measure-ment items with care to capture a broad range of individual behaviors. Although some of these behaviors may overlap with the concepts of reuse, reduction, and recycling, this study is expected to provide a more comprehensive and specific perspective on food waste reduction actions.

In this survey, participants were asked to recall how much food they threw away when eating out in the preceding month and to grade each line according to how it made them feel at that moment. The items were measured using a "five-point Likert scale", ranging from 1 ("strongly disagree") to 5 ("strongly agree"). The survey instrument is presented in Supporting Material S1. The dataset is included in the Supporting Material S2.

Common method bias. In this study, two different methodolo-gies were used for the statistical control. The common method bias (CMB) problem was verified using Harman's "single-factor" test, and the highest explained variation accounted for only 42.996% of the overall variance, which was less than the required threshold of 50% (Fuller et al., 2016). In addition, Kock (2014) proposed a full collinearity test to analyze CMB. In this study, all the latent constructs were regressed on a commonly created variable. As shown in Table 1, all variance inflation factor (VIF) values were less than 3.3, demonstrating that collinearity might not have been a problem (Hair et al., 2011). In other words, the CMB issue seems irrelevant to the current study.

Multivariate normality. This study used Web Power (link: https://webpower.psychstat.org/wiki/tools/index), a statistical web application, as recommended by Hair et al. (2019), to assess multivariate normality. According to the results, the data did not adhere to the characteristics of multivariate normal distribution. This was determined by the fact that the multivariate skewness and kurtosis p-values were lower than 0.05. Having said this, in line with Hair et al. (2019), structural equation modeling with partial least squares (PLS-SEM) is suitable for further investigation.

Table 1 Full collinearity test.							
	PV	AC	AR	SN	AG	FWI	FWB
Variance Inflation Factors Values	1.621	1.702	1.778	1.571	1.781	1.804	2.862

PV perceived values on sustainability, *AC* awareness of consequences, *AR* ascription of responsibility, *SN* social norms, *AG* anticipated guilt, *FWI* food waste reduction intention, *FWB* food waste reduction behavior.

Data analysis method. This study used PLS-SEM, which is better suited for exploring theoretical levels and examining intricate interactions between latent components, to evaluate a structural model using the PLS (Yang et al., 2022). Additionally, a composite model was used to investigate the measurement invariance of the composite models (MICOM). Three steps were essential: achieving invariance, achieving compositional invariance, and ensuring that there were no significant differences between the overall mean values and variances. The structural and measurement invariances were assessed using an extended composite detection approach.

Findings

The descriptive statistics as shown in Table 2 assert that this survey collected responses from a total of 1090 people. Most respondents were female (52.4%) and aged 31–40 years (23.3%). Additionally, 69.1% of respondents were in the workforce, 18.5% were retirees, 5.5% were students, and 6.9% were jobless. 56.4% of respondents said they ate out no more than once per week; 37.2% said they ate out four to seven times per week; and 6.3% said they ate out more regularly. 13.2% of those surveyed paid less than RMB30 for lunch at a restaurant (RMB—Chinese currency Renminbi). The majority of respondents (30.8%) and (30%) spent between RMB51 and 70. When eating out, the remaining 26% of respondents paid more than RMB70 for each meal.

Reliability and validity. We examined the measurement model by assessing "Cronbach's alpha," "composite reliability," "Dijkstra-Hensele's rho," "Average Variance Extracted" (AVE), and "discriminant validity" (Hair et al., 2021). Table 3 demonstrates that Cronbach's alpha, composite reliability, and Dijkstra-Hensele's rho values varied from 0.906 to 0.943, beyond the criterion of 0.7, thus demonstrating the validity of internal consistency (Hair et al., 2021). Convergent and discriminant validity was then investigated to assess the construct validity. In this study, the AVE, which indicates the average of the factor loading squares, and indicator loadings was investigated to evaluate convergence validity. As shown in Table 3, each latent variables AVE value surpassed 0.7, indicating that all the latent variables had sufficient convergent validity (Hair et al., 2017). Meanwhile, the Fornell-Larcker criterion and heterotrait-monotrait correlation ratio were employed to determine the discriminant validity of the factors. As shown in Supporting Material S3, the square root values of each latent variable were greater than the correlations between the structures. The reported HTMT values between the constructs were less than 0.9, suggesting acceptable validity (Fornell & Larcker, 1981; Henseler et al., 2014). The loading values are more than 0.5 and higher than the respective cross-loading values (please see Supporting Material S3) confirming the discriminant validity of the instruments used in this study.

Hypothesis testing. The first part of this section addresses the likelihood of multicollinearity. The multicollinearity between factors test should be performed because, when there is a high

Table 2 Demographic characteristics.					
	N	%		*N*	%
Gender			*Education*		
Male	519	47.6	High School Diploma	78	7.2
Female	571	52.4	Collage/Advanced Diploma	146	13.4
Total	1090	100.0	Bachelor's Degree or Equivalent	516	47.3
			Master's Degree or Equivalent	234	21.5
Age Group			Doctorate Degree	116	10.6
18–30 Years	230	21.1	Total	1090	100.0
31–40 Years	251	23.0			
41–50 Years	245	22.5	*Household size*		
51–60 Years	211	19.4	1–3 Members	583	53.5
61–70 Years	105	9.6	4–5 Members	332	30.5
Above 70 Years	48	4.4	6–7 Members	121	11.1
Total	1090	100.0	More than 7 members	54	5.0
			Total	1090	100.0
Employment Status					
Unemployed	75	6.9	*On average, how much do you spend on food (Eating Out) (Per Meal)?*		
Employed	753	69.1			
Retired	202	18.5	Less than RMB30	144	13.2
Student	60	5.5	RMB30-50RMB	336	30.8
Total	1090	100.0	RMB51- RMB70	327	30.0
			RMB71- RMB90	148	13.6
Eating Out Frequency			RMB91- RMB100	85	7.8
0–3 Times/Week	615	56.4	>100(RMB)	50	4.6
4–7 Times/ Week	406	37.2	Total	1090	100.0
More than 7 Times/ Week	69	6.3			
Total	1090	100.0			

