Article

How to Reduce College Students' Food Waste Behavior: From the Perspective of College Canteen Catering Modes

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Abstract: Reducing consumer food waste plays an important role in achieving the Sustainable Development Goals. Considering the large number of colleges in China, with the largest enrollment in the world, it is especially important to address the issue of food waste among college students. However, the mechanisms underlying the effects that the college canteen catering modes have on the food-saving behavior of college students remain unclear. To fill this gap, an integrated theoretical framework model was constructed from the perspective of "psychological factors–behavioral intention–external environment–actual behavior" based on the theory of planned behavior, the norm activation model, and the attitude–context–behavior theory. Then, 422 valid questionnaires were empirically analyzed by structural equation modeling and hierarchical regression. The main conclusions of this study are as follows: (1) Food-saving intention and herd mentality are the major drivers of college students' food-saving behavior. Personal norms, attitudes, subjective norms, perceived behavior control, and health risk perception are influencing factors on food-saving intention, among which personal norms have the greatest effect. (2) The standard-quantity catering mode has an inhibitory moderating effect, while the large-/small-portion-size and buffet catering modes have promoting moderating effects in the transformation of food-saving intention into actual behavior. Notably, the moderating effects of the buffet catering mode are more pronounced than those of the large-/small-portion-size catering mode. (3) The standard-quantity catering mode has a promoting moderating effect, while the large-/small-portion-size and buffet catering modes have inhibitory moderating effects in the path of the negative impact of herd mentality on food-saving behavior. These conclusions can help colleges recommend strategies to avoid food waste on their campuses from the perspectives of both the individual student and the food provider.

Keywords: food waste; food-saving behavior; catering mode; structural equation modeling; hierarchical regression analysis; college canteens; UN Sustainable Development Goals

1. Introduction

Food waste, one of the greatest challenges in the context of global climate change, is associated with huge economic losses [1], tremendous resource waste, and severe environmental damage [2,3]. The Sustainable Development Goals (SDGs) were introduced by the United Nations Summit on Sustainable Development on 25 September 2015, in the hope that from 2015 to 2030, people will be able to comprehensively address the three dimensions of development—that is, social, economic, and environmental dimensions—and shift to a path of sustainable development. Item 12.3 of the SDGs directly states that, by 2030, the per capita food waste at the retail and consumption stages should reach a specific target reduction of 50% [4]. According to the latest statistics from the United Nations Environment Program (UNEP), the total amount of food wasted globally has reached 1.03 billion tons per year, about 11% of which occurs at the consumption stage of the food supply

chain, while only 2% occurs at the retail stage [5]. Relevant studies have pointed out that intervening in consumers' food waste behaviors at the consumption stage can reduce food waste by about 50% [6]. In summary, reducing food waste in consumers' daily catering consumption activities is the key way to build a sustainable food system and achieve the goal of sustainable development.

In China, the catering industry generates about 17–18 million tons of food waste annually [7], accounting for approximately 3% of China's total annual grain yield. In the 1950s and 1960s, China experienced food shortages, and the food supply was less than the demand. The people born in this period experienced food crises, which resulted in their love of food and their desire to save it, a conclusion verified in the studies of Hou et al. [8] and Wang et al. [9], which also revealed that the youth are the key target of the food waste reduction task. Colleges and universities constitute a vital component of China's social development. Based on a current student scale of 44.3 million in China (2021) [10], the amount of food wasted by Chinese college students each year while dining in canteens is estimated to account for approximately 8% of China's total food waste [11]. This amount is sufficient to feed 10 million people for one year [12]. Consequently, with regard to ensuring the sustainable development of colleges and universities, food waste in college canteens poses an urgent problem.

Both weak food-saving intentions and barriers posed by the external environment tend to increase food waste by college students [13,14]. In response to the weak food-saving intentions among students, Chinese colleges and universities have taken a series of publicity and education measures. Prominent examples include strengthening public food-saving messaging and holding regular themed lectures and class meetings, as well as designing food-saving signs, slogans, and posters for placement in the entrance hall, dining table, wall, and food-recycling areas of university canteens, with the aims of enhancing the food-saving intention of students and reducing food waste in colleges and universities [15,16]. While these measures have improved the food-saving intentions of students to a certain extent, there is still a problem of negativity in their actual food-saving behavior [17]. This is consistent with the research findings of Ellison et al. [18], who showed that educational activities do not affect students' food-saving behavior, except for changing their opinions on saving food. In this sense, simply improving the food-saving intentions of college students through education is not sufficient to improve the status quo of food waste in colleges and universities; the effects of external environmental factors also need to be considered. At present, the main external barriers that prevent college students from saving food are the mismatch between the homogeneous and inflexible food supply modes in college canteens and the differentiated food-saving needs of college students [19]. However, it still remains unclear how the existing catering modes in college canteens affect college students' food-saving behavior and decision-making processes. In other words, the role that each catering mode plays in the transformation of college students' food-saving intentions into actual food-saving behavior has not yet been clarified.

2. Literature Review

The existing research related to consumer food-saving behavior focuses on exploring the psychological driving mechanisms behind it with the help of the theory of planned behavior (TPB) and the normative activation model (NAM). For example, Gokarn et al. [20] and Wang et al. [21] constructed a structural equation model with the help of the TPB and pointed out through empirical analyses that subjective norms, attitudes, and perceived behavioral control significantly affect consumers' food-saving intentions. Academics have also pointed out that the TPB has good extensibility and has attained a good explanation rate for explaining the psychological formation mechanism of individual pro-environmental behaviors [22,23]; however, some scholars have criticized the TPB for overemphasizing the influence of rational factors on individual pro-environmental behaviors and ignoring the influence of the individual's irrationality and the ethical motives for their behaviors [24,25]. Thus, Shin et al. [26] questioned the validity of the TPB in explaining pro-environmental behavior.

The NAM suggests that the performance of a behavior by an individual depends on the sense of moral obligation formed in the individual toward the behavior, stressing the explanation of individual pro-environmental behavior from the perspective of moral motives [27]. Wang et al. [28] constructed a model of the moral psychological driving mechanism of consumer food-saving behavior with the help of the NAM and conducted an empirical analysis with the help of structural equation modeling, pointing out that consumers' sense of moral obligation to save food positively affects their food-saving intentions, achieving a good explanation rate. However, some scholars have criticized the NAM for overemphasizing the moral motivation of individual pro-environmental behaviors and neglecting to explain individual environmental behaviors from the perspective of rational motivation [27]. As a result, the validity of the NAM in explaining the formation mechanism of individual pro-environmental behaviors has been questioned [26,29].

With the increasing depth of research, the combined use of the TPB and NAM is considered critical for analyzing the psychological driving mechanisms of consumer food-saving behaviors and developing effective guidance strategies. As Shin et al. [26] and Jia et al. [29] pointed out by constructing the TPB-NAM integrated theoretical model and using questionnaire research combined with structural equation modeling for empirical research, the TPB-NAM integrated model pays attention to both the rational and moral motivations of individual influences on behavior and strives to achieve a balance between pro-ego and pro-social in reducing consumers' food waste behaviors. Although the TPB-NAM integrative theoretical model has gained wide recognition at the level of the psychological formation mechanisms of individual pro-environmental behaviors, some experts have criticized the TPB-NAM integrative theoretical model for only focusing on the psychological factors of pro-environmental behaviors while largely ignoring the roles of external environmental factors in pro-environmental behavioral decision-making [30,31].

Catering mode has been shown to be an important external environmental factor in reducing consumer food waste behavior. Werkman et al. [32] identified the food portion size as an important influencing factor in consumer food waste, suggesting that most consumers with food-saving tendencies end up wasting food because the food portion size exceeds their personal appetites. Li et al. [33] uncovered that, when dining in cafeterias that grant them the freedom to choose both the food category and food portion size instead of a traditional restaurant, consumers often show strong food-saving tendencies. As academics focus on the issue of food waste among college students, research on food waste in colleges has clearly shown that food satisfaction [34] and the food portion size [35] are significant factors that influence the food-saving behaviors of college students; that is, the larger the food portion size, the lower the food satisfaction, and the more likely students are to waste food [35]. According to Zhao and Manning [36], the food category and food plate size both significantly affect students' food waste. Richardson et al. [37] proved that adjusting the size and shape of food plates helps to reduce food waste in college canteens. Based on a field survey of college canteens, Fan et al. [38] pointed out that college students' food-saving behaviors vary with the specific catering modes in college canteens. Moreover, students can save an average of 13.30 g of food per meal when dining at buffet buttery hatches (buttery hatch: a small window for passing food in university canteens) instead of standard-quantity buttery hatches. In summary, the catering modes in college canteens constitute a key factor influencing college students' food-saving behaviors.

The above studies have shown that food portion size and food category are important reasons affecting the food waste of college students at home and abroad; however, different types of catering modes in college canteens have different degrees of restriction on the students' selection of food portion size and food category, which, in turn, have different degrees of influence on the students' food-saving behavior. This study categorized the existing catering modes into the following three types based on the way that students choose their food categories and food portion sizes: the standard-quantity catering mode (fixed portion sizes), the large-/small-portion-size catering mode (portion sizes are optional), and the buffet catering mode (arbitrary choice of food categories and portion sizes). The above

research on the catering-mode factors makes up for the lack of external environmental factors in the existing research on food-saving behavior; however, it was limited to identifying the influences of the college canteen catering modes on the food-saving behaviors of college students through regression analysis or field measurements and did not conduct an in-depth analysis of the paths through which the different types of catering modes influence the food-saving behaviors. That is, the mechanisms underlying the effects of the college canteen catering modes on college students' food-saving behavior are still unclear, which is an unresolved issue in the existing research.

