

# Perceived behavioral control and habit as key factors in reducing plate waste practices

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**Abstract.** Background: Nutritional status is indirectly influenced by food security (1); therefore, ensuring food security is a fundamental factor in addressing nutritional problems in Indonesia. Plate waste practice represents a form of food waste behavior that negatively impacts food security. Understanding the determinant variables that influence this behavior is crucial for developing effective strategies to address and modify it. Objective: This study aimed to identify factors associated with the practice of plate waste. Methods: The study employed a cross-sectional design and utilized simple random sampling as the sampling method. Based on Cochran's formula, the sample size consisted of 140 high school students in Jember, Indonesia. Results: Knowledge ( $p = 0.035$ ), perceived behavioral control ( $p = 0.001$ ), habit ( $p = 0.001$ ), hunger level ( $p = 0.001$ ) and food preference ( $p = 0.010$ ) were significantly associated with plate waste practices in the bivariate analysis. Based on the multivariate analysis, perceived behavioral control ( $p = 0.032$ ), habit ( $p < 0.001^*$ ) and hunger level ( $p < 0.001^*$ ) were identified as predictor variables for plate waste practices. Designing interventions targeting these variables, particularly perceived behavioral control and habits, has the potential to effectively reduce plate waste practices.

## 1 Introduction

An individual's nutritional status is indirectly influenced by food security, parenting, environmental factors, and access to health services [1]. Hence, achieving food security is essential for addressing nutritional problems in Indonesia. Food waste behavior impacts food security, social conditions, financial resources, and environmental sustainability.

According to the FAO (2011) [2], food loss due to food waste accounts for approximately one-third (1.3 billion tonnes) of global food production. This issue undermines food security by decreasing the availability of nutritious food. The management of food loss and food waste is a crucial component of the Sustainable Development Goals (SDGs). To achieve this objective, governments are expected to establish reduction targets, implement measures to monitor progress, and take concrete actions to minimize food loss and food waste. Although

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not all countries have reached the same milestones in meeting the SDGs targets, developing a national strategy to address food loss and waste is an urgent priority.

Plate waste figures vary across countries. In Indonesia, research on plate waste behavior among college students reported an average of 31.83 grams per portion [3]. This indicates that plate waste behavior is not limited to developed countries but also occurs in developing nations. Additionally, research involving elementary school children revealed that food waste negatively affects the adequacy of their food intake [4].

Reducing food waste is challenging because it is closely linked to an individual's eating behavior. Internal factors and environmental influences can determine the extent to which an individual tends to leave food. Therefore, identifying the determinant factors of plate waste behavior is essential for developing effective strategies to address this issue.

Understanding this behavior in students is crucial, as social and cultural interactions often influence the eating habits of teenagers. The results of the literature review show that individual behavior regarding food waste is influenced not only by external factors, but also by internal factors.

Various models for behavior change interventions have been developed based on specific theories. For example, the Theory of Planned Behavior (TPB) is useful for understanding behavioral processes at the individual level. The variables in this theory can be modified to influence specific behaviors, in this case, such as plate waste behavior. According to this theory, behavior is influenced by attitude, subjective norms, perceived behavioral control, and intention [5]. The application of the Theory of Planned Behavior (TPB) is relevant for understanding behaviors related to food waste. However, there has been limited research on plate waste that utilizes this approach.

Understanding the modifiable variables that influence behavior is essential for developing an effective behavior change strategy. The purpose of this research is to identify factors related to plate waste practices. The variables examined include knowledge, attitude, subjective norm, perceived behavioral control, intention, habit, hunger level and food preference.

## **2 Materials and methods**

The study design was cross-sectional, and the sample was selected using a simple random sampling method. The study population consisted of students in grades 1 to 3 at High School Darus Sholah, Jember, Indonesia (365 students). Based on the Cochran's formula [6], the sample size was calculated to be 137 students, with an additional 10% added, resulting in 151 students. However, 11 students did not complete the research, leaving 140 students in the final sample. The selection of students was based on the school's student roster and was carried out randomly using the excel application with the formula =INT(RAND()\*N+1). The inclusion criteria for research subjects were: 1) students in grades 1-3 and 2) those who were willing to participate by signing the informed consent form.