1 USD = 6.35 RMB.

correlation between the observed variables in the measurement model, the problem of multicollinearity will appear, the standard error of the index weight will increase, and the sign and value of the estimated result will be biased. Table 3 shows that the VIF values were all below the cutoff value of 5 and ranged from 1.000 to 1.630 (Hair et al., 2021). Consequently, multicollinearity was not an issue for this study.

The internal structural model quality was assessed using the coefficient of determination (R^2). The results from the structural model are shown in Table 4. The R^2 values ranged from 0 to 1, with higher values indicating greater explanatory power. As Hair et al. (2021) showed, we conclude that the model's partial predictions are reasonable for FWI and FWB because their R^2 values are 0.424 and 0.365, respectively.

The hypotheses were analyzed using structural path analysis. The findings of the hypothesis testing are presented in Table 4. FWI was found to be significantly and positively influenced by PV (H_1: = 0.198, $p < 0.05$), AC (H_2: = 0.232, $p < 0.05$), AR (H_3: = 0.073, $p < 0.05$), SN (H_4: = 0.128, $p < 0.05$), and AG (H_5: = 0.231, $p < 0.05$). FWI had a substantial positive impact on FWB (H_6 = 0.604, $p < 0.05$). Additionally, the significance level was assessed at 90% confidence interval. As there was no zero value between the 5% and 95% confidence ranges for any of the hypotheses in Table 4, it may be argued that all hypotheses were valid and should be accepted.

According to the findings shown in Table 4 regarding mediating effects, FWI significantly and favorably mediated the relationships between PV ($\beta = 0.120$, $p < 0.05$), AC ($\beta = 0.14$, $p < 0.05$), PUS ($\beta = 0.06$, $p < 0.05$), AR ($\beta = 0.16$, $p < 0.05$), SN ($\beta = 0.11$, $p < 0.05$), AG ($\beta = 0.11$, $p < 0.05$) with FWB. In the case

Table 3 Reliability and validity.

Variables	No. items	Mean	Standard deviation	Cronbach's alpha	Dijkstra-Hensele's rho	Composite reliability	Average variance extracted	Variance inflation factors
PV	5	3.303	1.062	0.924	0.934	0.943	0.767	1.494
AC	5	3.268	1.044	0.917	0.919	0.938	0.752	1.520
AR	5	3.286	1.015	0.912	0.913	0.934	0.739	1.630
SN	5	3.260	1.033	0.919	0.921	0.939	0.755	1.486
AG	5	3.277	1.045	0.919	0.920	0.940	0.757	1.529
FWI	5	3.258	1.055	0.923	0.924	0.942	0.765	1.000
FWA	5	3.376	0.986	0.906	0.910	0.930	0.728	-

PV perceived values on sustainability, *AC* awareness of consequences, *AR* ascription of responsibility, *SN* social norms, *AG* anticipated guilt, *FWI* food waste reduction intention, *FWB* food waste reduction behavior.

Table 4 Hypothesis testing.

Hypothesis		Beta	CI min	CI max	t value	p value	f^2	R^2	Decision
H_1	PV → FWI	0.198	0.140	0.260	5.198	0.000	0.046	0.424	Supported
H_2	AC → FWI	0.232	0.175	0.294	6.404	0.000	0.062		Supported
H_3	AR → FWI	0.073	0.007	0.136	1.903	0.029	0.006		Supported
H_4	SN → FWI	0.128	0.068	0.194	3.349	0.000	0.019		Supported
H_5	AG → FWI	0.231	0.170	0.291	6.192	0.000	0.060		Supported
H_6	FWI → FWB	0.604	0.557	0.648	22.004	0.000	0.576	0.365	Supported
H_{M1}	PV → FWI → FWB	0.120	0.083	0.159	5.076	0.000			Mediates
H_{M2}	AC → FWI → FWB	0.140	0.102	0.179	6.070	0.000			Mediates
H_{M3}	AR → FWI → FWB	0.044	0.004	0.082	1.886	0.030			Mediates
H_{M4}	SN → FWI → FWB	0.077	0.040	0.118	3.278	0.001			Mediates
H_{M5}	AG → FWI → FWB	0.139	0.102	0.184	5.645	0.000			Mediates

PV perceived values on sustainability, *AC* awareness of consequences, *AR* ascription of responsibility, *SN* social norms, *AG* anticipated guilt, *FWI* food waste reduction intention, *FWB* food waste reduction behavior.

of these mediating effects, the 90% confidence level did not encompass the value of zero anywhere between 0.004 and 0.648 at a statistically significant level. Based on these findings, we conclude that H_{M1-5} were supported.

Multi-group analysis (MGA). MGA is often applied for confirmatory factor and path analyses by comparing important sociodemographic variables. Age, sex, educational attainment, and frequency of eating out were categorical variables provided to the MGA to investigate the differences between the various groups. The estimated pathways for each group are listed in Table 5.