The factors that influence consumer food-saving behavior are multi-dimensional [11]. This means that, in order to explore the mechanisms underlying the influences of the external environmental college canteen catering modes on college students' food-saving behaviors, it is necessary to consider the psychological decision-making mechanisms underlying how the college canteen catering modes influence individual food-saving behaviors by combining internal and external factors. The attitude–context– behavior (ABC) theory suggests that external environmental factors have moderating effects on the transformation of a psychological tendency into an actual behavior [39]. Although the ABC theory has achieved wide academic recognition in explaining the mechanisms by which external environmental factors influence individual behavior, some scholars have pointed out that the ABC theoretical model largely ignores the psychological formation mechanisms of individual behaviors, which makes its findings one-sided [40]; therefore, it is usually used in conjunction with theories that explore psychological factors [41]. Therefore, in this study, we investigated the mechanisms of the influences of the college canteen catering modes on the food-saving behavior of college students with the help of three theories: the TPB, NAM, and ABC theory.

When exploring the psychological decision-making mechanisms of the food-saving behavior of college students, it is not only necessary to determine whether the psychological variables selected for the study are the influencing factors of the behavior but also to identify the path through which each psychological factor influences the behavior. The existing studies mostly use structural equation modeling (SEM) to solve this kind of research problem [20,28,31]. SEM is a statistical method that is used to analyze the relationships between the variables based on their covariance matrix. Compared with the traditional regression analysis method, SEM can determine the path of influence of each factor on the behavior while performing a factor analysis, which is the advantage of this method and the reason that it was selected for this study [42,43]. While exploring the moderating effects of the external environmental factors (the college canteen catering modes) on college students' food-saving behavior with the help of the ABC theory, hierarchical regression analysis is the most commonly used and effective method to solve this type of problem in the existing research, and the advantage of choosing the hierarchical regression analysis method for this study is reflected in its ability to exclude other irrelevant variables, preventing them from interfering with the moderating variables [44].

To sum up, in this study, we took college students as the research object, constructed a research framework from the perspective of "psychological factors–behavioral intention–external environment–actual behavior" with the help of the TPB, NAM, and ABC theories, and used structural equation modeling through questionnaire research and stratified regression analysis for empirical testing to explore the influence mechanisms of the college canteen catering modes on college students' food-saving behavior. The results of this study provide a reference for China and other Asian countries for the development of effective strategies to reduce food waste in college canteens.

3. Theoretical Basis and Research Hypotheses

3.1. TPB and Research Hypotheses

The TPB maintains that the decision to perform a certain behavior involves a rational thinking process. According to the TPB, an individual's intention to behave is influenced by three factors: attitudes, subjective norms, and perceived behavioral control, and the

intention to behave is a key predictor of behavior [24]. Attitude refers to a consumer's positive or negative evaluation of food-saving behaviors. In general, a consumer with a more positive evaluation of food-saving behavior is more likely to possess strong food-saving intentions [20]. Subjective norms refer to the social pressure consumers experience when deciding whether to perform food-saving behavior. Generally speaking, when influenced by social conformity norms, an individual under greater social pressure has a stronger tendency to align with the expectations of those who are important to them. If a consumer experiences positive expectations from others (such as parents, teachers, and friends) and recognizes their food-saving behavior, the possibility that they will perform food-saving behavior will increase [21]. Perceived behavioral control refers to consumers' perception of the ease or difficulty of performing food-saving behavior, which is hindered by external environmental factors (such as the absence of (or change in) a purchase plan [45], an unwillingness to consume leftovers, and the inability to control food portion sizes). Perceived behavioral control is also influenced by judgments about the values created by the performance of food-saving behavior. This means that consumers who can better overcome the hindrance of external factors and who regard food-saving behavior as easier to perform will have strong food-saving intentions [21]. According to the TPB, the intention to behave is often considered a strong internal stimulus and an antecedent of behavior [46]. In situations in which it is difficult to measure individual pro-environmental behavior, scholars tend to replace actual behavior with the intention to behave [47]. It has been pointed out that consumer food-saving intentions positively affect their food-saving behaviors [21,46]. To summarize the above, the following hypotheses are proposed:

H1: *Students' attitudes have a significant positive effect on their food-saving intentions.*

H2: *Students' subjective norms have a significant positive effect on their food- saving intentions.*

H3: *Students' perceived behavioral control has a significant positive effect on their food-saving intentions.*

H4: *Students' food-saving intentions have a significant positive effect on their food-saving intentions.*

Recently, certain scholars have incorporated herd mentality and risk perception into their research on individual pro-environmental behavior and have identified them as important predictors in the TPB [44,48]. Therefore, in this paper, the above two factors are introduced into the basic model of the TPB, and the extended TPB model is used to explain the factors influencing college students' food-saving behavior at the level of individual rationality. Herd mentality refers to the psychological tendency of individuals to change their behavior under the influence of a particular behavior of the group around them, with the goal of aligning their behavior with that of the people around them [49]. Research has shown that Chinese consumers are more susceptible to the influence of the behavior of other groups than U.S. consumers [50]. When studying the catering consumption behavior of residents, scholars have found that consumers have a herd mentality toward food waste behavior, mainly because of their tendencies to save face and follow trends [22]. College students are the main consumers of college canteen catering activities, and their catering consumption behavior may also change with that of their classmates around them. Moreover, when college students go out for meals, most of them will refer to the treatment of leftovers by other students around them before making their own decisions as to whether to pack leftovers or not [51]. Considering the above-mentioned content, depending on its specific definition, herd mentality affects consumer food-saving intentions and behavior in different manners, either positively or negatively. As this study is aimed at solving the problem of food waste in colleges, herd mentality is defined as the tendency of college students to exhibit a consistent behavior or response when others generate food waste. It was speculated that, under the influence of an environment that tolerates food waste,

college students may relax the requirements for themselves in terms of their food-saving intentions and behavior. Accordingly, the following hypotheses are presented:

H5: *Students' herd mentality has a significant negative impact on their food-saving intentions.*

H6: *Students' herd mentality has a significant negative impact on their food-saving behavior.*

Risk perception is an intuitive judgment about the characteristics and severity of a specific, objective risk [52]. Property loss, environmental deterioration, and health threats are all risks posed by food waste. With the development of society and the improvement in people's quality of life, health risks are receiving increasingly close attention. For the purpose of this study, health risk perception refers to the individual's perception of the health risks posed by stale food and edible leftovers. Research on hotel and home catering consumption behaviors shows that consumers have weakened food-saving intentions when they have concerns about the health and hygiene status of packed leftovers [23], as well as about the potential harms of consuming expired food or leftovers [22,53]. Similarly, the authors suspect that students who perceive more severe health threats from stale food and edible leftovers are more likely to generate food waste. To this end, the following hypothesis is proposed:

H7: *Students' health risk perceptions have a significant negative impact on their food-saving intentions.*

3.2. NAM and Research Hypotheses

The NAM explains the pro-environmental behavior of an individual from the perspective of the moral norms formed by the individual toward such behavior. The NAM includes three core latent variables: awareness of consequences, ascription of responsibility, and personal norms [28]. Personal norms refer to the sense of moral obligation formed by an individual toward a certain behavior. Ascription of responsibility involves an individual's perception of responsibility for the adverse consequences of not performing a certain behavior. Awareness of consequences relates to an individual's perception of the potential impact that a certain behavior may have on society and others [28]. To a certain extent, consumers' moral norms can influence their daily consumption behavior [27]. The NAM suggests that the source of power that drives individuals to perform food-saving behavior is their sense of moral obligation (i.e., their personal norms). Based on a TPB-NAM integrated model, scholars have pointed out that positive personal norms play an important role in the formation of food-saving intentions [30]. A consumer with a stronger perception of the ascription of responsibility toward food-saving behavior is more likely to self-condemn and feel guilty for the serious adverse consequences caused by food waste; this further stimulates personal norms to promote the performance of food-saving behavior [54]. The stronger the consumers' perception of the adverse consequences of food waste, the more likely it will be that their personal norms will be activated to urge their performance of food-saving behavior [55]. Generally speaking, when individuals become aware of the serious adverse consequences of not performing pro-environmental behaviors, they develop an effective sense of an ascription of responsibility toward such consequences and engage in behaviors that comply with personal norms [56]. In summary, the following hypotheses are proposed:

H8: *Students' personal norms have a significant positive effect on their food-saving intentions.*

H9: *Students' ascription of responsibility has a significant positive effect on their personal norms.*

H10: *Students' awareness of consequences has a significant positive effect on their personal norms.*

H11: *Students' awareness of consequences has a significant positive effect on their ascription of responsibility.*

Relying on the extended TPB model, scholars have identified subjective norms as an antecedent of personal norms, suggesting that subjective norms can not only be used to test the social correctness of individual behavior but can also be perceived and internalized as personal norms by individuals [57]. Therefore, if individuals perceive that food-saving behavior is socially accepted, they will feel obligated to perform such behavior. Related studies have also confirmed the connection between individual subjective norms and personal norms [58]. In general, under the combined pressure from society, schools, parents, and teachers, individual students tend to enhance their sense of moral obligation toward pro-environmental behaviors. Hence, the stronger a college student's perception of subjective norms toward food-saving behavior, the stronger their perception of responsibility, and the higher their level of personal norms. In summary, the following hypothesis is proposed:

H12: *Students' subjective norms have a significant positive effect on their personal norms.*

3.3. ABC and Research Hypotheses

According to the ABC theory, the psychological tendency of an individual when deciding whether to perform a behavior is subject to interference from the external environment [39]. In a favorable external environment, if an individual has a positive psychological tendency toward a certain behavior, then that individual will likely perform the behavior. On the contrary, in an unfavorable external environment, if an individual has a negative psychological tendency toward a certain behavior, such an external environment will hinder that individual from performing the behavior. In this study, the catering modes (external environmental factors) are considered to potentially play moderating roles, as they directly affect consumers' ordering behavior and further influence their food-saving behavior. As a case in point, Li [59] substituted students' food-saving intentions for their actual food-saving behaviors. Using the PRECEDE-PROCEED model, Li pointed out that enabling factors (including catering modes) can moderate the relationship between an individual's food-saving intention and its antecedents.