To operationalize the constructs in the TPB theory, the researcher adapted several question items from previous research [7] [8], [9]. The researcher prepared a set of questions to be tested for validity and reliability, with items that did not meet the standards being removed from the construct. Each construct consisted of the following: attitude (3 items), subjective norm (4 items), perceived behavioral control (3 items), intention (3 items), habits (4 items), knowledge (20 items), and hunger level (1 item). The respondents for the validity and reliability tests were students from Madrasah Aliyah Darus Sholah (equivalent to high school). Using Pearson's Product-Moment analysis, all questions were found to be valid ( $r$ -count >  $t$ -table). The reliability of these variables was also assessed using Cronbach's alpha analysis, confirming their consistency. All variables demonstrated a Cronbach's alpha value

exceeding the recommended threshold of 0.70, indicating good reliability (knowledge=0.752, attitude=0.802, perceived behavioral control=0.798, subjective norm=0.780, intention=0.728, habit=0.835). The measurements were conducted using a 5-point Likert scale, ranging from “strongly agree” to “strongly disagree”.

The equipment and materials used by the research team included research instruments such as questionnaires, self-reports forms, and digital kitchen scales with an accuracy of 0.1 grams. The researcher initially provided detailed information about the study to potential participants. Following the explanation, all potential participants agreed to participate and signed informed consent forms.

During data collection, researchers gathered information on leftover food from breakfast and dinner. Leftover food was identified by labeling each plate with the student’s name. Students dined together in the dining hall and left their plates behind after eating. Before meals, students completed a self-report form that included questions about their hunger level. These forms were returned after the students finished eating. The researcher then weighed the remaining food and recorded the measurements on the provided forms.

In the next stage, the researcher conducted interviews with each research subject using a questionnaire. The knowledge questionnaire was administered separately from the other questionnaires due to the large number of questions. Research subjects completed the questionnaires independently, with guidance from the enumerator. A total of 11 participants did not complete the study due to their absence during the food waste measurement or interviews, resulting in a final sample size of 140 participants. Data analysis was conducted using bivariate and multivariate analyses to examine the relationships between knowledge, attitude, perceived behavioral control, subjective norm, intention, habit, and food preference with plate waste practices, as well as to identify predictors of plate waste practices.

### 3 Results and discussion

Based on Table 1, the variables of knowledge, attitude, subjective norms, perceived behavioral control, intention, habits, hunger level and food preferences are categorized as good, sufficient, or poor.

**Table 1.** Distribution of knowledge, attitudes, subjective norms, perceived behavioral control, intentions, habits and preferences towards food

Variable	Frequency (f)	%
<b>Knowledge</b>		
Good (score: >80%)	12	8.57
Sufficient (score: 60 – 80%)	66	47.14
Poor (score: <60%)	62	44.29
<b>Attitude</b>		
Good (average score: $\geq 4$ )	51	36.43
Sufficient (average score 3 - <4)	57	40.71
Poor (average score <3)	32	22.88
<b>Subjective norm</b>		
Good (average score: $\geq 4$ )	48	34.29
Sufficient (average score 3 - <4)	59	42.14
Poor (average score <3)	33	23.57
<b>Perceive behavioral control</b>		
Good (average score: $\geq 4$ )	16	11.43
Sufficient (average score 3 - <4)	73	52.14
Poor (average score <3)	51	36.43

**Table 1.** Distribution of knowledge, attitudes, subjective norms, perceived behavioral control, intentions, habits and preferences towards food (continue)