Throughout the investigation, the measurement invariance of composite models (MICOM) was used to analyze the measurement invariance of the two distinct groups. The respondents in Group 1 were under 40 years old ($N = 481$), whereas those in Group 2 were over 40 years old ($N = 609$). The permutation p-values for each concept in this study were higher than 0.05, supporting partial measurement invariance. PLS-MGA was used to compare the route coefficients between the two groups. According to the findings in Table 5, there were no statistically substantial variations between the two groups in any of the anticipated correlations based on the age of the respondent. In addition, the sex-based MICOM included males ($N = 519$) in Group 1 and females ($N = 571$) in Group 2, with all permutation p-values for the constructs being >0.05, indicating partial measurement invariance. Table 5 also shows that there were no statistically significant variations in any of the hypothesized correlations between sexes. Additionally, the MICOM approach was used to compare the two groups depending on educational attainment: those with a master's degree or higher (Group 2, $N = 350$) and those with a bachelor's degree or lower (Group 1,

Table 5 Multi-group analysis.

Associations		Respondent's age ≤40 years (N = 481) >40 years (N = 609) Difference		Respondent's gender Male (N = 519) Female (N = 571) Difference	
		Beta	p value	Beta	p value
H_1	PV → FWI	−0.012	0.438	−0.127	0.049
H_2	AC → FWI	−0.044	0.281	−0.025	0.365
H_3	AR → FWI	−0.025	0.375	0.136	0.043
H_4	SN → FWI	0.060	0.216	0.001	0.493
H_5	AG → FWI	0.021	0.392	−0.062	0.206
H_6	FWI → FWB	0.031	0.282	−0.021	0.343

Associations	Respondent's education level Bachelor's degree and below (N = 740) Master's degree and PhD (N = 350) Difference		Frequency of eating out (per week) One to three times (N = 615) More than three times (N = 475) Difference	
	Beta	p value	Beta	p value
H_1 PV → FWI	0.056	0.255	−0.014	0.441
H_2 AC → FWI	0.017	0.425	0.141	0.028
H_3 AR → FWI	−0.050	0.282	0.078	0.162
H_4 SN → FWI	0.056	0.250	−0.119	0.065
H_5 AG → FWI	−0.079	0.156	−0.106	0.087
H_6 FWI → FWB	0.022	0.357	−0.032	0.278

PV perceived values on sustainability, *AC* awareness of consequences, *AR* ascription of responsibility, *SN* social norms, *AG* anticipated guilt, *FWI* food waste reduction intention, *FWB* food waste reduction behavior.

$N = 740$). We also discovered partial measurement invariance in this instance. Lastly, the MICOM technique was utilized to assess the relative measurement invariance between the following two groups: Group 1 comprised one to three outings, and Group 2 contained more than three outings. Except for awareness of consequences, all constructs' permutation p-values surpassed 0.05, supporting partial measurement invariance. Our model found only one statistically significant difference: the association between the number of times a person eats out and the awareness of the consequences of their intention to reduce food waste.

Discussion

This research provides evidence in support of hypothesis (H_1) that there is a strong and positive association between the intention to reduce food waste behavior and values linked with sustainability. The findings of this study are consistent with those of previous studies (Filimonau et al., 2021; Kim et al., 2019). Educating consumers about sustainable practices and implementing them may have a greater impact on the amount of food they throw away. Previous studies indicate that people who respect sustainability are more likely to practice the 3Rs of minimizing food waste, which includes buying eco-friendly products, encouraging minimal food packaging, and labeling products with eco-labels (Sakai et al., 2011). Hence, environmentally conscious consumers avoid wasting food, preserve scarce natural resources, and improve the planet for future generations.

The results of this study provide evidence to support the hypothesis (H_2), which states that there is a significantly positive association between awareness of consequences and behavioral intention to reduce food waste. These findings lend credence to those of previous studies. Awareness of the consequences influences behavior toward reducing food waste (Kochan et al., 2016). It can be said that households whose members have strong intentions to reduce food waste are aware of the problems that might arise from food waste and work to address them. While consumer awareness of food waste continues to increase, their understanding of the economic, social, and environmental harm caused by food waste continues to grow. Thus, customer education and food awareness are essential for improved management of wasted food in households (Burlea-Schiopoiu et al., 2021).

The findings from this study provide credence to the third hypothesis (H_3), which postulates a strong association between the ascription of responsibility and behavioral intention to decrease food waste. This result validates the findings of previous studies (Kollikkathara et al., 2009; Obuobi et al., 2022). One could argue that when consumers consider the negative repercussions of food waste, such as its severe effects on the climate, environment, economy, and society, their food waste behaviors are reduced, and they are more likely to establish their notions and standards for food conservation. More precisely, when consumers feel that they have a greater personal commitment to limiting food waste while eating out, they are more likely to maintain their moral commitment to themselves. Additionally, when people are aware of how their food waste affects others and the society as a whole and feel accountable for the results of their actions, they develop personal norms to preserve food.

Our findings support H_4 by demonstrating a strong link between community awareness and decreased household food waste. According to the findings, consumers who feel like they belong to society are more likely to actively examine social standards, show consideration for others' concerns, and look for social identity within the group. For instance, customers with stronger feelings toward the community will take proactive measures to reduce food waste. Customers feel obligated to uphold the social norms and standards set inside groups and

communities, in addition to experiencing a feeling of identification and belonging to them. Ethical standards use social learning to influence and enhance customer behavior, such as encouraging waste reduction and food recycling. Therefore, it can be said that a sense of community among customers influences their behavior toward reducing food waste.