Currently, there are three main catering modes offered in college canteens: (1) the standard-quantity catering mode, wherein the food portion size served by the canteen staff is basically the same for each student and only two or three dishes are offered with a set meal of rice; (2) the large-/small-portion-size catering mode, wherein a large portion size and a small portion size, allocated by the canteen staff, are available for selection by students as needed; and (3) the buffet catering mode, wherein students can freely choose the category and portion size of food that they like, and the food is then weighed and charged accordingly. At present, the standard-quantity catering mode is the dominant catering mode across college canteens. However, due to the varied food needs of students, even those with strong food-saving tendencies may end up wasting food, as they have no control over the category or portion size of their food. Specifically, students with large appetites may find the standardized portion size insufficient and purchase several portion sizes, while students with small appetites (or those who are picky) may find the standardized portion size excessive. In both cases, food is wasted, and the performance of food-saving behavior is hindered. In addition, when students have a low level of control over the category and portion size of their food, they may relax the requirements for themselves in terms of food-saving behavior under the influence of others who produce food waste, causing food waste. Conversely, when students have a high level of control over the category and portion size of their food, the effect of their food-saving intention on their behavior will be enhanced. At the same time, as they are able to control the category and portion size of their food, they tend to take only according to their needs, in which case the degree of food waste due to the herd mentality influence is reduced. Summing up the above, the following hypotheses are proposed:

H13: *The standard-quantity catering mode plays a moderating role between food-saving intention and behavior.*

H14: *The large-/small-portion-size catering mode plays a moderating role between food-saving intention and behavior.*

H15: *The buffet catering mode plays a moderating role between food-saving intention and behavior.*

H16: *The standard-quantity catering mode plays a moderating role between herd mentality and food-saving behavior.*

H17: *The large-/small-portion-size catering mode plays a moderating role between herd mentality and food-saving behavior.*

H18: *The buffet catering mode plays a moderating role between herd mentality and food-saving behavior.*

Moreover, Guo et al. [60] and Ma et al. [61] concluded that individual-attribute factors, such as gender, education, household registration, and economic status (comprising monthly living expenses and average daily spending on meals), can all affect college students' food-saving behavior. Scholars have also pointed out that the situation of food waste is more serious for female students than male students, as well as more serious for undergraduate students than graduate students [62] and for students with better family economic conditions than those with poorer family economic conditions [11]. To summarize the above, the following hypothesis is proposed:

H19: *Individual-attribute factors have significant effects on food-saving behavior.*

In summary, in this study, we integrated the above three classical behavioral theoretical models and established a hypothetical model for extending the TPB-NAM-ABC integrated theoretical framework, as shown in Figure 1. This model can be used to examine the mechanisms underlying the formation of college students' food-saving behavior from two perspectives: internal psychological factors and external environmental factors. To identify the psychological driving mechanisms underlying the food-saving behavior of college students, an extended TPB-NAM model was constructed. To identify the mechanisms by which the catering modes affect college students' food-saving behavior, the ABC model was integrated with the extended TPB-NAM model for a more detailed explanation.
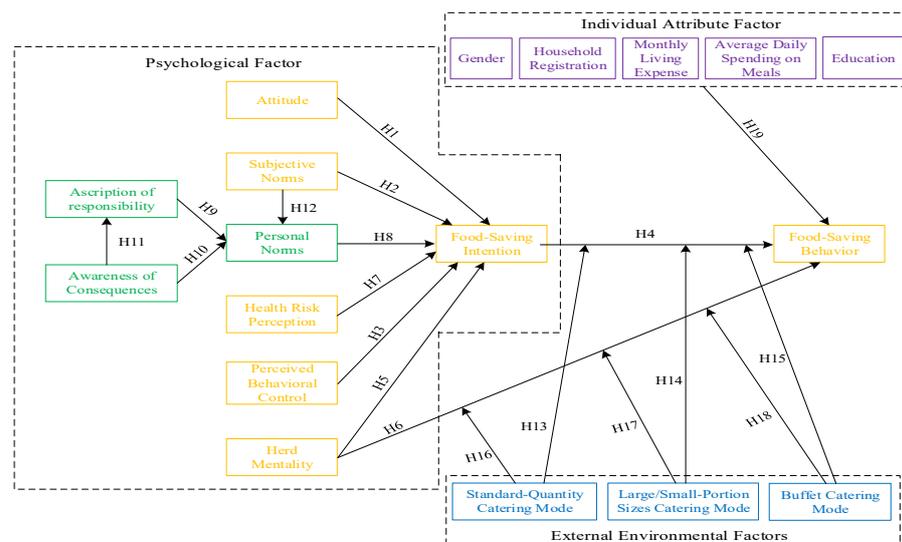
Figure 1. Diagram of the hypothetical model for extending the theory of planned behavior (TPB)/norm activation model (NAM)/attitude–context–behavior (ABC) (TPB-NAM-ABC) integrated theoretical framework. Note: The yellow boxes contain the related factors of the extended TPB; the green boxes contain the related factors of the NAM; the blue boxes contain the external environmental factors related to the ABC model; and the purple boxes contain the factors related to the individual attributes.

4. Research Methodology

4.1. Questionnaire Design

To quantify the 13 selected latent variables that affect college students' food-saving behavior, a questionnaire was designed, drawing on mature scales from existing studies in behavioral science fields. The questionnaire consisted of four parts: Part 1 sampled the college students' basic information, including their gender, education, monthly living expenses, average daily spending on meals, household registration, and the meal most often wasted in a day, as well as the specific causes of the food waste. Part 2 and Part 3 sampled the observations of individual psychological factors and external environmental factors, respectively. The individual psychological factors involved the nine latent variables: attitudes, subjective norms, perceived behavioral control, food-saving intention, herd mentality, health risk perception, personal norms, ascription of responsibility, and awareness of consequences. The external environmental factors included the three latent variables: the standard-quantity catering mode, the large-/small-portion-size catering mode, and the buffet catering mode. A seven-point Likert scale, with 1, 2, 3, 4, 5, 6, and 7 denoting "strongly oppose", "oppose", "comparatively oppose", "general", "comparatively agree", "agree", and "strongly agree", respectively, was used to measure the aforementioned variables. Part 4 sampled the observation of the college students' food-saving behavior, wherein pertinent measurement methods developed by scholars such as Visschers et al. [63] and Soorani and Ahmadvand [64] were used for reference. In this regard, the college students' food-saving behavior was observed through reverse transformation by gathering their self-reported food waste levels after they dined in the canteens during the previous week. The measurements were conducted using a seven-point Likert scale, with 1, 2, 3, 4, 5, 6, and 7 denoting "no waste", "0–10% waste", "10–20% waste", "20–30% waste", "30–50% waste", "50–70% waste", and "greater than 70% waste", respectively. The design of the observation question items for the latent variables and their sources are shown in Table 1.

Table 1. Design of observation question items for latent variables and their sources.

Latent Variable	Observed Variable	Definition	Reference Scale
Food-saving intention (FSI)	FSI1	I am willing to try my best to reduce food waste in the daily dining process.	Soorani and Ahmadvand [64] Liao et al. [27] Viccaro et al. [58]
	FSI2	I try to eat all the food I have bought.	
	FSI3	In the future, when I eat in the canteens, I will save food by ordering in moderation.	
	FSI4	In the future, I will take the "Clean Plate Campaign" when I eat in the canteens.	
Attitude (AT)	AT1	I think college students should save food.	Visschers et al. [63] Soorani and Ahmadvand [64]
	AT2	I think it makes sense for college students to save food	
	AT3	I think saving food for college students is worth popularizing.	
	AT4	I think it is immoral for college students to waste food.	
Subjective norms (SNs)	SN1	My parents and relatives approve of my food saving behavior.	Stefan et al. [45] Van der Werf et al. [65]
	SN2	My friends and classmates around me support my food saving behavior.	
	SN3	People who are important to me will support my food saving behavior.	
Perceived behavioral control (PBC)	PBC1	I think I can save food in the daily dining process.	Lorenz et al. [66] Van der Werf et al. [65]
	PBC2	It is entirely up to me to reduce food waste when eating in the canteens.	
	PBC3	I always can share the leftover food with others or pack it and eat it again.	
	PBC4	I am very confident that I will reduce food waste when eating in the canteens in the future.	
Herd mentality (HM)	HM1	When eating in the canteens, I will give priority to the delicious food recommended by everyone.	Ding [22]
	HM2	If my classmates don't pack leftovers, I won't pack them either.	
	HM3	When eating in the canteens, I try to be consistent with my classmates around me.	
Health risk perception (HRP)	HRP1	I am worried that eating leftovers will be bad for my health.	Schmidt [53] Visschers et al. [63]
	HRP2	I'm worried that the leftovers packed back are unsanitary.	
	HRP3	For the sake of health, the leftover food in college canteens should be thrown away.	
	HRP4	Food that is not fresh can jeopardize the health of college students.	

