



Determinants of Food Management Behavior on Food Waste Reduction and Household Food Security through Expenditure Efficiency and Energy Consumption

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ARTICLE INFO

Article History:

Received May, 26th, 2025

Accepted Jun, 25th, 2025

Published online Jun, 30th, 2025

Keywords:

Food Waste;

Food Management;

Food Security;

Household Behavior;

Theory of Planned Behavior;

ABSTRACT

Food Waste (FW) in urban households remains a serious issue as it contributes to economic losses, reduced dietary quality, and weakened food security. This study aims to identify the dominant factors influencing food management behavior, FW generation, and their implications for household food security in urban settings. A cross-sectional design was applied with urban households as the study population, and samples were selected using purposive sampling. Data were analyzed using Structural Equation Modeling (SEM) within the framework of the Theory of Planned Behavior (TPB) and Nudge Theory. The results indicate that attitude ($\beta = 0.42$; $p < 0.01$), subjective norm ($\beta = 0.31$; $p < 0.05$), and perceived behavioral control ($\beta = 0.36$; $p < 0.01$) significantly influence intention toward food management. Furthermore, intention strongly predicts actual food management behavior ($\beta = 0.55$; $p < 0.001$), which subsequently reduces FW ($\beta = -0.47$; $p < 0.001$). Reduced FW positively affects both food expenditure efficiency ($\beta = 0.39$; $p < 0.01$) and energy intake adequacy ($\beta = 0.34$; $p < 0.05$), two critical indicators of urban household food security. Behavioral factors play a crucial role in reducing FW and strengthening food security in urban households. Therefore, behavior-based interventions using TPB and Nudge Theory are recommended to be integrated into food education programs, household assistance, and urban food security policies to ensure effectiveness and sustainability.

INTRODUCTION

Household food consumption patterns are largely determined by how food is managed. These management practices have a direct impact on the volume of Food Waste (FW) generated. The phenomenon of food waste at the household level is a multidimensional problem influenced by consumer behavior throughout the food journey chain, from the purchase process to the final stage of disposal.¹ Several factors contribute to the incidence of food waste in households including education level, age, number of family members, and income.² In addition, an individual's perception of food and daily habits also influences waste behavior. Although society generally considers preventing food waste as an ideal and socially positive action, the implementation of such behavior is often not in line. This may be due to the gap between understanding and action, where a person may know the importance of avoiding food waste, but does not apply it due to a lack of familiarity or practical skills in its management.³

Household food management is a key factor in reducing food waste at the domestic level. This align with the consumption patterns of urban communities in general, where fast-paced and consumptive lifestyles lead to impulsive buying behavior without adequate planning.⁴ Studies in Tehran City show that consumer behavior contributes to the high amount of household food waste. In urban areas, actions such as buying food in bulk and storing it excessively and often triggered by concerns about food price fluctuations have the potential to increase the volume of food waste. Research on food management behavior in the context of food waste reduction and its contribution to household food security is limited. Efficient food management, such as proper food storage and processing, can help households continue to have access to sufficient food despite economic constraints.⁵ To date, there is no comprehensive study that investigates all stages of food management, from purchase planning, consumption, to the utilization of food waste (including FHF) in supporting household food security.

Therefore, behavioral interventions aimed at improving household food management are needed to reduce food waste. These strategies include systematic consumption planning, making shopping lists, optimal food storage, efficient

food processing, and wise food consumption based on a zero waste approach. This study is designed as a preliminary determination test to identify the dominant factors influencing household FW generation and food security conditions. The findings of this test are expected to serve as the basis for developing more targeted interventions that align with the characteristics of urban households. The main focus is directed toward improving food expenditure efficiency and household energy intake adequacy, which are key indicators in strengthening food security. To achieve this, the study employs the Theory of Planned Behavior (TPB) and Nudge Theory as analytical frameworks for behavioral change, ensuring that FW reduction strategies are not only educational but also capable of fostering wiser and more sustainable consumption decisions.