The findings confirmed H_5 by demonstrating a substantial positive link between consumers' anticipated feelings of guilt and their intentions to reduce household food waste. The finding supports earlier research (Stefan et al., 2013). According to previous research, anticipatory emotions serve as motivating factors in the construction of behavioral intentions, and the mechanisms underlying the formation of behavioral intentions are complex. Consumers' decision-making is significantly influenced by emotions. If customers do not make every effort to prevent food waste, they feel guilty. The anticipation of feeling bad encourages customers to donate food, feed livestock, or compost leftovers for reuse and recycling. In other words, consumers anticipate that their moral standards or internalized norms will be violated by wasteful actions, which leads to guilt, and further influences consumers' behaviors to avoid food waste.

In this study, the intention to reduce food waste was shown to have a substantial positive effect on the actual reduction in food waste (H_6). These results found to be consistent with the findings of prior studies (Coşkun & Özbük, 2020; Attiq et al., 2021a). The previous hypothesis regarding the intention to reduce food waste was consistent with these findings. However, our results add new findings presenting the mediating role (H_{M1}, H_{M2}, H_{M3}, H_{M4}, and H_{M5}) of intention to reduce food waste in the relationships between perceived values on sustainability, awareness of consequences, the ascription of responsibility, social norms, and anticipated guilt, and the reduction of food waste behavior. Household consumers are more likely to have good intentions and engage in behaviors that reduce food waste if they have greater cognition of the perceived values on sustainability, awareness of consequences, ascription of responsibility, social norms, and anticipated guilt.

Implications

This research adds to the existing body of literature by utilizing the TIB to explore the factors that shape Chinese household consumers' intentions and behaviors towards reducing food waste. This study is unique in its focus on the Chinese context, as prior research on food waste behavior has mainly been conducted in wealthy Western countries. This study offers a unique viewpoint and fills a crucial gap in the literature by exploring the particular factors that shape Chinese household consumers' intentions and actions to reduce food waste. Additionally, the incorporation of the TIB framework facilitates a comprehensive understanding of the cognitive, environmental, social, and emotional elements that influence individuals' intentions and subsequent actions. The TIB framework is further enhanced by the inclusion of variables such as perceived value on sustainability, consequence of awareness, ascription of responsibility, social norms, and anticipated guilt, making this study particularly unique. The confirmation of the direct and mediating hypotheses provides empirical support to the theoretical framework and enhances understanding of food waste reduction behavior in the Chinese context. The following sub-sections portray the theoretical and practical implications of this study.

Theoretical contributions. This study theoretically contributes to the existing body of knowledge. It incorporates TIB as the theoretical foundation and provides a comprehensive framework to understand the factors influencing Chinese households'

intentions to reduce food waste and their actual food waste behavior. This study extends the application of the existing theory to a particular situation of reducing food waste using TIB, which encompasses cognitive, environmental, social, and emotional aspects. This theoretical foundation strengthens the reliability and validity of the findings and advances the knowledge of consumer behavior regarding food waste. This theoretical integration is crucial because the vast body of previous research has mostly ignored other theoretical frameworks in favor of the TPB, which may not be adequate for forecasting the complicated behavior of people (Kuo & Young, 2008).

Additionally, this study contributes to the existing knowledge on food waste reduction by addressing the profound influence of critical factors on intention in predicting actual behavior. This study identifies and validates the importance of these specific factors within the TIB framework as key determinants of food waste reduction intentions and behavior among Chinese households. This model can potentially overcome the explanatory power constraints of other theories concerning consumers' intentions to prevent food waste. The findings support the significant roles of the perceived value of sustainability (cognitive factor), consequence awareness and ascription of responsibility (environmental factors), social norms (social factor), and anticipated guilt (emotional factor) in shaping individuals' intentions to reduce food waste and their subsequent behavioral outcomes. These findings provide empirical evidence to support the relevance and applicability of these variables within the context of food waste reduction, further strengthening the theoretical foundation of TIB. The empirical findings offer insightful information to develop measures, policies, and initiatives to encourage sustainable food consumption and minimize household food waste.

Moreover, this study addresses the critical issue of food waste reduction and contributes to enhancing Chinese food waste research from multiple perspectives. This is driven by the lack of data, theory, and empirical evidence in Chinese culture, specifically in research on food waste in Chinese households. By shedding light on this underexplored area, this study seeks to offer valuable insights and fill the knowledge gaps, which would help develop effective strategies for reducing food waste, particularly in emerging countries.

Practical implications. The conclusions of this study have practical ramifications for decision-makers and other pertinent entities. For instance, highlighting extreme environmental degradation, this study informs household customers about the risks associated with food waste, helping them comprehend the effects of food waste, and attempts to change their behavior. This study inspires consumers to act in the area of sustainability by proactively focusing on social and environmental responsibilities. This study also demonstrated that subjective standards help lower household food waste habits. It is important to take action to instill a sense of community and encourage waste-reduction practices. Interventions were devised specifically to encourage better home-planning practices by reinforcing subjective standards and individual consumer attitudes. Consider making thoughtful preparations and planned purchases for three daily meals, acknowledging obligation to respect food and preventing food waste from winning the admiration and respect of others. Moreover, research has shown that practices aimed at preventing food waste directly affect it (Schanes et al., 2018). According to previous studies, actions taken to reduce waste directly impact the amount of food wasted. As a result, those who engage in more proactive preventive activities, such as recycling or buying fewer unnecessary items, tend to be more motivated to reduce food waste. However, households may be more motivated to reduce food waste if cities plan and implement solid waste management initiatives such as the 3Rs (reduce, reuse, and recycle) programs. The generation of food waste has been found to increase as a result of marketing and sales strategies like "buy one, get one free" and unnecessary packaging. Finally, this study demonstrates that food waste creation can be considerably affected by promotional offers, advertising, and product positioning in supermarkets. Hence, when developing food waste initiatives, governments should consider the roles of food corporations and merchants.