Table 1. *Cont.*

Latent Variable	Observed Variable	Definition	Reference Scale
Personal norms (PNs)	PN1	Participating in the "Clean Plate Campaign" is in line with my values.	Obuobi et al. [54] Loh et al. [65]
	PN2	I feel guilty when I produce food waste.	
	PN3	Regardless of what anyone else does, I think it is important to minimize food waste at meals.	
	PN4	I am obligated to take part in the "Clean Plate Campaign" through moral reasoning.	
Ascription of responsibility (AR)	AR1	I should be responsible for global warming caused by food waste.	
	AR2	I should be responsible for the natural resources consumed in grain production.	
	AR3	I am responsible for the environmental pollution caused by food waste.	
Awareness of consequences (AC)	AC1	Reducing food waste by college students can reduce environmental pollution.	
	AC2	Reducing food waste for college students can reduce resource consumption.	
	AC3	Reducing food waste by college students can reduce the food crisis.	
Standard-quantity catering mode (SQ)	SQ1	When I eat at the standard-quantity buttery hatch, the portion size of food is determined by the canteens staff, which is not conducive to saving food for me.	Self-developed
	SQ2	It is limited for me to choose the choice of food when I eat at the standard-quantity buttery hatch, which is not conducive to saving food for me.	
	SQ3	When I eat in the canteens, it is not conducive to save food when I am limited in my choice of food category and the degree of control over food portion size.	
Large-/small-portion-size catering mode (LS)	LS1	Adding the large/small-portion size buttery hatch in college canteens will help me to save food.	Self-developed
	LS2	When eating at the large/small-portion size buttery hatch, I can choose the portion size of food, which is conducive to saving food.	
	LS3	Being able to control the portion size of food to a certain extent helps me to save food.	
Buffet catering mode (BF)	BF1	Adding the buffet buttery hatch in college canteens will help me to save food.	Self-developed
	BF2	When I eat at the buffet buttery hatch, I can pick my favorite food category and control the portion size of food, which is good for me to save food.	
	BF3	When I eat in a canteens, the more freedom I have to choose food categories and decide on portion sizes, the better it is for me to save food.	
Food-saving behavior (FSB)	FSB1	How much of the food you ordered was wasted when you ate in the canteens in the last week?	Stefan et al. [45] Lorenz et al. [66]
	FSB2	How many staple foods have you wasted in the canteens in the last week?	
	FSB3	How many vegetables have you wasted in dining in the canteens in the last week?	
	FSB4	How much meat did you waste when eating in the canteens in the last week?	
	FSB5	How many soups have you wasted in the dining hall in the last week?	

4.2. Ethical Statement

The content of this study strictly adhered to the Declaration of Helsinki, and because this study did not involve animal or human clinical trials, we applied for an ethical review waiver statement from the Institutional Review Board of the School of Management of Xi'an University of Architecture and Technology prior to the start of the research activities. During the implementation of the research activities, each participant was informed in advance of the following five points: (1) the specific purpose of the research and the type of questions; (2) that all their responses would be anonymous and confidential; (3) that the results of the survey are for academic research use only and will not affect them negatively in any way; (4) that they would each receive a pack of garbage bags as a prize upon completion of the research; (5) that the decision as to whether or not to participate in this research activity would be voluntary; the research questionnaire was distributed to participants for completion after obtaining their signed informed consent. The researcher did not identify individual participants during or after data collection because all the participants were anonymous for this research activity. The researcher inquired about the age of the participants before the questionnaires were distributed to ensure that each participant was 18 years of age or older and that no minors participated in this study.

4.3. Questionnaire Distribution and Collection

4.3.1. Questionnaire Distribution

In China, college canteen catering modes can be categorized into three types based on the ways in which students select their food categories and food portion sizes, namely, standard-quantity catering (fixed portion sizes), large-/small-portion-size catering (portion sizes are optional), and self-service catering (arbitrary choices of food categories and portion sizes). In this regard, Xi'an University of Architecture and Technology is not an exception. In this study, we used only Xi'an University of Architecture and Technology as an example to reveal the influence mechanisms of the college canteen catering modes on college students' food-saving behavior, but the results are applicable to all colleges in China. In order to ensure the readability and comprehensibility of the questionnaire design, the researchers first randomly selected 35 students in the target institutions to carry out the pre-survey and, in the process of the pre-survey, recorded the questions that the participants did not understand or found ambiguous. Their findings were then combined with the views of the relevant experts. The questionnaire was repeatedly adjusted to form the final version. The formal research activity was conducted from 1 March to 1 April 2023. In order to ensure that the questionnaire distribution is representative, and the random-sampling method was adopted to collect data by conducting offline questionnaire research at Xi'an University of Architecture and Technology. The questionnaires were distributed in the apartment buildings of male and female students of Xi'an University of Architecture and Technology. The number of questionnaires distributed was 35 times the number of latent variables, that is, 450, of which 225 were for male and 225 for female students. Our method of questionnaire distribution simultaneously satisfies all the characteristics of the simple random sampling method: limitation, personality-by-personality, non-returnability, and equal likelihood. Thus, it also ensured that the questionnaire distribution in this study was representative to an objective degree.

4.3.2. Questionnaire Collection

In order to increase the effective recovery rate of the questionnaire and enhance the representativeness of the research data, we took the following four measures in the process of the questionnaire distribution: (1) to avoid a loss of data due to the mistakes of researchers, the researchers were trained before the start of the research to ensure that they were clear about the purpose of the research and the related precautions; (2) to reduce the loss of questionnaire numbers due to missing questions, once the participants completed the questionnaire, the investigator checked the levels of completion and directed them to fill in any omissions; (3) to fully motivate the participants to fill out the questionnaire seriously, before the questionnaire research, the participants were informed that they would receive the corresponding gift for filling out the questionnaire; (4) to avoid the distortion of the questionnaire data due to the participants' lack of understanding of the questions, they could ask questions about topics they did not understand at any time during the questionnaire completion process, and the researcher described the meaning of the text of the questions rather than inducing responses. In this study, 450 questionnaires were distributed to students, and, after excluding 28 invalid questionnaires, 422 valid questionnaires were obtained. The validity rate of the questionnaires was 93.8%. Referring to Jackson et al. [67], for the sample size requirement when obtaining research data based on questionnaires, the sample size needs to be greater than or equal to more than 10 times the number of latent variables in the study. There were 13 latent variables in this study; therefore, the sample size met the requirement and could be analyzed in the next step. The meals most often wasted in a day by the canteen-dining college students were lunch (60.70%) and dinner (36.70%), and the reasons for the food waste were mainly unreasonable catering modes (61.37%) and the unsatisfactory taste of the food (56.40%). Again, this result demonstrates the necessity of exploring the mechanisms underlying the effects of college canteen catering modes on college students' food-saving behavior. The results of the descriptive statistical analysis of the specific sample are shown in Table 2.

Table 2. Descriptive statistical analysis of individual-attribute variables.

Variable	Categories	Frequency	Percent (%)	Variable	Categories	Frequency	Percent (%)
Gender	Male	224	53.1%	Average daily spending on meals	≤CNY 20	93	22%
	Female	198	46.9%		CNY 21–30	189	44.8%
Education	Undergraduate	220	52.1%		≥CNY 31	140	33.2%
	Postgraduate	159	37.7%	The meal most often wasted in a day	Breakfast	12	2.80%
	Doctoral student	43	10.2		Lunch	256	60.70%
Household registration	Rural areas	223	52.8%		Dinner	155	36.7%
	Urban areas	199	47.2%	Reasons for food waste	Unreasonable catering modes	259	61.37%
Monthly living expenses	≤CNY 1000	75	17.8%		Unsatisfactory taste of food	238	56.40%
	CNY 1001–1500	110	26.1%		Weight loss goal	44	10.43%
	CNY 1501–2000	135	32%		Dining time is short	42	9.95%
	≥CNY 2001	102	24.2%		Poor sanitation and others	32	7.58%

4.4. Data Analysis Methods

A data analysis was performed mainly using SPSS 24.0 and AMOS 24.0. SPSS 24.0 has the following objectives: (1) to conduct a descriptive statistical analysis on the respondents' individual-attribute information; (2) to determine whether the respondents' food-saving behavior differed in terms of the individual-attribute factors by performing independent-sample *t*-tests and one-way ANOVA; (3) to ensure the reasonable design and representativeness of the questionnaire and the acquisition of reliable data through reliability testing, validity testing, and confirmatory factor analysis; and (4) to test the validity of the hypothesis on the moderating effects of external environmental factors through hierarchical regression analysis. AMOS 24.0 was adopted for the following tasks: (1) the construction of a structural equation model; (2) the testing of the model fitness index; (3) path analysis of the latent variables of each psychological factor; and (4) a bootstrap mediating-effect test, which was mainly conducted to test the presence of a mediating effect in the hypothetical model. The research conclusions were drawn by comprehensively utilizing the aforementioned methods.

5. Results and Analysis

5.1. Difference Test of Individual-Attribute Factors

In this study, difference tests were conducted on the binary variables of gender and household registration in the individual attributes of the college students using independent-sample *t*-tests. Difference tests were also conducted on the multi-level variables in the individual attributes, such as education, monthly living expenses, and average daily spending on meals, using one-way ANOVA. The test results are shown in Table 3.

The data in Table 3 show that the self-reported food-saving behavior of female students was lower than that of male students, and that students with rural household registration were more inclined to save food than those with urban household registration. There was no significant difference in the self-reported food-saving behavior among the college students in terms of education. The self-reported food-saving behavior of the college students decreased with increasing individual monthly living expenses and average daily spending on meals. Thus, H19 is partially valid.

Table 3. Independent-sample *t*-test results and one-way ANOVA results for individual-attribute variables.

Individual Attribute	Categories	Frequency	Mean Self-Reported Food-Saving Behavior	Standard Deviation	F	p
Gender	Male	224	6.161	0.974	4.512	0.000
	Female	198	5.747	0.897		

Table 3. *Cont.*

Individual Attribute	Categories	Frequency	Mean Self-Reported Food-Saving Behavior	Standard Deviation	*F*	*p*
Household registration	Rural areas	223	6.068	0.849	2.306	0.022
	Urban areas	199	5.853	1.062		
Education	Undergraduate	220	5.978	0.869	0.308	0.735
	Postgraduate	159	5.928	1.004		
	Doctoral student	43	6.051	1.224		
Monthly living expenses	≤CNY 1000	75	6.144	1.022	4.711	0.003
	CNY 1001–1500	110	6.056	1.030		
	CNY 1501–2000	135	6.021	0.783		
	≥CNY 2000	102	5.669	0.047		
Average daily spending on meals	≤CNY 20	93	6.159	1.019	4.397	0.013
	CNY 21–30	189	6.002	0.842		
	≥CNY 31	140	5.791	0.088		

5.2. Reliability and Validity Tests

The overall reliability of the sample data was tested using SPSS 24.0, and the Cronbach's α coefficient (0.906) was greater than 0.8. According to Table 4, the Cronbach's α of each latent variable was greater than 0.8, which testified to the high reliability of the sample data.