Variable	Frequency (f)	%
<b>Intention</b>		
Good (average score: $\geq 4$ )	39	27.86
Sufficient (average score 3 - $< 4$ )	86	61.43
Poor (average score $< 3$ )	15	10.71
<b>Habit</b>		
Good (average score: $\geq 4$ )	44	31.43
Sufficient (average score 3 - $< 4$ )	59	42.14
Poor (average score $< 3$ )	37	26.43
<b>Hunger level</b>		
Good (average score: $\geq 4$ )	38	27.14
Sufficient (average score 3 - $< 4$ )	54	38.57
Poor (average score $< 3$ )	48	34.29
<b>Food preference</b>		
Good (average score: $\geq 4$ )	12	8.57
Sufficient (average score 3 - $< 4$ )	66	47.14
Poor (average score $< 3$ )	62	44.29

In the knowledge variable, only 9% of respondents possess good knowledge, while the majority (47%) have sufficient knowledge. Most respondents exhibit good and sufficient attitudes, at 35% and 41% respectively. Similarly, in the subjective norm variable, 34% of respondents fall into the good category and 42% are in the sufficient category. More than 50% of respondents demonstrate sufficient perceived behavioral control; however, 35% still exhibit poor perceived behavioral control. The majority of respondents have sufficient intentions (61%), with only a few classified as having good or poor intentions. Regarding habits in plate waste practices, 42% of respondents fall into the sufficient category, while the remainder are evenly distributed between the poor and good categories. When measuring hunger levels, most respondents were categorized as having sufficient or poor hunger levels. Only 9% of respondents exhibited a good preference for the food served, while the remainder showed sufficient or poor preference.

The results of the statistical test showed that knowledge, as the foundation of the constructs in the TPB model, had a significant effect on attitude ( $r=0.612$ ,  $p<0.001$ ) and subjective norms ( $r=0.474$ ,  $p<0.001$ ). However, there was no significant relationship between knowledge and perceived behavioral control ( $r=-0.159$ ,  $p<0.06$ ). Knowledge also showed a significant effect on intention ( $r=0.293$ ,  $p<0.001$ ), while attitude significantly influenced intention ( $r=0.285$ ,  $p<0.001$ ), and subjective norms had a significant effect on intention ( $r=0.215$ ,  $p<0.010$ ). In the TPB model, internal factors such as perceived behavioral control, subjective norm, and attitude influence individuals, leading to intentions that ultimately result in specific behaviors [5].

It was found that five variables influenced plate waste: knowledge, perceived behavioral control, habits, hunger level, and food preference ( $p<0.05$ ). There is a strong relationship between perceived behavioral control, habits and hunger level with plate waste practices, as shown by the following correlation coefficients: perceived behavioral control ( $r=-0.467$ ,  $p<0.001$ ), habits ( $r=-0.588$ ,  $p<0.001$ ), and hunger level ( $r=-0.645$ ,  $p<0.001$ ) (Table 2).

**Table 2.** The association between knowledge, perceived behavioral control, subjective norms, attitude, intention, habit, hunger level, food preference and plate waste practice

Variable	r	p-value
Knowledge	-0.178	0.035*
Attitude	0.033	0.691
Subjective norms	0.047	0.575
Perceived behavioral control	-0.467	0.001**
Intention	-0.118	0.161
Habit	-0.588	0.001**
Hunger level	-0.645	0.001**
Food preference	-0.326	0.010*

\*Significant at alpha 0.05

\*\*Significant at alpha 0.01

In line with previous predictions the results of this study indicate that knowledge influences attitude, intention, and subjective norm. These findings align with prior research suggesting that campaigns enhance individuals' understanding of the impact of their actions and improve attitudes toward food waste [10]. According to Bandura [12], knowledge of risks and benefits is a prerequisite for behavioral change, as individuals are unlikely to alter their intentions if they lack awareness of the behavior. Without awareness of a behavior, individuals have little reason to alter it. Gaining new understanding influences a person's emotions, motivation, perceptions, and values, shaping their attitude toward a specific behavior, either positively or negatively. The effect of knowledge on subjective norms remains uncertain. However, according to the Theory of Planned Behavior (TPB), subjective norms are shaped by an individual's beliefs, which are influenced by the views of others (normative beliefs) [5]. These beliefs are closely linked to the knowledge that the individual possesses.