Limitation and Future Directions. The use of self-reported behaviors could be a limitation of this study. Future investigations could further optimize the agreement between self-reported and observed behavioral measures, which would enhance the quality and generalizability of the findings. Another limitation is that the study participants were only from China. Consequently, future research should be expanded to other countries and areas to identify home consumer groups in diverse cultures and grasp the purpose of reducing food waste more clearly. Furthermore, due to practical constraints such as time, resources, and the large-scale nature of our study involving multiple households, direct observation and weighing of food waste were not feasible. Future studies could consider incorporating direct observation and weighing methods to enhance the accuracy and objectivity of food waste measurements.

Data availability
The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author/s.

Note
1 "Food and Agricultural Organization of the United Nations" in 2011, which says that food waste is the loss of food during the process of eating that can be stopped in the present (Munesue et al., 2014). Later, the United Nations' 2020 Sustainable Development Agenda redefines food waste definitions and it is the physical loss of food in stores, restaurants, and homes (Bux & Amicarelli, 2022). From both points of view, food waste is the loss of things that can be eaten during the eating phase.

References
Aktas E, Sahin H, Topaloglu Z, Oledinma A, Huda AK, Irani Z, Sharif AM, Van't Wout T, Kamrava M (2018) A consumer behavioural approach to food waste. J Enterprise Inform Manag 31(5):658–673. https://doi.org/10.1108/jeim-03-2018-0051

Attiq S, Cha KY, Bashir S, Habib MD, Azam RI, Wong W-K (2021a) Sustainability of household food waste reduction: a fresh insight on youth's emotional and cognitive behaviors. Int J Environ Res Publ Health 18(13):7013. https://doi.org/10.3390/ijerph18137013

Attiq S, Habib DM, Kaur P, Hasni MJS, Dhir A (2021b) Drivers of food waste reduction behaviour in the household context. Food Qual Prefer 94:104300. https://doi.org/10.1016/j.foodqual.2021.104300

Bai L, Cao S, Gong S, Huang L (2022) Motivations and obstructions of minimizing suboptimal food waste in Chinese households. J Clean Prod 342:130951. https://doi.org/10.1016/j.jclepro.2022.130951

Bhattacharya CB, Sen S (2004) Doing better at doing good: When, why, and how consumers respond to corporate social initiatives. Calif Manage Rev 47(1):9–24. https://doi.org/10.2307/41166284

Bouman T, Verschoor M, Albers CJ, Böhm G, Fisher SD, Poortinga W, Whitmarsh L, Steg L (2020) When worry about climate change leads to climate action: How values, worry and personal responsibility relate to various climate

actions. Global Environ Chang 62:102061. https://doi.org/10.1016/j.gloenvcha.2020.102061

Burlea-Schiopoiu A, Ogarca RF, Barbu CM, Craciun L, Baloi IC, Mihai LS (2021) The impact of covid-19 pandemic on food waste behaviour of young people. J Clean Prod 294:126333. https://doi.org/10.1016/j.jclepro.2021.126333

Bux C, Amicarelli V (2022) Material flow cost accounting (MFCA) to enhance environmental entrepreneurship in the meat sector: Challenges and opportunities. J Environ Manage 313:115001. https://doi.org/10.1016/j.jenvman.2022.115001

Coşkun A, Özbük RMY (2020) What influences consumer food waste behavior in restaurants? an application of the extended theory of planned behavior. Waste Manage 117:170–178. https://doi.org/10.1016/j.wasman.2020.08.011

Damiani M, Pastorello T, Carlesso A, Tesser S, Semenzin E (2021) Quantifying environmental implications of surplus food redistribution to reduce food waste. J Clean Prod 289:125813. https://doi.org/10.1016/j.jclepro.2021.125813

Di Talia E, Simeone M, Scarpato D (2019) Consumer behaviour types in household food waste. J Clean Prod 214:166–172. https://doi.org/10.1016/j.jclepro.2018.12.216

Ekanem EO (1998) The street food trade in Africa: Safety and socio-environmental issues. Food Control 9(4):211–215. https://doi.org/10.1016/s0956-7135(97)00085-6

ElHaffar G, Durif F, Dubé L (2020) Towards closing the attitude-intention-behavior gap in Green Consumption: a narrative review of the literature and an overview of future research directions. J Clean Prod 275:122556. https://doi.org/10.1016/j.jclepro.2020.122556

Ericksen PJ (2008) Conceptualizing food systems for global environ chang research. Global Environ Chang 18(1):234–245. https://doi.org/10.1016/j.gloenvcha.2007.09.002

Faul F, Erdfelder E, Buchner A, Lang A-G (2009) Statistical Power analyses using G*Power 3.1: tests for correlation and regression analyses. Behav Res Methods 41(4):1149–1160. https://doi.org/10.3758/brm.41.4.1149

Filimonau V, Coşkun A, Derqui B, Matute J (2021) Restaurant Management and food waste reduction: factors affecting attitudes and intentions in restaurants of Spain. Int J Contemp Hosp M 34(3):1177–1203. https://doi.org/10.1108/ijchm-07-2021-0899