Table 4. Results of descriptive statistics and reliability and validity tests for each latent variable.

Latent Variable	Observed Variable	Mean	Standard Deviation	Standardized Factor Loading	Cronbach's α	C.R.	AVE
Food-saving behavior (FSB)	FSB1	5.967	1.147	0.785	0.898	0.893	0.626
	FSB2			0.832			
	FSB3			0.872			
	FSB4			0.775			
	FSB5			0.680			
Food-saving intention (FSI)	FSI1	6.361	1.109	0.809	0.912	0.909	0.717
	FSI2			0.791			
	FSI3			0.864			
	FSI4			0.917			
Attitude (AT)	AT1	6.247	1.433	0.965	0.917	0.921	0.745
	AT2			0.896			
	AT3			0.793			
	AT4			0.786			
Subjective norms (SNs)	SN1	6.332	1.098	0.936	0.961	0.961	0.892
	SN2			0.926			
	SN3			0.971			
Perceived behavioral control (PBC)	PBC1	5.000	1.412	0.896	0.880	0.885	0.660
	PBC2			0.768			
	PBC3			0.690			
	PBC4			0.878			
Herd mentality (HM)	HM1	4.543	1.816	0.819	0.862	0.863	0.678
	HM2			0.856			
	HM3			0.795			
Health risk perception (HRP)	HRP1	4.845	1.445	0.771	0.872	0.872	0.631
	HRP2			0.739			
	HRP3			0.800			
	HRP4			0.862			

Table 4. *Cont.*

Latent Variable	Observed Variable	Mean	Standard Deviation	Standardized Factor Loading	Cronbach's α	C.R.	AVE
Personal norms (PNs)	PN1 PN2 PN3 PN4	6.068	1.260	0.817 0.811 0.807 0.902	0.901	0.902	0.697
Ascription of responsibility (AR)	AR1 AR2 AR3	5.167	1.512	0.920 0.872 0.750	0.882	0.886	0.723
Awareness of consequences (AC)	AC1 AC2 AC3	5.620	1.536	0.845 0.918 0.885	0.915	0.914	0.780
Standard-quantity catering mode (SQ)	SQ1 SQ2 SQ3	2.611	1.544	0.901 0.904 0.804	0.880	0.904	0.758
Large-/small-portion-size catering mode (LS)	LS1 LS2 LS3	5.573	1.313	0.885 0.894 0.835	0.894	0.905	0.760
Buffet catering mode (BF)	BF1 BF2 BF3	6.108	1.121	0.802 0.837 0.838	0.837	0.865	0.682

A cConfirmatory factor analysis was performed using AMOS 24.0. Table 4 displays the test results. As shown in Table 4, the standardized-factor-loading value of each observed variable exceeded the recommended cutoff of 0.5. The CR value of each latent variable was greater than the recommended cutoff of 0.7. The average-variance-extracted (AVE) value of each latent variable was also greater than the recommended threshold of 0.5. Therefore, all the latent variables involved in this study had good convergent validity. Table 5 shows that the correlation coefficients between the latent variables (the values below the diagonal cells) were all smaller than the specified upper limits (i.e., the square roots of the corresponding AVE values, formatted in bold in the diagonal columns). In this study, the values formatted in bold in the diagonal cells were significantly greater than all the values below the columns in which they were located. Therefore, the discriminant validity was good for all the latent variables involved in this study. By combining Tables 4 and 5, it can be concluded that the questionnaire designed for this study has high validity and reliability.

Table 5. Latent variable correlation coefficients and square roots of average variances extracted.

Latent Variable	FSB	FSI	AT	SN	PBC	HM	HRP	PN	AR	AC	SQ	LS	BF
FSB	**0.791**												
FSI	0.465	**0.847**											
AT	0.370	0.682	**0.863**										
SN	0.320	0.729	0.594	**0.944**									
PBC	0.379	0.587	0.568	0.518	**0.812**								
HM	−0.184	−0.179	−0.176	−0.132	−0.152	**0.824**							
HRP	−0.068	−0.042	−0.066	0.065	0.043	0.158	**0.794**						
PN	0.391	0.737	0.555	0.665	0.560	−0.151	0.024	**0.835**					
AR	0.161	0.414	0.287	0.423	0.370	−0.042	0.090	0.523	**0.850**				
AC	0.152	0.421	0.337	0.423	0.427	−0.094	0.103	0.608	0.547	**0.883**			
SQ	−0.093	−0.011	0.049	−0.068	−0.003	0.049	−0.023	−0.046	−0.084	−0.071	**0.871**		
LS	0.198	0.189	0.202	0.204	0.164	0.037	−0.163	0.263	0.146	0.208	−0.352	**0.872**	
BF	0.299	0.186	0.118	0.227	0.146	−0.085	−0.056	0.236	0.156	0.191	−0.409	0.478	**0.826**

Note: The values formatted in bold represent the square roots of the AVE values.

5.3. Tests of Fitness and Validity of Structural Equation Modeling

5.3.1. Tests of Fitness and Validity of Structural Equation Modeling

The model's fitness reflects the degree of consistency between the hypothetical theoretical model and the actual situation; that is, it reflects the correctness of the proposed hypothetical structural equation model. The fitting results of the fitness index of the extended TPB-NAM model are shown in Table 6. The RMSEA value of the model was 0.040, which is lower than the recommended threshold of 0.08. The X^2/df value was 1.689, which is lower than the recommended threshold of 3. The GFI value was 0.888, the NFI value was 0.923, the IFI value was 0.967, the TLI value was 0.963, the CFI value was 0.967, and the AGFI value was 0.869. All these values were greater than the recommended threshold of 0.8; the closer the fitting value to 1, the better the fitness of the model. To sum up the above analysis, the fitting values of the various indices of the structural equation model (i.e., the extended TPB-NAM model) established in this study all met the relevant requirements, indicating the satisfactory fitting results of the model.

Table 6. College student food-saving behavior SEM fitting index..

Index	X^2/df	p	RMSEA	NFI	CFI	GFI	TLI	IFI	AGFI
Recommended threshold	<3	<0.5	<0.08	>0.8	>0.8	>0.8	>0.8	>0.8	>0.8
Fitness index value	1.689	0.000	0.040	0.923	0.967	0.888	0.963	0.967	0.869

5.3.2. Comparison of the Extended TPB-NAM Model with Existing Related Research Models

By building an extended TPB-NAM model based on prior studies, we examined the psychological driving mechanisms underlying college students' food-saving behaviors. The extended TPB-NAM model was compared with other related models to test its validity. Specifically, the comparison focused on the model explanation rate (the squared multiple correlation) of each model for the two latent variables of food-saving intention and food-saving behavior. The comparison results are displayed in Table 7. As shown in Table 7, the explanation rates of the extended TPB-NAM model on food-saving intention and food-saving behavior were 79.8% and 28.8%, respectively, which are both higher than those of the existing models. This shows that the extended TPB-NAM model was superior to the models in the existing studies, which confirmed its validity.

Table 7. Explanation rates of food-saving intention and food-saving behavior in different models.

Model	TPB	NAM	Extended TPB	TPB-NAM	Extended TPB-NAM
FSI (SMC)	0.739	0.647	0.750	0.789	0.798
FSI (SMC)	0.269	0.263	0.280	0.269	0.288

5.4. Results of Effect Paths of Psychological Factors

Table 8 presents the empirical test results of the effect paths between the latent variables for psychological factors in the extended TPB-NAM-ABC model. As shown in Table 8, in the extended TPB model, the effects of both attitudes and subjective norms on the food-saving intention were significant at the statistical level of 0.1%. The effect of perceived behavioral control on the food-saving intention was significant at the statistical level of 5%, and that of the health risk perception was also significant at the statistical level of 1%. These results indicate that the students' food-saving intentions were significantly affected by their intuitive evaluation of food-saving behavior, their perception of the social pressure related to saving food, their perception of the ease or difficulty associated with performing food-saving behavior, and their perception of the health threats emanating from stale food and edible leftovers. Thus, H1, H2, H3, and H7 are all valid. The effects of food-saving intention and herd mentality on food-saving behavior are significant at the statistical levels of 0.1% and 5%, respectively. This result shows that the students' food-saving behavior

was directly affected by their individual behavioral intentions toward food saving and by the food waste behavior of the classmates around them. Thus, H4 and H6 are valid. The effect of herd mentality on the food-saving intention was non-significant, but it exerted a significant negative impact on the food-saving behavior. This clarifies that even students with strong food-saving intentions might waste food under the influence of classmates, friends, and the luxurious and wasteful environment around them [22]. Thus, H5 is invalid.

Table 8. Results of effect paths of psychological factors in SEM.

Hypothesis		Path		Standardized Coefficient	S.E.	C.R.	*p*	Result
H1	AT	→	FSI	0.303	0.039	6.714	***	Valid
H2	SN	→	FSI	0.273	0.047	5.888	***	Valid
H3	PBC	→	FSI	0.094	0.04	2.168	0.03	Valid
H4	FSI	→	FSB	0.489	0.042	9.521	***	Valid
H5	HM	→	FSI	−0.007	0.022	−0.239	0.811	Invalid
H6	HM	→	FSB	−0.129	0.03	−2.519	0.012	Valid
H7	HRP	→	FSI	−0.089	0.024	−2.95	0.003	Valid
H8	PN	→	FSI	0.374	0.054	7.87	***	Valid
H9	AR	→	PN	0.135	0.038	2.862	0.004	Valid
H10	AC	→	PN	0.371	0.033	7.457	***	Valid
H11	AC	→	AR	0.608	0.044	11.347	***	Valid
H13	SN	→	PN	0.493	0.038	11.392	***	Valid

Note: *** $p < 0.001$.