The statistical test results indicate that knowledge influences plate waste practices. Research demonstrates that providing information can significantly reduce plate waste [11]. Additionally, the study's findings reveal that the attitude variable impacts the intention to minimize plate waste. These results align with research conducted by Visschers et al. [11]. This study also found that subjective norms significantly influence the intention to reduce leftover food on the plate, aligning with similar findings in previous research [14]. Additionally, the results indicate that perceived behavioral control impacts plate waste practices, though this differs from the findings of previous research [13]. Food preferences are associated with plate waste, which is consistent with other studies highlighting factors such as food quality [15]. These factors represent other psychological influences on eating behavior, alongside hunger level [15].

This study shows that perceived behavioral control and habit are strongly related to plate waste practices, with a negative effect. This means that the higher the perception of behavioral control and the stronger the habit, the lower the food waste. These results are consistent with the research by Russel [14]. Additionally, the hunger level also shows a strong relationship with plate waste practices. These findings align with research by Zao et al. [15]. Data analysis, conducted using multiple regression analysis, is presented in Table 3.

**Table 3.** Results of multiple regression analysis of independent variables on plate waste practice

Variable	Coefficient	t	p-value
Constanta	397.12	11.12	0.000*
Knowledge	0.62	1.74	0.080
Attitude	-4.56	-1.54	0.121
Subjective norms	-1.98	-0.91	0.360
Perceived behavioral control	-8.47	-3.45	0.032*
Intention	2.11	0.99	0.323
Habit	-10.82	-7.37	0.000*
Hunger level	-25.48	-4.69	0.000*
Food Preference	-3.56	-0.59	0.551

\*Significant at alpha 0.05

This study shows that perceived behavioral control and habit are strongly related to plate waste practices, with a negative effect. This means that the higher the perception of behavioral control and the stronger the habit, the lower the food waste. These results are consistent with the research by Russel et al. [14].

After conducting the stepwise regression method to select the best variables, three predictor variables were identified as having an influence on plate waste practice: habits, hunger level, and perceived behavioral control. The adjusted R-Square value obtained was 61.7%, which is slightly lower than the previous model adjusted R-squared of 62.3%.

This study shows that perceived behavioral control is a significant predictor of plate waste, with a relatively high coefficient ( $\beta=9.473$ ). Modifying this variable is expected to be effective in reducing food waste practices. Habit-based interventions can also be utilized, as indicated by the relatively high coefficient ( $\beta=-10.299$ ). With a strong relationship, modifying these variables are likely to be effective in reducing plate waste practices. Meanwhile, although hunger level shows a strong relationship, this variable cannot be easily modified.

Based on the bivariate analysis, there is an association between knowledge, perceived behavioral control, habit, hunger level, food preference, and plate waste practices. Perceived behavioral control, habit, and hunger level are strongly related to plate waste practices. According to the multivariate analysis, perceived behavioral control, habit, and hunger level are predictors of plate waste practices. However, only perceived behavioral control and habit are modifiable variables that hold potential for intervention.

Based on this study, perceived behavioral control and habit are identified as key variables with the potential to reduce plate waste practices. It is recommended that interventions be designed to target the TPB variables, particularly perceived behavioral control and habit, as these factors have been shown to effectively influence and reduce plate waste behavior.

Perceived behavioral control reflects an individual's belief in their ability to influence the outcomes of their actions. Educational strategies, constructive feedback, and a supportive environment can help enhance self-confidence and reinforce an individual's sense of control over their behavior [12]. Developing strategies based on stimulus control and habit formation is crucial for fostering positive behaviors and sustainable habits.

## 4 Conclusion

Based on this study, the researchers concluded that the variables with the greatest potential to reduce plate waste practices are perceived behavioral control and habit. The Theory of Planned Behavior (TPB) emphasizes the importances of various background factors in

influencing behavior. Designing an intervention that targets TPB variables, particularly perceived behavioral control and habit, could effectively reduce plate waste practices.

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