Fischer A, Peters V, Vávra J, Neebe M, Megyesi B (2011) Energy use, climate change and folk psychology: does sustainability have a chance? results from a qualitative study in five European countries. Global Environ Chang 21(3):1025–1034. https://doi.org/10.1016/j.gloenvcha.2011.04.008

Fornell C, Larcker DF (1981) Structural equation models with unobservable variables and measurement error: algebra and statistics. J Marketing Res 18(3):382. https://doi.org/10.2307/3150980

Fuller CM, Simmering MJ, Atinc G, Atinc Y, Babin BJ (2016) Common methods variance detection in business research. J Bus Res 69(8):3192–3198. https://doi.org/10.1016/j.jbusres.2015.12.008

Goh E, Jie F (2019) To waste or not to waste: exploring motivational factors of generation Z hospitality employees towards food wastage in the hospitality industry. Int J Hosp Manag 80:126–135. https://doi.org/10.1016/j.ijhm.2019.02.005

Graham-Rowe E, Jessop DC, Sparks P (2015) Predicting household food waste reduction using an extended theory of planned behaviour. Resour Conserv Recy 101:194–202. https://doi.org/10.1016/j.resconrec.2015.05.020

Gu B, Wang H, Chen Z, Jiang S, Zhu W, Liu M, Chen Y, Wu Y, He S, Cheng R, Yang J, Bi J (2015) Characterization, quantification and management of household solid waste: a case study in China. Resour Conserv Recy 98:67–75. https://doi.org/10.1016/j.resconrec.2015.03.001

Gustavsson J, Cederberg C, Sonesson U, Emanuelsson A (2013) The methodology of the FAO study: Global Food Losses and Food Waste-extent, causes and prevention- FAO, 2011. Available: https://www.diva-portal.org/smash/get/diva2:944159/FULLTEXT01.pdf. Accessed 25th Jan. 2023

Hair JF, Hult GT, Ringle CM, Sarstedt M, Danks NP, Ray S (2021) Partial least squares structural equation modeling (PLS-SEM) using r: A workbook. Cham, Switzerland: Springer

Hair JF, Matthews LM, Matthews RL, Sarstedt M (2017) PLS-SEM or CB-SEM: updated guidelines on which method to use. Int J Multivariate Data Anal 1(2):107. https://doi.org/10.1504/ijmda.2017.10008574

Hair JF, Ringle CM, Sarstedt M (2011) PLS-SEM: indeed a silver bullet. J Marketing Theor Pract 19(2):139–152. https://doi.org/10.2753/mtp1069-6679190202

Hair JF, Risher JJ, Sarstedt M, Ringle CM (2019) When to use and how to report the results of PLS-SEM. European Bus Rev 31(1):2–24. https://doi.org/10.1108/ebr-11-2018-0203

Han H, Hwang J, Lee MJ (2016) The value–belief–emotion–norm model: investigating customers' eco-friendly behavior. J Travel Tour Mark 34(5):590–607. https://doi.org/10.1080/10548408.2016.1208790

Hebrok M, Boks C (2017) Household food waste: drivers and potential intervention points for design – an extensive review. J Clean Prod 151:380–392. https://doi.org/10.1016/j.jclepro.2017.03.069

Heidari A, Mirzaii F, Rahnama M, Alidoost F (2020) A theoretical framework for explaining the determinants of food waste reduction in residential households: a case study of Mashhad, Iran. Environ Sci Pollut Res Int 27:6774–6784. https://doi.org/10.1007/s11356-019-06518-8

Henseler J, Ringle CM, Sarstedt M (2014) A new criterion for assessing discriminant validity in variance-based structural equation modeling. J Acad Market Sci 43(1):115–135. https://doi.org/10.1007/s11747-014-0403-8

Jabeen F, Dhir A, Islam N, Talwar S, Papa A (2023) Emotions and food waste behavior: do habit and facilitating conditions matter? J Bus Res 155:113356. https://doi.org/10.1016/j.jbusres.2022.113356

Kim HJ, Kim JY, Oh KW, Jung HJ (2016) Adoption of eco-friendly faux leather. Cloth Text Res J 34(4):239–256. https://doi.org/10.1177/0887302x16656439

Kim MJ, Hall CM, Kim D-K (2019) Predicting environmentally friendly eating out behavior by value-attitude-behavior theory: Does being vegetarian reduce food waste? J Sustain Tour 28(6):797–815. https://doi.org/10.1080/09669582.2019.1705461

Kim W, Che C, Jeong C (2022) Food waste reduction from customers' plates: Aapplying the norm activation model in South Korean context. Land 11(1):109. https://doi.org/10.3390/land11010109

Klöckner CA (2015) The psychology of pro-environmental communication: beyond standard information strategies. Cham, Switzerland: Springer

Kochan GC, Pourreza S, Tran H, Prybutok VR (2016) Determinants and logistics of E-waste recycling. Int J Logist Manag 27(1):52–70. https://doi.org/10.1108/ijlm-02-2014-0021

Kock N (2014) Advanced mediating effects tests, multi-group analyses, and measurement model assessments in PLS-based sem. Int J e-Collaboration 10(1):1–13. https://doi.org/10.4018/ijec.2014010101

Kollikkathara N, Feng H, Stern E (2009) A purview of waste management evolution: special emphasis on USA. Waste Manage 29(2):974–985. https://doi.org/10.1016/j.wasman.2008.06.032