In the NAM, the effect of personal norms on the food-saving intention, the effect of the awareness of consequences on personal norms, and the effect of the awareness of consequences on the ascription of responsibility were all significant at the statistical level of 0.1%. The effect of the ascription of responsibility on personal norms was significant at the statistical level of 1%. Thus, H8, H9, H10, and H11 are all valid. The above results validated the chain mediation between awareness of consequences, ascription of responsibility, and personal norms on the one hand and individual behavioral intention on the other [57]. That is, college students with a higher awareness of consequences are more likely to perceive the negative impacts of massive food waste (such as resource consumption and environmental pollution) at a psychological level [68]. This enables them to realize that saving food helps reduce the consumption of resources and energy and eases environmental crises. They internalize food saving as a sense of responsibility, thereby activating personal norms to enhance their food-saving intentions.

In addition, in the extended TPB-NAM model, the effects of subjective norms on personal norms also passed the significance test at the statistical level of 0.1%. This result suggests that individuals under higher pressure from parents, society, and schools in terms of food-saving behavior could better strengthen their sense of moral obligation toward saving food [69], thereby enhancing their food-saving intentions. Thus, H12 is valid.

The extended TPB-NAM-ABC model developed in this study includes a partial mediation model in its framework. The presence of the above mediating effects was tested using the bootstrap method. According to this method, the first step is to judge whether the total effect is significant (when the 95% bootstrap CI does not include 0, it is significant; otherwise, it is non-significant). When the total effect is significant, the next step is to determine whether the direct effect is also significant. When the direct effect is significant, there is a partial mediating effect; when the direct effect is non-significant, there is a full mediating effect. Otherwise, no mediating effect exists. According to the results of the mediating-effect tests presented in Table 9, ascription of responsibility (AR) played a partial mediating role in the "AC → PN" path, accounting for 18.10% of the total effect. Personal norms (PN) played a partial mediating role in the "SN → FSI" path, accounting for 40.26% of the total effect.

Table 9. Results of the mediating-effect test for ascription of responsibility (AR) and personal norms (PN).

Intermediary Path	Index	Effect Value	Boot SE	Bias-Corrected 95% CI		Proportion in Total Effect (%)
				Lower	Upper	
AC→AR→PN	Total effect	0.453	0.063	0.336	0.581	
	Direct effect	0.371	0.067	0.244	0.508	81.90%
	Indirect effect	0.082	0.030	0.025	0.145	18.10%
SN→PN→FSI	Total effect	0.457	0.067	0.324	0.584	
	Direct effect	0.273	0.076	0.131	0.425	59.74%
	Indirect effect	0.184	0.054	0.097	0.308	40.26%

5.5. Moderating Effects of Three Catering Modes

In this study, a hierarchical regression analysis was performed to validate the moderating effects of the three catering modes in the extended TPB-NAM-ABC model. The specific test steps were as follows: Step 1: The construction of Model 1. In this step, a regression analysis was performed on both the independent variable and the dependent variable. This step constitutes the establishment of the moderating effects, wherein the key lies in ensuring that the regression coefficient of the independent variable on the dependent variable is significant. Step 2: The construction of Model 2. A regression analysis of the dependent variable was performed based on Model 1 by adding a moderator variable. This step helps to ascertain whether the moderator variable is an influence factor on the dependent variable. Step 3: The construction of Model 3. Based on Model 2, the interaction term between the independent variable and the moderator variable is added to perform regression analysis on the dependent variable. When the regression results are significant, the moderator variable plays a moderating role in the effect path of the independent variable on the dependent variable. The test results are shown in Tables 10 and 11.

According to Table 10, the results of Model 1 indicate that food-saving intention had a significant positive promoting effect on food-saving behavior. The results of Model 2 show that the standard-quantity catering mode had a significant negative inhibitory effect on food-saving behavior. That is, most students believed that the standard-quantity catering mode, which awards them with a low level of autonomy over the category and portion size of their food, hinders their performance of food-saving behavior. The results of Model 3 clarified that the standard-quantity catering mode played a negative moderating role in the "FSI → FSB" path ($\beta = -0.122$; $p < 0.001$). That is, the more that canteen buttery hatches use the standard-quantity catering mode, the more difficult it is for students to transform their food-saving intentions into food-saving behavior. Thus, H13 is valid.

Table 10. Moderating-effect tests for three catering modes in the "FSI → FSB" path.

Variable	Model 1	Model 2	Model 3	Model 2′	Model 3′	Model 2″	Model 3″
FSI	0.454 ***	0.453 ***	0.449 ***	0.433 ***	0.469 ***	0.414 ***	0.445 ***
SQ		−0.061 *	−0.036				
LS				0.092 **	0.078 *		
BF						0.217 ***	0.212 ***
FSI * SQ			−0.122 ***				
FSI * LS					0.089 *		
FSI * BF							0.105 ***
R²	0.217	0.224	0.251	0.229	0.237	0.263	0.275
Adjusted R²	0.215	0.221	0.245	0.225	0.231	0.260	0.270
F value	116.172 ***	60.598 ***	46.608 ***	62.282 ***	43.246 ***	74.833 ***	52.876 ***

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

The results of Models 2′ and 2″ in Table 10 indicate that both the large-/small-portion-size catering mode and the buffet catering mode had significant promoting effects on the students' food-saving behavior. That is, most students believed that a certain level of autonomy over the category and portion size of their food facilitates their food-saving behavior performance. The results of Models 3′ and 3″ show that the large-/small-portion-size catering mode and the buffet catering mode both had positive moderating effects in the "FSI → FSB" path ($\beta = 0.089$, $p = 0.041 < 0.05$; and $\beta = 0.105$, $p < 0.001$). That is, increasing large-/small-portion-size and buffet buttery hatches in the canteens would make it easier for students to transform their food-saving intentions into actual food-saving behavior. Thus, H14 and H15 are valid.

Table 11. Moderating-effect tests on three catering modes in the "HM → FSB" path.

Variable	Model 1	Model 2	Model 3	Model 2′	Model 3′	Model 2″	Model 3″
HM	−0.113 ***	−0.111 ***	−0.116 ***	−0.118 ***	−0.122 ***	−0.098 ***	−0.108 ***
SQ		−0.058	−0.060				
LS				0.165 ***	0.173 ***		
BF						0.281 ***	0.282 ***
HM * SQ			−0.039 *				
HM * LS					0.057 *		
HM * BF							0.068 *
R^2	0.034	0.041	0.050	0.076	0.089	0.115	0.128
Adjusted R^2	0.032	0.036	0.044	0.071	0.082	0.110	0.122
F value	14.745 ***	8.945 ***	7.383 ***	17.177 ***	13.554 ***	27.105 ***	20.422 ***

Note: * $p < 0.05$; *** $p < 0.001$.

To better understand the moderating effects of the three existing canteen catering modes in the "FSI → FSB" path, the simple-slope analysis proposed by Robinson et al. [70] was used. The different types of catering modes were divided into two levels (high and low) according to their proportions in the total number of buttery hatches in college canteens, and the food-saving intention psychological factors were also divided into high and low levels. Detailed graphs were drawn, as shown in Figure 2. Figure 2a shows that the higher the proportion of standard-quantity buttery hatches in the total number of buttery hatches in college canteens, the more difficult it is for college students to transform their food-saving intentions into actual food-saving behavior. Figure 2b,c show that the higher the proportions of large-/small-portion-size and buffet buttery hatches, the easier it is for college students to transform their food-saving intentions into actual food-saving behavior.


(a) (b) (c)
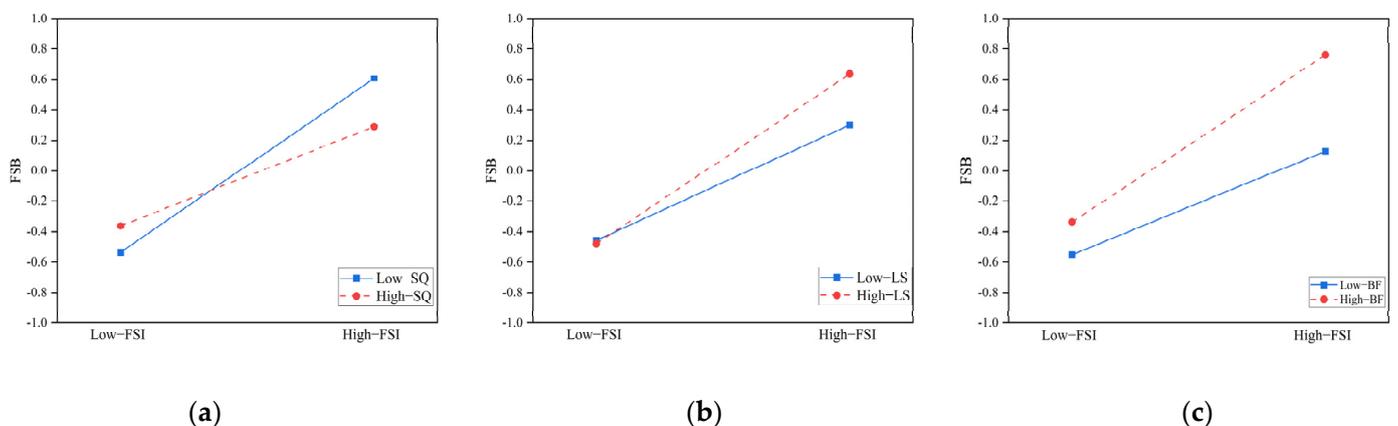
Figure 2. (**a**) Moderating effect of SQ on "FSI → FSB" path; (**b**) moderating effect of LS on "FSI → FSB" path; (**c**) moderating effect of BF on "FSI → FSB" path.