MATERIAL AND METHOD

This research applies a cross-sectional study design, where all variables are collected and observed simultaneously at a single point in time. The research implementation process took place during the period December 2023 to February 2024. The population in this study includes all households in Tanah Sareal Sub-district, Bogor City, totalling 64,192 households (Tanah Sareal in Figures, 2021). The sample in this study is part of a population with similar characteristics, selected through specific procedures, to represent the population as a whole. The sampling technique used was Stratified Random Sampling with the following inclusion criteria: (1) Women who act as housewives aged between 30 to 55 years, (2) Are part of a household with one Family Card, (3) Have storage facilities in the form of a refrigerator, (4) Conduct traditional or conventional household management, (5) Express willingness to follow the series of research until completion, and (6) Be in good health and able to provide appropriate answers at the time of data collection.

This study will examine the determination of food management behavior before and after intervention using SEM-PLS. Partial Least Square (PLS) is a component or variance-based Structural Equation Model (SEM).⁶ PLS is an alternative approach that shifts from a covariance-based SEM approach to a variance-based approach. Covariance-based SEM generally tests causality or theory, while PLS is more oriented

toward predictive models. There are differences between covariance-based SEM and component-based PLS. Namely, in the use of structural equation models to test theory or develop theory aimed at making predictions.

RESULTS

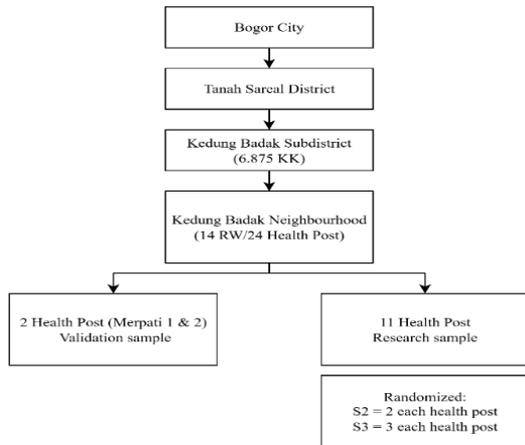
The characteristics of respondents in this study, which consisted of housewives, included the variables of age (in years), number of family members (people), education level (in years), type of employment, total household income (in IDR per month), and total household expenditure (in IDR per month). The household expenditure component is divided into two categories, namely expenditure on food and non-food expenditure. Based on Table 1, the average age of respondents is 38 years old, with an age range between 30 and 55 years old. The average number of family members is 4, and the average length of formal education of respondents is 11 years. One important aspect of the demographic characteristics analyzed in this study is socioeconomic status, which is reviewed through household income and expenditure data.

The average total reported household income is Rp 3,731,186 per month, with a minimum income of Rp 400,000 and a maximum of Rp 4,800,000. In comparison, the minimum wage in Bogor City is Rp 4,813,988 per month. Meanwhile, the average monthly household expenditure was recorded at Rp 2,602,191, with the lowest expenditure at Rp 642,500 and the highest reaching Rp 6,637,000 (Table 1).

Expenditure on food consumption is an important indicator in describing household consumption patterns. The results show that the average household food expenditure is Rp 1,791,218 per month, with a minimum expenditure range of Rp 276,000 and a maximum of Rp 5,587,000 per month. When analyzed by proportion, food expenditure accounted for 68.8% of total household expenditure. This figure is higher than the national average of 49.51%.⁷

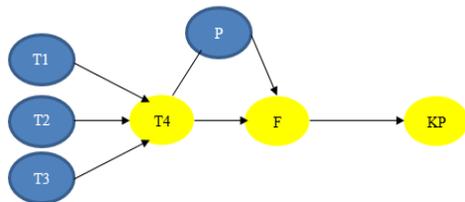
Behavior (Subjective Norms, Attitudes, Behavioral Control, and Intentions) on Food Management, Food Waste, and Household Food Security

Behavioral parameters measured based on Theory Planned Behaviour (TPB) include attitudes, subjective norms, behavioral control, and intentions. Then, aspects of food management behavior include planning, purchasing, storage, processing, and consumption. Food waste studied includes the average amount over 8 days and the type based on food groups in the Food Consumption Score (FCS). The average amount of all aspects can be seen in Table 2.