Kortright R, Wakefield S (2010) Edible backyards: a qualitative study of household food growing and its contributions to food security. Agr Hum Values 28(1):39–53. https://doi.org/10.1007/s10460-009-9254-1

Kuo F-Y, Young M-L (2008) Predicting knowledge sharing practices through intention: a test of competing models. Comput Hum Behav 24(6):2697–2722. https://doi.org/10.1016/j.chb.2008.03.015

Lehner M, Mont O, Heiskanen E (2016) Nudging – a promising tool for sustainable consumption behaviour? J Clean Prod 134:166–177. https://doi.org/10.1016/j.jclepro.2015.11.086

Liao C, Li H (2019) Environmental education, knowledge, and high school students' intention toward separation of solid waste on campus. Int J Environ Res Publ Health 16(9):1659. https://doi.org/10.3390/ijerph16091659

Liao C, Qiao L, Wang X, Lu S (2022) Exploring food waste prevention through advent food consumption: the role of perceived concern, consumer value, and impulse buying. Front Sustain Food Syst 6:988260. https://doi.org/10.3389/fsufs.2022.988260

Li Y, Wang L, Liu G, Cheng S (2021) Rural household food waste characteristics and driving factors in China. Resour Conserv Recy 164:105209. https://doi.org/10.1016/j.resconrec.2020.105209

Lin B, Guan C (2021) Determinants of household food waste reduction intention in China: the role of perceived government control. J Environ Manage 299:113577. https://doi.org/10.1016/j.jenvman.2021.113577

Mkono M, Hughes K (2020) Eco-guilt and eco-shame in tourism consumption contexts: understanding the triggers and responses. J Sustain Tour 28(8):1223–1244. https://doi.org/10.1080/09669582.2020.1730388

Mumtaz S, Chu AMY, Attiq S, Shah HJ, Wong W-K (2022) Habit - does it matter? bringing habit and emotion into the development of consumers' food waste reduction behavior with the lens of the theory of interpersonal behavior. Int J Environ Res Publ Health 19(10) https://doi.org/10.3390/ijerph19106312

Munesue Y, Masui T, Fushima T (2014) The effects of reducing food losses and food waste on global food insecurity, natural resources, and greenhouse gas emissions. Environ Econ Policy Stud 17(1):43–77. https://doi.org/10.1007/s10018-014-0083-0

Niu Z, Ng SJ, Li B, Han J, Wu X, Huang Y (2022) Food waste and its embedded resources loss: a provincial level analysis of China. Sci Total Environ 823:153665. https://doi.org/10.1016/j.scitotenv.2022.153665

Obuobi B, Zhang Y, Adu-Gyamfi G, Nketiah E (2023) Households' food waste behavior prediction from a moral perspective: a case of China. Environ Dev Sustain. https://doi.org/10.1007/s10668-023-03136-w

Obuobi B, Zhang Y, Adu-Gyamfi G, Nketiah E, Grant MK, Adjei M, Cudjoe D (2022) Fruits and vegetable waste management behavior among retailers in Kumasi, Ghana. J Retail Consum 67:102971. https://doi.org/10.1016/j.jretconser.2022.102971

Ojo AO, Fauzi MA (2020) Environmental awareness and leadership commitment as determinants of IT professionals engagement in Green IT practices for environmental performance. Sustain Prod Consum 24:298–307. https://doi.org/10.1016/j.spc.2020.07.017

Ogunmoroti A, Liu M, Li M, Liu W (2022) Unraveling the environmental impact of current and future food waste and its management in Chinese provinces. Resour Environ Sustain 9:100064. https://doi.org/10.1016/j.resenv.2022.100064

Oviedo-García MÁ, Castellanos-Verdugo M, Vega-Vázquez M, Orgaz-Agüera F (2016) The mediating roles of the overall perceived value of the ecotourism site and attitudes towards ecotourism in sustainability through the key relationship ecotourism knowledge-ecotourist satisfaction. Int J Tour Res 19(2):203–213. https://doi.org/10.1002/jtr.2097

Parizeau K, von Massow M, Martin R (2015) Household-level dynamics of food waste production and related beliefs, attitudes, and behaviours in Guelph, Ontario. Waste Manage 35:207–217. https://doi.org/10.1016/j.wasman.2014.09.019

Principato L, Mattia G, Di Leo A, Pratesi CA (2021) The household wasteful behaviour framework: a systematic review of consumer food waste. Ind Mark Manag 93:641–649. https://doi.org/10.1016/j.indmarman.2020.07.010

Russell SV, Young CW, Unsworth KL, Robinson C (2017) Bringing habits and emotions into food waste behaviour. Resour Conserv Recy 125:107–114. https://doi.org/10.1016/j.resconrec.2017.06.007

Sakai S-I, Yoshida H, Hirai Y, Asari M, Takigami H, Takahashi S, Tomoda K, Peeler MV, Wejchert J, Schmid-Unterseh T, Douvan AR, Hathaway R, Hylander LD, Fischer C, Oh GJ, Jinhui L, Chi NK (2011) International comparative study of 3R and waste management policy developments. J Mater Cycles Waste Manag 13(2):86–102. https://doi.org/10.1007/s10163-011-0009-x

Schanes K, Dobernig K, Gözet B (2018) Food waste matters - a systematic review of household food waste practices and their policy implications. J Clean Prod 182:978–991. https://doi.org/10.1016/j.jclepro.2018.02.030

Sirieix L, Lála J, Kocmanová K (2017) Understanding the antecedents of consumers' attitudes towards doggy bags in restaurants: Concern about food waste, culture, norms and emotions. J Retail Consum 34:153–158. https://doi.org/10.1016/j.jretconser.2016.10.004

