Analysis of food waste behavior by muslim generation Z through online food delivery

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In recent years, there has been a consistent annual increase in the prevalence of food waste, which negatively affects the economy of various countries, such as Indonesia. Previous studies showed that food waste in Indonesia reached 41.4% of the total composition of national waste in 2021. This increase is accompanied by technological developments that affect consumption patterns, such as online food delivery (OFD) services. Therefore, this study aims to analyze food waste behavior among Muslim Generation Z through OFD in West Java using the Theory of Planned Behavior (TPB). Primary data were obtained from 180 participants and analyzed using the Structural Equation Modeling- Partial Least Square (SEM-PLS). The results showed that there was a significant positive relationship between the attitude variable and perceived behavior control with intention, while the subjective norms variable had no effect. A significant positive relationship was also obtained between promotion, OFD, and perceived behavior control with food waste behavior. Meanwhile, intention and OFD had no significant effect.

1 Introduction

Food waste has become a critical global issue with severe environmental and socio-economic consequences. In 2019, approximately 931 million tons of waste were generated globally, with households contributing the largest share at 61%, followed by food services (26%) and retail stores (13%). Alarmingly, 17% of global food production ended up being wasted, significantly exacerbating global warming and climate change (UNEP 2021b; UNEP 2021a). Food and Agriculture Organization (FAO 2013) defines food waste as consumable items discarded after prolonged storage or due to deliberate neglect, often stemming from excessive purchasing habits.

Indonesia shows the severity of this crisis, ranking as the second-largest producer among Muslim-majority countries and generating 300 kg per capita annually (EIU 2017). From 2000 to 2019, the country's food loss and waste generation ranged from 115 to 184 kg per capita per year, with the consumption stage having the highest contribution. The underlying factors driving this crisis include shifting quality standards, evolving consumer preferences, lack of public education, and behavior such as over-purchasing (Bappenas 2021). In 2022, food waste accounted for 41.34 percent of Indonesia's total waste composition, emphasizing its widespread nature (Figure 1).

Consumers behavior significantly influence food waste, particularly those driven by the economic principle of utility maximization. Conventional economic theory posits that consumers often aim to maximize satisfaction (utility) from goods and services. However, the "Law of Diminishing Marginal Utility" shows that as the consumption of a good increases, the additional satisfaction gained from each unit decreases. This diminishing marginal utility typically leads to over-purchasing and waste as consumers struggle to balance needs and desires (Mankiw 2018; Hidayat 2020).

The emergence and growth of online food delivery (OFD) services have introduced a new dimension to food waste. OFD platforms, which gained substantial traction during the COVID-19 pandemic, have reshaped consumption patterns by making it easier and more convenient to access various edible items. In January 2023, Indonesia recorded 19.85 million OFD users, marking a 16.5% year-on-year increase in users and a 26.3% rise in transaction values. Although OFD provides convenience

and creates employment opportunities (Liu & Chen 2021), these services also encourage impulsive purchasing and over-ordering. The trend is particularly prevalent among Generation Z users, who dominate the OFD user demographic in Indonesia (Tenggara 2022).

Despite Indonesia's majority Muslim population of 237.5 million, the Islamic prohibition against wastefulness (*tabdzir*) has not significantly reduced food waste. Islamic teachings emphasize moderation, fairness, and sharing, as reflected in the Qur'anic verses Al-Isra' 26-27, which discourage extravagant consumption and advocate for resource sharing with relatives, the poor, and travelers (Rarawahyuni 2022). However, the country remains Southeast Asia's largest producer of food waste, generating 20.9 million tons annually (UNEP 2021a).
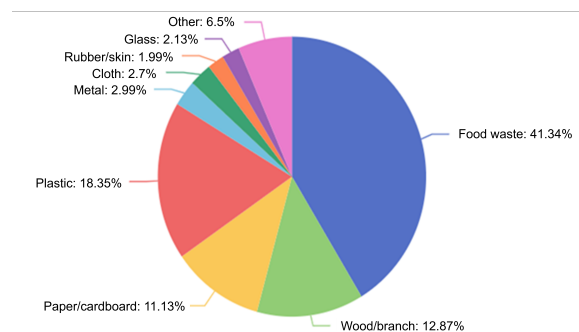

Figure 1: Composition of national waste for 2022

Addressing food waste behavior requires a deeper understanding of the underlying psychological, social, and economic factors. The Theory of Planned Behavior (TPB) offers a robust framework for predicting and analyzing human actions, identifying attitudes, social norms, and perceived behavior control as key determinants (Atkas *et al.* 2018). Empirical studies have also extensively applied TPB to examine food waste behavior, providing valuable insights into the motivations and barriers associated (Shankar *et al.* 2022; Prasetyo & Djuwita 2020; Aktas *et al.* 2018).