Source: Primary Data, 2024

Figure 1. Research Sample



Description:
 T1: Attitude; T2: Subjective Norm; T3: Perceived behavioral control; T4: Intention; P: Food Management Behavior; F: Food Waste; KP: Household Food Security
 Source: Primary Data, 2024

Figure 2. Initial SEM-PLS Model

Characteristics	Mean ± SD	Min	Max
Age (Years)	38.20 ± 0.60	30	55
Number of Family Members (People)	4.00 ± 0.10	2	9
Education (Years)	11.09 ± 0.2	5	16
Total Household Income (IDR/Month)	3,731,186 ± 115,471	400,000	4,800,000
Household Expenditure (IDR/Month)			
Food	1,791,218 ± 962,124	276,000	5,587,000
Non-Food	616,859 ± 52,484	46,000	3,675,666
Total	2,602,191 ± 110,142	642,500	6,637,000

Source: Primary Data, 2024

Based on this data, it is known that the median (IQR) value for the first variable is 45.00 (9.00) with 45% of housewives above the median value and 55% below it. For the second variable, the median (IQR) is 38.00 (5.00), with 33% of housewives above the median and 67% below it. Furthermore, the median (IQR) for the third variable is 27.00 (2.00), with 30% of housewives above the median and 70% below it. For the fourth variable, the median (IQR) is 21.00 (3.25), with 42% of households above the median and 58% below it (Table 2).

In addition, it is known that food management behavior from the aspects it is known that the median (IQR) for the first variable is 14.00 (3.00) with 43% of housewives above the median and 57% below it; the second variable has a median (IQR) of 58.00 (9.00), with 41% above the median and 59% below it; storage behavior shows a median (IQR) of 41.00 (7.00), with 40% above the median and 60% below it; processing data had a median (IQR) of 25.00 (5.00) with 30% above the median and 70% below it; while consumption data showed a median (IQR) of 44.00 (8.00) with 43% above the median and 57% below it (Table 2).

The results of the indicators were then integrated into the Maxwell method (Table 3), where based on household TKE, it was found that 45% (50) of respondent families fell into the food insecure category and 44% (48) fell into the food vulnerable category, the rest fell into the food resistant category 5% (5) and food resilient 6% (7).

Table 2. Subjective Norm, Attitude, Behavioral Control, Intention, Food Management Behavior, and Household Food Waste

Variables	Median (IQR)	Min	Max
Attitude	45.00 (9.00)	36.00	60.00
Subjective Norm	38.00 (5.00)	27.00	52.00
Behavior Control	27.00 (2.00)	19.00	35.00
Intention	21.00 (3.25)	17.00	28.00
Planning/P1*	14.00 (3.00)	0.72	1.60
Purchase/P2*	58.00 (9.00)	13.86	24.42
Storage/P3*	41.00 (7.00)	5.67	10.92
Management/P4*	25.00 (5.00)	1.95	4.16
Consumption/P5*	44.00 (8.00)	7.75	14.75
Variables	Mean ± SD	Min	Max
FW (8 days)	79.83 ± 56.78	8.81	358.90
Type FW 9	69.07 ± 17.07	20.00	90.00

Source: Primary Data, 2024;

*Total score per aspect after weighting

Table 3. Distribution of Household Food Security

KP Category	TKE*	
	n = 110	%
Food Resistant	7	6
Food Range	48	44
Lack of Food	5	5
Food Insecurity	50	45

Source: Primary Data, 2024

*Household food security is based on the proportion of food expenditure and household energy consumption levels

Factors of Food Management, Food Waste, and Household Food Security (Before Intervention)

Based on the basic model on Figure 1, it is known that there are several variables that want to know their influence, such as how the implementation of the TPB (subjective norms, attitudes, and behavioral control) affects the intention to reduce food waste. Then, how does the intention to reduce food waste affect food management behavior (PPM) and how is the intention towards food waste (type and amount). In addition, the effect of food waste (type and amount) on household food security in urban areas is also examined.