The results of Model 1 in Table 11 indicate that herd mentality had a significant negative impact on food-saving behavior. The results of Model 3 show that the standard-quantity catering mode had a significant promoting moderating effect in the path of the negative impact of herd mentality on food-saving behavior ($\beta = -0.039$, $p = 0.043 < 0.05$). That is, the more canteens offering standard-quantity buttery hatches, the higher the degree of food waste because of the influence of herd mentality. Thus, H16 is valid. The results of Models 3' and 3" in Table 11 clarify that both the large-/small-portion-size catering mode and the buffet catering mode had significant inhibitory moderating effects in the path of the negative impact of herd mentality on food-saving behavior ($\beta = 0.057$, $p = 0.016 < 0.05$; $\beta = 0.068$, $p = 0.012 < 0.05$). That is, the higher the proportions of large-/small-portion-size and buffet buttery hatches, the weaker the negative impact of the students' herd mentality on their food-saving behavior. Thus, H17 and H18 are valid. To better understand the moderating effects of the three existing canteen catering modes in the "HM → FSB" path, we drew more detailed graphs in this study, which are presented in Figure 3.

(a)   (b)   (c)
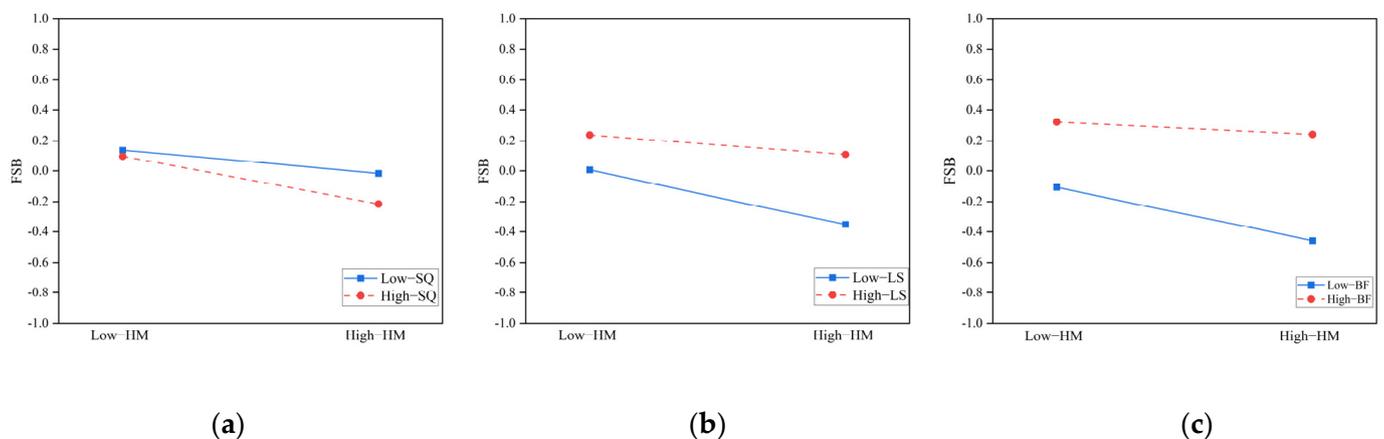
Figure 3. (**a**) Moderating effect of SQ on "HM → FSB" path; (**b**) moderating effect of LS on "HM → FSB" path; (**c**) moderating effect of BF on "HM → FSB" path.

According to Figure 3a, the higher the proportion of standard-quantity buttery hatches in the total number of buttery hatches in college canteens, the more susceptible college students are to imitating the food waste behavior of the other classmates around them, and the more serious their food waste behavior. By contrast, according to Figure 3b,c, the higher the proportions of large-/small-portion-size and buffet buttery hatches, the easier it is for college students to overcome the herd mentality and enhance their own food-saving behavior.

To compare the moderating effects of the large-/small-portion-size catering mode and the buffet catering mode, first, the frequencies of the latent variable sample scores of the three catering modes were counted, as shown in Figure 4a. Students generally gave high scores for the large-/small-portion-size catering mode and buffet catering mode. In other words, they generally believed that the buffet catering mode and large-/small-portion-size catering mode facilitate their food-saving behavior. Secondly, the matched-sample *t*-test was conducted on the averages of the latent variable samples of the three catering modes, as shown in Figure 4b. The results showed that the mean score of the buffet catering mode was significantly higher than that of the large-/small-portion-size catering mode. Therefore, the buffet catering mode had a more significant moderating effect than the large-/small-portion-size catering mode in both the "FSI → FSB" path and the "HM → FSB" path.

(**a**) (**b**)
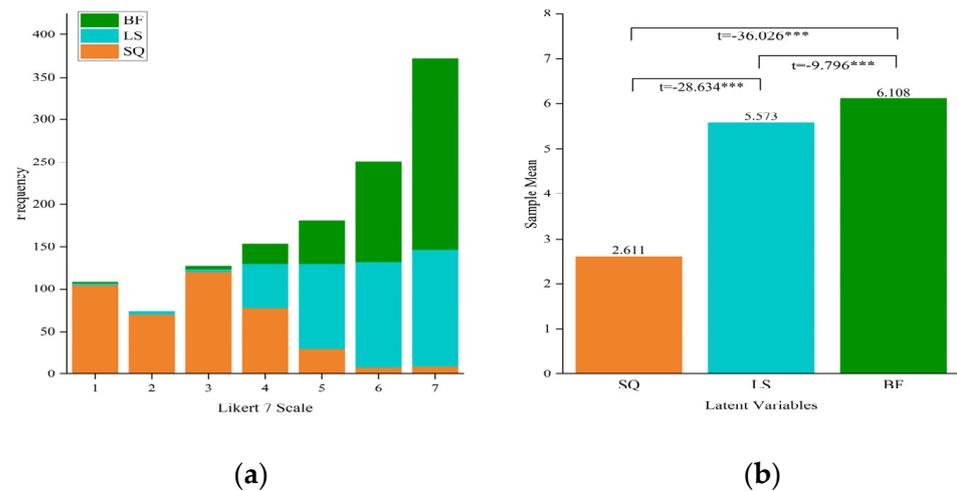
Figure 4. (**a**) Frequency statistics of latent variable scores of three catering modes; (**b**) latent variable-mean paired-sample *t*-test for three catering modes. Note: For (**a**), a latent variable score > N but ≤N + 1 (N = 1, 2, . . ., 6) is counted as N + 1. To be specific, the score of a latent variable is calculated via the average score of the observed variables. For (**b**), *** $p < 0.001$.

6. Discussion

6.1. Differences in College Students' Food-Saving Behavior in Terms of Individual-Attribute Factors

The difference test results showed that while there was no significant difference in the college students' food-saving behavior in terms of their education levels, significant differences were found in terms of gender, household registration, monthly living expenses, and average daily spending on meals. The food-saving behavior of male students was more pronounced than that of female students, which is consistent with the findings of Painter et al. [71]. This is because the standard-quantity catering mode is the dominant catering mode in college canteens, which means that both male and female students are often given roughly the same portion sizes of food. In this case, female students are more likely to waste food than male students because male students generally have larger appetites [72]. Students with rural household registration have more pronounced food-saving behavior than those with urban household registration, which is consistent with the findings of Guo et al. [60]. The reason for this result is that students with rural household registration have farming experience and have witnessed the hard work that farmers put into grain production, which is why they are more inclined to save food while dining in the canteens. College students' food-saving behavior declines as their economic statuses (comprising monthly living expenses and average daily spending on meals) increase, which is consistent with the findings of Xu et al. [7] on household food waste behavior and those of Hafiz et al. [73] on reducing food waste behavior among college students (i.e., when consumers have a higher monthly income or college students have sufficient monthly living expenses, they tend to spend more on food purchases, which, in turn, leads to a lot of food waste). The finding that there was no significant difference in the college students' food-saving behavior in terms of education is inconsistent with the findings of Wu et al. [62]. A possible explanation is that there is no significant age difference among college students, and that the students in this age bracket have not witnessed periods of extreme food scarcity [74]. As a result, the differential effect of education on the college students' food-saving behavior was non-significant. In summary, college administrators should develop targeted guidance strategies for various student groups to reduce food waste in the canteens.

6.2. Psychological Driving Mechanisms Underlying College Students' Food-Saving Behavior

According to the results of a comparison of different structural equation models in terms of the explanation rates for food-saving intention and food-saving behavior, the

extended TPB-NAM model has better explanatory power for the psychological driving mechanisms underlying college students' food-saving behavior. The following can be distilled from the SEM results:

First, of the two direct drivers of food-saving behavior, food-saving intention had a more significant effect on food-saving behavior among the college students (β = 0.489) than herd mentality (β = −0.129). This result is similar to the findings of existing studies in that it is feasible to predict an individual's food-saving behavior based on their food-saving intention. For example, a study on household food waste noted that food-saving intention is an antecedent of food-saving behavior [65]. This study also proved that in addition to food-saving intention, the herd mentality also has a direct impact on the food-saving behavior of college students, and the results of this study are consistent with the findings of Hafiz et al. [73]; that is, in the interview process, college students said that they desire to be recognized by society, and that they desire to be included in the surrounding group rather than excluded, and, under this pressure, they behave in the same way as the surrounding group; however, existing studies in colleges and universities only found a direct relationship between food-saving intention and behavior [19,21,64]. To summarize the aforementioned analysis, in situations in which it is difficult to directly observe college students' food-saving behavior, their food-saving intentions can be observed as a substitute.