Song G, Semakula HM, Fullana I-PP (2018) Chinese household food waste and its' climatic burden driven by urbanization: a Bayesian Belief Network modelling for reduction possibilities in the context of global efforts. J Clean Prod 202:916–924. https://doi.org/10.1016/j.jclepro.2018.08.233

Soorani F, Ahmadvand M (2019) Determinants of consumers' food management behavior: applying and extending the theory of planned behavior. Waste Manage 98:151–159. https://doi.org/10.1016/j.wasman.2019.08.025

Springmann M, Clark M, Mason-D'Croz D, Wiebe K, Bodirsky BL, Lassaletta L, de Vries W, Vermeulen SJ, Herrero M, Carlson KM, Jonell M, Troell M, DeClerck F, Gordon LJ, Zurayk R, Scarborough P, Rayner M, Loken B, Fanzo J, Willett W (2018) Options for keeping the food system within environmental limits. Nature 562(7728):519–525. https://doi.org/10.1038/s41586-018-0594-0

Stancu V, Haugaard P, Lähteenmäki L (2016) Determinants of consumer food waste behaviour: two routes to food waste. Appetite 96:7–17. https://doi.org/10.1016/j.appet.2015.08.025

Stefan V, van Herpen E, Tudoran AA, Lähteenmäki L (2013) Avoiding food waste by Romanian consumers: the importance of planning and shopping routines. Food Qual Prefer 28(1):375–381. https://doi.org/10.1016/j.foodqual.2012.11.001

Steg L, Groot J (2010) Explaining prosocial intentions: testing causal relationships in the norm activation model. Br J Soc Psychol 49(4):725–743. https://doi.org/10.1348/014466609x477745

Talwar S, Kaur P, Kumar S, Salo J, Dhir A (2022) The balancing act: how do moral norms and anticipated pride drive food waste/reduction behaviour? J Retail Consum 66:102901. https://doi.org/10.1016/j.jretconser.2021.102901

Teller C, Holweg C, Reiner G, Kotzab H (2018) Retail store operations and food waste. J Clean Prod 185:981–997. https://doi.org/10.1016/j.jclepro.2018.02.280

Thyberg KL, Tonjes DJ, Gurevitch J (2015) Quantification of food waste disposal in the United States: a meta-analysis. Environ Sci Technol 49(24):13946–13953. https://doi.org/10.1021/acs.est.5b03880

Triandis HC (1979) Values, attitudes, and interpersonal behavior. Nebr Symp Motiv 27:195–259

UNEP - United Nations Environment Programme (2021) Food Waste Index Report 2021. Nairobi. Available: https://www.unep.org/resources/report/unep-food-waste-index-report-2021 Accessed 23rd Jan. 2023

van Geffen L, van Herpen E, Sijtsema S, van Trijp H (2020) Food waste as the consequence of competing motivations, lack of opportunities, and insufficient abilities. Resour Conserv Recy: X 5:100026. https://doi.org/10.1016/j.rcrx.2019.100026

Vermeir I, Verbeke W (2008) Sustainable food consumption among young adults in Belgium: theory of planned behaviour and the role of confidence and values. Ecol Econ 64(3):542–553. https://doi.org/10.1016/j.ecolecon.2007.03.007

Visschers VHM, Wickli N, Siegrist M (2016) Sorting out food waste behaviour: a survey on the motivators and barriers of self-reported amounts of food waste in households. J Environ Psychol 45:66–78. https://doi.org/10.1016/j.jenvp.2015.11.007

Webb TL, Sheeran P (2006) Does changing behavioral intentions engender behavior change? A meta-analysis of the experimental evidence. Psychol Bull 132(2):249–268. https://doi.org/10.1037/0033-2909.132.2.249

Wu Y, Kurisu K, Phuphisith S, Fukushi K (2023) Household food-waste prevention behaviors in Beijing, Shanghai, and Wuhan in China compared with those in Tokyo and Bangkok. Resour Conserv Recy 192:106901. https://doi.org/10.1016/j.resconrec.2023.106901

Xu L, Lin T, Xu Y, Xiao L, Ye Z, Cui S (2016) Path analysis of factors influencing household solid waste generation: a case study of Xiamen Island, China. J Mater Cycles Waste Manag 18(2):377–384. https://doi.org/10.1007/s10163-014-0340-0

Xue L, Liu X, Lu S, Cheng G, Hu Y, Liu J, Dou Z, Cheng S, Liu G (2021) China's food loss and waste embodies increasing environmental impacts. Nat Food 2(7):519–528. https://doi.org/10.1038/s43016-021-00317-6

Yang Q, Al Mamun A, Hayat N, Md Salleh MF, Salameh AA, Makhbul ZK (2022) Predicting the mass adoption of eDoctor apps during COVID-19 in China using hybrid sem-neural network analysis. Front Public Health https://doi.org/10.3389/fpubh.2022.889410

Zhang P, Zhang D, Cheng S (2020) The effect of consumer perception on food waste behavior of urban households in China. Sustainability 12(14):5676. https://doi.org/10.3390/su12145676

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Ethics approval

The human research ethics committee of Nanjing Audit University Jinshen College, China approved this study (Reference number: JS-2022-012). This study has been performed in accordance with the Declaration of Helsinki.

Informed consent

Written informed consent for participation was obtained from respondents who participated in the survey. No data were collected from anyone under 18 years old.

Competing interests

The authors declare no competing interests.

Additional information

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