The Effect of Subjective Norms, Attitudes, and Behavioral Control on Intention

The implementation of Theory of Planned Behavior (TPB) tested on intention includes three main constructs, namely attitudes, subjective norms, and behavioral control. Based on the results of the analysis, it was found that attitude has a significant effect on intention ($p < 0.1$) with a coefficient value of 0.181, which indicates that each increase in attitude by one unit will increase intention by 0.181. Furthermore, subjective norms are also shown to have a significant influence on intentions ($p < 0.05$) with a coefficient of 0.365, which means that a one-unit increase in subjective norms will increase intentions by 0.365. Finally, behavioral control shows a significant influence on intention ($p < 0.05$) with a coefficient of 0.263, which indicates that a one unit increase in behavioral control will increase intention by 0.263. These findings indicate that the three constructs in TPB empirically contribute to the formation of individual intentions.

The Effect of Subjective Norms, Attitudes, and Behavioral Control on Intention

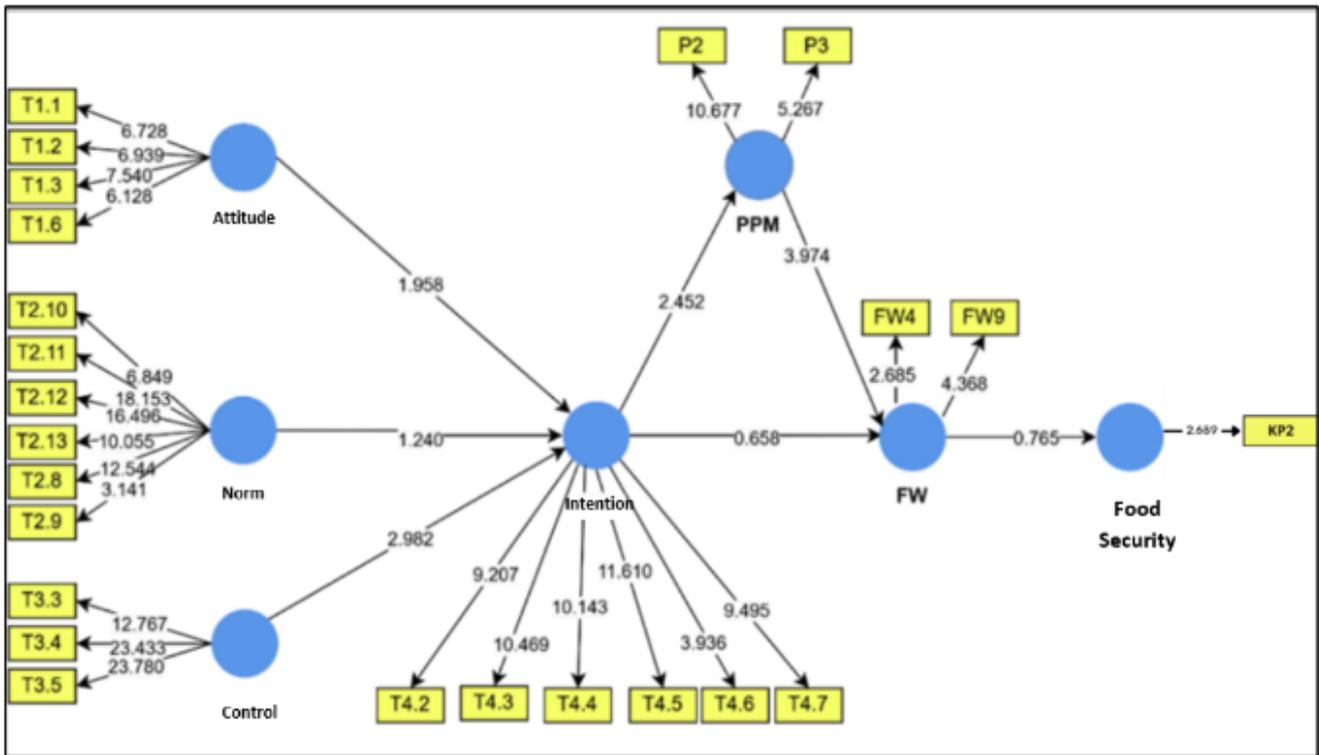
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Effect of Intention on Food Management and Food Waste

In the model used, intention affects food management and food waste (FW). The test results show that intention has a significant effect on food management ($p < 0.05$; $\beta = 0.269$), but has no significant effect on food waste ($p > 0.05$). Furthermore, food management has a significant effect on food waste ($p < 0.05$; $\beta = 0.365$), but food waste is not proven to affect household food security ($p > 0.05$).