Second, of the five latent variables that are directly associated with the food-saving intention of college students, personal norms (β = 0.374) had the most significant effect, followed in descending order by attitudes (β = 0.303), subjective norms (β = 0.273), perceived behavioral control (β = 0.094), and perceived health risks (β = −0.089). The above findings do not contradict the results of the existing studies on pro-environmental behaviors, such as college students' food-saving behavior. Wang et al. [21], in a study devoted to college students reduction food waste behaviors, also noted that attitudes, subjective norms, and perceived behavioral control can significantly influence college students' food-saving intentions. Elliott et al. [75] also pointed out that the more positive attitudes that students have toward food-saving behavior, the greater their willingness to reduce food waste; in contrast, negative attitudes are a deterrent to food-saving intentions. The finding that subjective norms are related to college students' food-saving intentions is consistent with the findings of Wu et al. [62]. Thus, if students perceive higher food-saving expectations from people who are important to them, they will be more inclined to save food. Perceived behavioral control refers to students' perceptions of the level of difficulty or ease with which they implement food-saving behaviors in a particular setting, based on the food skills, resources, and knowledge they possess, which, in turn, influences their food-saving intentions. This finding is in agreement with the findings of Truman et al. [76]. That is, if students have fewer relevant food skills, resources, and knowledge, they will judge that the implementation of reduced food waste behaviors in that particular context will be hindered, and thus the food-saving behavior will be lower. Health risk perception negatively influences college students' food-saving intentions. This finding is consistent with the findings of Williams et al. [77] on the influencing factors of food waste in households. Therefore, the higher the health threat of stale food and leftover re-edible meals, the more likely students are to produce food waste. In addition, a study on energy-saving behavior in college student dormitories found that personal norms had the most substantial impact on the students' energy-saving intentions [78]. This conclusion demonstrates that the pro-environmental intentions of highly educated people can be more easily stimulated by elevating their moral levels rather than making them rationally cognizant of such behavior, thereby encouraging their pro-environmental behavior.

Third, the chain mediation model connecting the intention to behave, personal norms, ascription of responsibility, and awareness of consequences was verified. This finding is consistent with the findings of the existing studies. For example, a study that analyzed household food waste behavior from a moral perspective noted that a household's awareness of the consequences of food waste behavior has a positive effect on its ascription of responsibility, that they both positively affect personal norms, and that personal norms can

positively affect the food-saving intentions of the household [54]. This study also validates the research conclusions of Viccaro et al. [68] and Wu et al. [69], namely, that personal norms mediate the relationship between subjective norms and the intention to behave. The above findings suggest that two measures can be taken by college administrators to enhance students' ethical norms regarding pro-environmental behaviors: (1) the implementation of pertinent ethical education activities; and (2) cooperation with students' families to compel the pro-environment behavior of college students from both inside and outside the campus.

6.3. Moderating Effects of Catering Modes on College Students' Food-Saving Behavior

According to the statistics of the sample data, the latent variables for the food-saving intention had a mean value of 6.361, suggesting that college students are highly willing to save food. However, only 30.33% of the 422 questionnaire samples lived up to the criteria of the "empty plate" campaign in the week preceding the survey, suggesting that there is still a substantial gap between college students' food-saving intentions and their actual behavior. These findings also indicate that students regard unreasonable catering modes in college canteens as the primary cause of food waste, which means that finding a reasonable catering mode may help to narrow this gap.

The results of the moderating-effect test in this study showed that the standard-quantity catering mode had a significant inhibitory moderating effect in the pathway of food-saving intention and food-saving behavior, but it had a significant promoting moderating effect in the pathway of the negative influence of herd mentality on food-saving behavior. This result suggests that the standard-quantity catering mode is not conducive to students' implementation of food-saving behavior, which is consistent with the findings of Fan et al. [38] and Hafiz et al. [73]. That is, if students eat a fixed amount of food every day, it will cause them to produce more food waste. One possible explanation for this result is that the standard-quantity catering mode offers a comparatively fixed portion size to college students while ignoring their varying and unstable appetite levels. As a result, the implementation of food-saving behavior is hindered [38].

The moderating effect test results also showed that both the large-/small-portion-size catering mode and the buffet catering mode had significant promoting moderating effects in the path of food-saving intention and food-saving behavior, while they had a significant inhibitory moderating effect in the path of the negative impact of herd mentality on food-saving behavior. This suggests that the large-/small-portion-size catering mode and the buffet catering mode are both conducive to the implementation of food-saving behavior among students. As stated by Elliott and Truman [79], external environmental factors such as food portion sizes, food choices, and individual food preferences are important factors that hinder students' food-saving behaviors, and if students are provided with larger-portion-size food or food categories that do not meet their dietary preferences during canteen meals, their food-saving behaviors are hindered, which results in the creation of food waste. Conversely, if students are provided with food portion sizes and food types that match their food needs, the greater the likelihood that they will implement reduced food waste behaviors while eating in the canteens. This result justifies the strategic recommendations given in related studies that advocate for the introduction of half-portion-size food, small-portion-size food, and other catering modes in college canteens [37,38]. Based on the results of this study, it can be seen that when college students are in an environment that makes saving food easy (i.e., when the portion size and category of food can be controlled by individuals to a certain extent), they tend to order food according to their dietary preferences and appetite demands. Such an environment not only promotes the transformation of positive food-saving intentions into actual behavior but also alleviates the situation of food waste caused by the influence of herd mentality.

In summary, in this study, we confirmed that college canteen managers should adjust most of the existing standard-quantity buttery hatches in college canteens into large-/small-portion-size and buffet buttery hatches. This will provide a convenient external environment that encourages food-saving behavior in college students, which will help

them to transform their knowledge of food saving into actual behaviors, thereby narrowing the gap between food-saving intention and actual food-saving behavior.

7. Conclusions and Suggestions

7.1. Conclusions

Reducing food waste in college students' catering activities and guiding them toward the implementation of food-saving behavior contribute to the achievement of the Sustainable Development Goals (SDGs) proposed by the United Nations World Summit on Sustainable Development, and in particular to the achievement of SDG 12.3, "Reduce food waste at the consumption stage". In this study, relying on data from 422 valid questionnaires retrieved from a survey administered at Xi'an University of Architecture and Technology, China, we built an extended TPB-NAM-ABC theoretical framework model. Using this model as a basis, we explored the mechanisms underlying the effects of external environmental factors (i.e., catering modes) on college students' food-saving behavior. This exploration was based on a comprehensive consideration of both internal and external factors using SEM and hierarchical regression analysis. The main conclusions of this study are as follows:

(1) The food-saving degree is higher in male students than in female students, higher in students of rural household registration than in those of urban household registration, and higher in students with better economic status (comprising monthly living expenses and average daily spending on meals).

(2) Food-saving intention and herd mentality are major drivers of college students' food-saving behavior. Personal norms, attitudes, subjective norms, perceived behavior control, and health risk perception are the influencing factors of food-saving intention, among which, personal norms have the greatest effect. Personal norms can be activated either directly through the awareness of consequences or indirectly through the ascription of responsibility, thereby affecting the food-saving intention. Moreover, subjective norms can also activate personal norms.

(3) The standard-quantity catering mode has an inhibitory moderating effect in the transformation of food-saving intention into actual food-saving behavior, but it has a promoting moderating effect in the path through which herd mentality negatively impacts food-saving behavior. Both the large-/small-portion-size catering mode and buffet catering mode have promoting moderating effects in the transformation of food-saving intention into actual food-saving behavior, but they have an inhibitory moderating effect on the path through which herd mentality negatively impacts food-saving behavior. Notably, the moderating effects of the buffet catering mode are more significant than those of the large-/small-portion-size catering mode.

7.2. Suggestions

Sustainable food systems play a crucial role in achieving sustainable development, particularly in eradicating hunger, ensuring food security, and promoting sustainable agricultural development. The key to creating a culture of sustainability and frugality on campus is to urge college students to take responsibility for themselves, others, society, and the environment. Based on the conclusions of this study, the following two suggestions are provided:

Firstly, food waste should be reduced from the perspective of the individual student. Food-saving education and publicity activities should be organized to raise students' awareness of saving food. Positive ethical norms and attitudes regarding food saving can be fostered in students by actively developing food-saving educational activities in colleges and universities (e.g., food-saving lectures, class meetings, and knowledge contests). To increase students' awareness of the detrimental effects of food wastage and encourage them to take actions to avoid it, colleges and universities should also post the total amount of food and resources wasted over the course of the previous week or month on the display screens in their canteens. In addition, as college students must strictly adhere

to teaching and training programs, colleges and universities may also consider making environmental courses or environmental practices a mandatory part of their education, which is conducive to raising students' awareness of environmental issues and boosting their food-saving behavior.

Secondly, food waste should be reduced from the perspective of the food supply side. Efforts should be made to meet the diverse food-saving needs of individual students and to optimize the catering modes in college canteens. College canteens should adjust the existing catering modes by increasing the number of large-/small-portion-size and buffet buttery hatches, thereby ensuring that students with different individual attributes can select the most suitable catering mode according to their dining habits. These measures can help transform students' food-saving intentions into actual food-saving behavior.

7.3. Limitations and Future Research

In this study, we examined the mechanisms underlying the effects of catering mode on college students' food-saving behavior in conjunction with the related internal psychological driving mechanisms. Valuable conclusions were obtained. However, certain limitations persist, which open avenues for future research. First, in this study, when exploring the influencing mechanism of the catering mode on the food-saving behavior of college students, the types of college canteen catering modes were classified based on the students' methods of selecting their categories and portion sizes of food, and the conclusions of this study will not be applicable if the basis of the catering-mode classification is different (e.g., food prices, cooking methods, etc.). In the future, scholars can try to consider the type of catering mode according to different classification criteria and conduct research with the help of this study's methodology so as to enhance the generalizability of the results of this study to college students in China and other Asian countries or to other consumer groups in society. Second, in this study, the college students' food-saving behavior was measured using self-reported behavior rather than actual experiments, which may not reflect reality, as there is generally a gap between self-reported behavior and actual behavior. In future related research, the food-saving behavior of research subjects can be observed more accurately through field measurement experiments, which will also help to improve the accuracy of the results. Third, the focus of this study was on exploring the influence of different types of catering modes in college canteens on the process of transforming students' food-saving awareness into actual behaviors. Therefore, the psychological driving mechanisms of the food-saving behaviors of college students were not sufficiently considered. However, some studies have pointed out that the religiosity and family upbringing of individuals and their (grand)parents are important factors in the formation of college students' food-saving intentions. Therefore, in the future, researchers should consider exploring the mechanisms of their influences on food-saving intentions from the perspectives of the religiosity and family upbringing of individuals and their (grand)parents in order to fill in the gaps in the existing literature.

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