Effect of Food Management on Food Waste and its Implications for Food Security

Food management has a significant effect on food waste ($p < 0.05$; $\beta = 0.365$), meaning that an increase in food management by one unit increases food waste control by 0.365. Meanwhile, food waste is not proven to affect household food security ($p > 0.05$).



Source: Primary Data, 2024

Figure 3. Model of Food Management Behavior, Food Waste, and Food Security (Before Intervention)

DISCUSSION

Household Characteristics

In general, what influences the behavior of FSWs in households can be divided into two factors, namely factors that influence behavior that comes from within humans themselves, called internal factors and human behavior that is influenced from outside humans, called external factors.⁸ The internal factors in question are ethnicity, gender, physical characteristics, personality, intelligence, and talent. Tribe reflects typical behaviors and habits (e.g. eating habits, etc.), while gender relates to the role of women in the household in relation to decision-making related to family food consumption.

External factors include education, religion, environment, and socioeconomics.⁷ Education has a huge influence on a person's behavior, where someone with a high education will have a different behavior from someone with a low education.² Religion will make individuals behave in accordance with the norms and values taught by the religion they believe in.³ The behavior of a person in a particular culture will be different from people who live in other cultures, for example the behavior of Javanese people with the behavior of Sulawesi people.⁴ The environment is everything around the individual, both the physical, biological, and social environment. The environment is influential in changing the nature and behavior of individuals because the environment has great power in determining behavior, often even greater power than individual factors.⁵ A person's socioeconomic status will determine the availability of a facility needed to carry out certain activities, so that this socioeconomic status will affect a person's behavior.⁹

Occupation influences behavior externally, including the occupation of housewives and the occupation of husbands and other household members (who are already working). Based on the results of the study, it is known that the husband, in this case the head of the family, is mostly a laborer (34.55%) and a private employee (30.91%), while all (100%) respondents are housewives. Occupation in the household has a significant influence on household food management behavior and the level of FHF produced. Employment affects household food manage-

ment related to time and energy, when both spouses work, the time available to manage food is limited. This often leads them to choose quick solutions such as ready meals or rely on delivery services which can increase the likelihood of food wastage.^{10,11}

Behavior (Subjective Norms, Attitudes, Behavioral Control, and Intentions) on Food Management, Food Waste, and Household Food Security

Subjective Norms. Based on the results of the study, it is known that the family spearheads the motivation to reduce food waste. The family functions as the smallest unit in society that has an important role in value socialization. They can transfer knowledge about the negative impacts of food waste to the next generation. Providing good understanding to children from an early age can familiarize children to appreciate food and understand the importance of managing food waste wisely. Support from family members and relatives can create an environment where everyone feels responsible for reducing food waste. When one family member shows the intention to reduce food waste, other family members tend to follow suit, thus creating greater collective awareness.^{12,13}

Attitude. The study mentioned that reprocessing excess food is an effective strategy to reduce food waste in households. With increasing awareness of the environmental impact of food waste, there are many innovative ways to utilize food waste. Reprocessing excess food not only helps reduce the amount of waste, but can also improve food security by utilizing existing resources more efficiently.^{14,15}

Behavioral Control. Intention is strongly influenced by how individuals have behavioral control. Each component of the question shows that respondents behavioral control is good. However, what needs to be improved is instilling knowledge to respondents that reducing food waste is very easy. On average, respondents did not know that donating excess food is one way to reduce food waste. Many individuals do not have adequate knowledge on how to store food properly. For example, misunderstanding expiration date labels often leads to food that is still fit for consumption being thrown away. A study showed that 50.18% of respondents recognized

that excessive food portions were the main cause of food waste, reflecting a lack of awareness of portion management.^{16,17}

Intention. The reflection of respondents intentions is reflected in the three aspects above, where it is known that there is a good intention from respondents to reduce food waste. What needs to be instilled in respondents so that the intention to reduce food waste is getting better is to provide education that reducing food waste is not a difficult thing because the average respondent still feels it is difficult to do. However, building good intentions by providing an understanding that reducing food waste is not a difficult thing can be done with education. Education can be given to family members about the negative environmental, financial and social impacts of food waste. For example, explaining that wasting food can lead to global warming, huge food disposal costs, and the threat of hunger in the community.^{18,19} In addition, it is also important to educate people on food management from planning, purchasing, storage, processing and consumption.

Planning. In terms of planning, respondents "sometimes" plan the menu to be cooked, have difficulty determining the menu to be cooked, and determine the menu for the day. Menu planning is an important step in reducing food waste. By planning menus effectively, individuals and households can minimize food waste that occurs due to over-purchasing or lack of understanding of food management. There are several reasons why menu planning is essential in reducing food waste: (1) Avoiding Over-purchasing, (2) Optimizing the Use of Leftovers, (3) Better Storage Management, (4) Increased Awareness of Expiration Dates, (5) Environmental and Economic Impacts.

Purchasing. In the aspect of purchasing, the data shows that the lowest scores are on implementing a shopping list in the household and buying food according to a plan. Making a planned shopping list is an important step in reducing food waste because making a shopping list can avoid overspending, indirectly forces individuals to make menu plans, and encourages individuals to check stocks first before making purchases. The benefits of reducing food waste through shopping lists are: (1) Better economy, (2) Positive environmental impact, and accord-

ing to the benefits of reducing food waste are (3) Better health.²⁰

Storage also plays an important role in reducing food waste, as the data shows that respondents do not know how to store food properly. For example, storing fresh food in plastic and storing food at the wrong temperature. Good food storage is essential in reducing food waste in households. Applying proper storage techniques can extend the shelf life of foodstuffs and avoid wastage. Important aspects related to food storage and its impact on reducing food waste are: (1) Extending the Shelf Life of Food, (2) Avoiding Excessive Purchases, (3) Food Preparation and Meal Planning, (4) Leftover Management.

Processing. Proper processing according to the number of household members is important in reducing food waste in households. The data shows that the lowest scores for processing aspects are on the allocation of cooking time that is not too much, cooking according to the mother's wishes, and improper processing and not looking at the expiration date. Good food processing in households can significantly reduce MPAs by applying good hygiene and sanitation principles. Good food processing principles start with the selection of fresh and quality food ingredients. Ensuring food ingredients are free from harmful chemicals and come from trusted sources.¹⁰ Paying attention to the storage of cooked food is also important. After cooking, food should be stored at a safe temperature (below 5°C for refrigeration or above 60°C for serving). Cooked food should not remain at room temperature for more than 4 hours.² Thus, good food processing is not only beneficial to health but also contributes to the reduction of food waste in households.

Consumption. Consumption contributes to food waste through food preparation and selection. The data shows that the lowest scores in consumption are related to preferences and not reprocessing excess food that can still be consumed. Preferences are important in food processing as contributing to food waste can help in designing more effective strategies to reduce food waste. Preferences are influenced by cultural and social influences, which often affect how individuals interact with food. In some cultures, leaving food on a plate can be

considered a sign of respect or abundance, which can increase plate waste.²¹ In addition, preferences are also influenced by awareness and education. Lack of awareness of the environmental impact of food waste and lack of education on sustainable practices contribute to waste. Many people do not realize that food waste can be an opportunity to reduce global hunger.^{22,23} In addition, preference is also influenced by the individual.

Different food preferences, including dietary restrictions can lead to food waste. When individuals are presented with food that does not suit their tastes or dietary needs, they are likely to abandon it.^{24,25} Based on research conducted on the same respondents, it is known that respondents preferences are divided into 2, namely positive and negative preferences. A total of 83 (94.3%) respondents with positive food preferences tend to contribute more food waste due to their curiosity to try different types of food. Meanwhile, as many as 5 (5.7%) respondents with negative food preferences tend to consume food that is convenient and according to taste. It is further explained that there is a relationship between food preferences and household food waste (p-value <0.05).²²

Food waste data in the study is also not much different from previous research conducted in Bogor Regency in 2022 where food that is still suitable for consumption and wasted is 29 kg/cap/year (37.7%) while this study shows food waste that is still suitable for consumption is 29.1 kg/cap/year (>10%). when viewed from the type of food ingredients that produce food waste, each food ingredient has a different carbon content. According to FAO, the commodities that produce the highest carbon emissions are cereals (more than 30%) and beef (20%). Rice is a type of cereal that has a higher impact because rice emits methane gas (CH₄).²⁶ When viewed by type, this high score is due to the largest contributor to food waste, namely from the staple food group (rice), which is 152.67 ± 14.63 g/cap/day, while vegetables are ranked second with an average food waste of 54.23 ± 4.84 g/cap/day, and others at 47.88 ± 6.65 g/cap/day. Other food types include wet cakes and fried foods.

The distribution of expenditure on food out of total expenditure is a proxy indicator of household food security.²⁷ Engel's theory states that

the higher the income level, the lower the percentage of household expenditure on food consumption. Food expenditure is a good proxy for measuring welfare and food security. The higher the welfare of a country's society, the smaller the share of food expenditure of its population.

Food waste, or the loss of edible food that is wasted or not consumed, has a significant positive relationship with socio-economic conditions, particularly in Indonesia. Understanding the relationship between socio-economic factors and food waste can provide insights into potential solutions to reduce waste and improve food security. Nationally, food waste in Indonesia is estimated to result in economic losses ranging from IDR213 to IDR551 trillion per year, or equivalent to about 4-5% of the country's GDP. These losses are mainly due to the costs associated with food production, transportation and disposal.²⁸ This volume of wasted food has the potential to feed between 61 to 125 million people, highlighting the stark difference between overfed and starving people in Indonesia. This gap underscores inefficiencies in food distribution and consumption practices.

Welfare must be followed by good quality human resources. The quality of human resources is reflected in the adequacy of nutrition consumed. A well-nourished population will be able to carry out activities smoothly so that the results obtained can be maximized to meet the needs of life. The level of nutritional adequacy is expressed in the Nutritional Adequacy Score (NAC) which describes the minimum amount of calories and protein needed by each resident per day to be able to live a healthy and active life. Based on the data, the level of household energy and protein adequacy is sufficient (>100%), however, the average energy consumption of 1,554.16 kcal/cap/day and protein of 54.67 grams/cap/day is still lower than the 2018 Susenas data which reported that the average calorie consumption of the Indonesian population was 2,147.09 kcal/cap/day and protein of 62.19 grams/cap/day. The Susenas report has not met the IMR standard according to the results of the National Widyakarya Pangan dan Gizi (WNPG) X in 2012, where the Energy Adequacy Rate (AKE) is 2,150 kcal/day. However, the Protein Adequacy Rate (PFA) has exceeded the standard of 57 grams/day.

Factors of Food Management, Food Waste, and Household Food Security (Before Intervention)

The final model is described in Figure 1. It is known that there are 4 things that explain the respondents attitude to reduce food waste such as their motivation to preserve the environment, help people in need, reduce waste, and food waste can be reduced through proper portion control. In the aspect of subjective norms, it is explained that the support to reduce food waste in a row from the most influential is from the nuclear family, close relatives, and neighbors. On behavioral control, it is explained that respondents know that there are many choices of ways to reduce food waste, the main one is meal planning and shopping.

Understanding the environmental impact of food waste will motivate housewives to reduce food waste. Housewives who have knowledge of the negative impacts of food waste, such as increased carbon emissions and environmental damage, are more likely to take action. Research shows that awareness of environmental issues can encourage individuals to reduce their food waste.^{19,29} The role of all core family members is needed for greater food waste reduction as family members, including fathers and children, play a role in creating awareness of the importance of reducing food waste. Research shows that high rates of food waste in households correlate with family members' values and attitudes towards food management.³⁰ With regard to behavioral control, the strongest influence on food waste reduction behavior is planning. Good planning, which involves all family members, can help minimize over-purchasing and ensure that all purchased food can be consumed before it expires. This suggests that collaboration in food planning and purchasing is essential to reduce food waste.^{19,31} Intention to reduce food waste in households is reflected in how willing respondents are to make menu plans, make shopping lists, good storage and processing, not leaving food on plates, and reprocessing excessive food. This is also part of food management that must be done so that food waste can be reduced. However, in the PPM variable, there are 2 things that must be considered if food waste reduction is expected to have significant results, namely planned and wise purchases and good and proper storage.

Many studies suggest that wise purchasing includes; (1) Menu planning, by planning the menu before shopping, consumers can buy only the groceries they need. This helps avoid impulse purchases that often lead to food that will not be used. Then, (2) buying the right amount as needed can prevent food from expiring before it has a chance to be consumed. For example, buying the right amount of fresh vegetables for your family to consume in one week. Finally, (3) choosing products with more distant expiration dates can ensure that the food will last longer, reducing the chances of it being wasted.

With regard to efficient storage, respondents should better understand how to store food properly. Understanding how to store different types of food (e.g. vegetables in the refrigerator, fruit at room temperature) can extend the shelf life and keep food fresh. This also includes using airtight containers to prevent spoilage. Respondents are also expected to be able to rotate food stocks. Using the FIFO (First in First Out) principle in storage helps ensure that older food is used first, thus reducing the risk of wastage. Furthermore, the use of labels and dates such as marking the date of purchase or expiry date on food packaging can help families to more easily remember which ones to use first.

The results also show that food waste is not directly related to food security. Food waste in households and household food security do have a complex relationship. However, there are several reasons why food waste is not always considered directly related to food security. First, food security is influenced by various factors, including income, knowledge and food productivity. Research shows that these variables have a more significant influence on food security than the amount of food wasted.¹⁴ For example, households with higher income and good knowledge tend to have better food security, regardless of their level of food waste. Secondly, food waste is often the result of poor food management habits, such as ineffective shopping planning or incorrect storage. Research shows that many households still engage in food waste even when they have access to sufficient food.³ In other words, despite the waste, these households may still be able to meet their food needs through other sources. Thirdly, although food waste has major environmental

impacts, such as contributing to greenhouse gas emissions and wasting resources, these effects are not necessarily directly related to domestic food security. Food waste is more related to the efficiency of the food system as a whole than to food availability at the household level.^{14,32}

Therefore, while reducing food waste is important for environmental sustainability, it does not necessarily guarantee a direct improvement in food security. People's economic conditions also play an important role in food security. Households that are in good economic conditions may be able to cope with food waste without affecting their ability to obtain food.³³ In contrast, poor households may experience food insecurity even if they waste little food, due to limited access and income.

Food security is a dynamic concept and is influenced by many external factors. External factors including climate change, government policies and market conditions can affect overall food availability more than household waste. Furthermore, households often adapt to changing conditions, such as seeking alternative foods or changing consumption patterns. Resource availability, consumption behavior, socio-cultural aspects as well as the dynamics of food security itself play a key role in determining the extent to which food waste affects food security. Therefore, focusing on better food management and raising awareness of the importance of sustainability can help reduce waste without compromising food security.

CONCLUSION AND RECOMMENDATION

The conceptual SEM model illustrates that attitude ($\beta = 0.42$, $p < 0.01$), subjective norm ($\beta = 0.31$, $p < 0.05$), and perceived behavioral control ($\beta = 0.36$, $p < 0.01$) significantly influence behavioral intention of food management among urban households. Furthermore, behavioral intention shows a strong effect on actual food management behavior ($\beta = 0.55$, $p < 0.001$), which subsequently reduces food waste generation ($\beta = -0.47$, $p < 0.001$). Reduced FW positively affects both food expenditure efficiency ($\beta = 0.39$, $p < 0.01$) and energy intake adequacy ($\beta = 0.34$, $p < 0.05$), two critical indicators of household food security.

In summary, the SEM findings confirm that strengthening household attitudes, social norms, and perceived control is essential to increase behavioral intention and actual food management practices, leading to lower FW and improved household food security.

AUTHOR CONTRIBUTIONS

The contribution of each author is described as follows, as part of the dissertation defense of PDS. PDS was responsible for the conceptualization, data collection, data analysis, and manuscript drafting. YFB served as the chair of the supervisory committee, while DM and DB were members of the committee. All supervisors (YFB, DM, and DB) made substantial contributions by supervising the research process and critically reviewing the manuscript. PDS = Prita Dhyani Swamilaksita; YFB = Yayuk Farida Baliwati; DM = Drajat Martianto; DB = Dodik Briawan.

CONFLICTS OF INTEREST

The authors declare that they have no financial conflicts of interest or personal relationships that could influence the results of the research reported in this article.

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