This multidimensional perspective is crucial for designing effective interventions to mitigate the crisis and promote sustainable consumption patterns in Indonesia and globally. Attitude significantly contributes to predicting individuals' intention, particularly in reducing food waste. A positive attitude can effectively predict the intention to minimize food waste (Soorani & Ahmadvand 2019). Additionally, individuals often feel compelled to act when influenced by other important people in their lives, showing the impact of subjective norms (Aryani & Ririh 2020). In addition, subjective norms are strong predictors of a intention to reduce food waste and have a positive effect (Sorani & Ahmadvand 2019; Jia *et al.* 2022). Perceived behavior control (PBC) distinguishes the TPB from the Theory of Reasoned Action. PBC represents the perception of barriers or ease in performing behavior (Ajzen 1991) and has been found to have a significant direct effect on food-wasting behavior more than its influence on the intention to reduce food waste (Stancu *et al.* 2016). Intention also plays a vital role in determining behavior, where the stronger the intention, the higher the potential of acting. However, external constraints or a lack of ability can cause behavior to deviate from intention (Fishbein & Ajzen 2010). A study by Aktas *et al.* (2018) found that intention negatively correlated with food-wasting behavior. Promotions in OFD services influence shopping behavior and food waste. In addition, promotional offers such as free shipping and discounts significantly enhance consumer purchasing interest, as seen in Grab Food (Tobing *et al.* 2022). Minimum price requirements also encourage consumers to buy more than necessary to qualify for delivery services, often leading to uneaten food being discarded due to changes in its taste or freshness (Liu & Chen 2021).

a. H1: Attitude toward food waste has a positive effect on the intention to reduce food waste.
b. H2: Subjective norms have a positive relationship with the intention not to waste food.
c. H3: Perceived behavior control has a positive effect on the intention to reduce food waste.
d. H4: Perceived behavior control has a negative effect on food-wasting behavior.
e. H5: Intention to reduce food waste has a negative effect on food-wasting behavior.
f. H6: Promotion has a positive effect on OFD shopping behavior.
g. H7: OFD shopping behavior has a positive effect on food waste behavior.

2 Methodology

2.1 Collection and Measurement of Data

Data was collected in January-June 2022 by distributing Google form online questionnaires via social media such as WhatsApp and Instagram. This study used a non-probability sampling method with the required sample criteria, which included the following:

a. Represents generation Z
b. born in 1997 to 2012
c. Domiciled in West Java
d. Religion of Islam
e. Have used online food delivery in the last 3 months

According to Hair *et al.* (2014), 100 samples or more were good sample sizes. The minimum sample in this study was 160, calculated by multiplying 5 times the number of indicators used [13]. The sample in this study was the Z generation of Muslims in West Java who used OFD, totaling 175 respondents. The participants of this study did not give written consent for their data to be shared publicly, and due to the sensitive nature of the study, supporting data was not available.

2.2 Data Analysis Methods

This study used the descriptive analysis method and Structural Equation Model-Partial Least Square (SEM-PLS). Descriptive analysis was used to describe the characteristics of the study respondents. SEM analysis was used to determine the factors that influenced food-wasting behavior in Generation Z Muslims who used OFD. The collected data was processed and analyzed using Microsoft Excel 2013, SPSS version 25, and SmartPLS 3 software.

3 Result

3.1 Descriptive Findings and Analysis
3.1.1 Demographic Characteristics of Respondents

Table 1 showed that the majority of respondents were born between 2001-2005 or aged 18-22 years, with a percentage of 79.43%. These participants were women, reaching 82.29% of the total respondents, and the majority lived in Bogor District/City, with a percentage of 69.14%. This result stated that women tend to produce more leftover food than men. In terms of education, the majority of respondents had a high school/vocational school/equivalent education level, with a percentage of 66.29%, and were also students or university students, reaching 86.29% of the total respondents. Most of the participants had income below IDR 1,000,000.00, reaching a percentage of 42.29%. When talking about spending on food, the majority spent between IDR 500,001.00 and IDR 1,000,000.00, with a percentage of 50.86%.

Table 1: Demographic characteristics of respondents

Characteristics	Category	Amount	Percentage
Year of birth	1996–2000	35	20%
	2001–2005	139	79%
	2006–2010	1	1%
Gender	Woman	144	82%
	Man	31	18%
Domicile	Bogor Regency/City	121	69%
	Regency/City of Bekasi	12	7%
	Regency/City of Bandung	15	9%
	Regency/City of Sukabumi	3	2%
	City of Depok	10	6%
	Sumedang District	4	2%
	Karawang Regency	2	1%
	Cirebon Regency	2	1%
	Purwakarta Regency	2	1%
	Other	4	2%
Last education	High school/Equivalent	116	66%
	Diploma	45	26%
	Bachelor	13	7%
	Masters	1	1%
Work	Student/Student	151	86%
	Private	11	6%
	Self-employed	2	1%
	Professional Employee	2	1%
	Doesn't work	4	2%
	Other	4	2%
Income	< IDR 1,000,000	74	42%
	Rp. 1,000,001 - Rp. 2,000,000	68	39%
	Rp. 2,000,001 - Rp. 3,000,000	16	9%
	Rp. 3,000,001 - Rp. 4,000,000	6	3%
	Rp. 4,000,001 - Rp. 5,000,000	5	3%
	> Rp. 5,000,000	6	3%
Expenses for food	< IDR 500,000	60	34%
	Rp. 500,001 - Rp. 1,000,000	89	51%
	Rp. 1,000,001 - Rp. 2,000,000	25	14%
	> Rp. 2,000,000	1	1%

3.2 Behavior Characteristics of Respondents

The majority of respondents in this study had a transaction value on OFD services below IDR 500,000.00. The most commonly used was less than 5 times in the last 3 months, as shown in Table 2. The majority of respondents used the Gojek OFD application, specifically the Go-Food feature. Regarding food wastage, the majority of respondents rarely waste food (less than 5 times), with a percentage of 57.14%.

Table 2: Behavior characteristics of respondents

Characteristics	Category	Amount	Percentage
Transaction value on online food delivery (OFD)	< IDR 500,000	135	77%
	Rp. 500,001 < Rp. 1,000,000	30	17%
	Rp. 1,000,001 < Rp. 2,000,000	8	5%
	> Rp. 2,000,000	2	1%
OFD usage frequency	Rarely (<5 times)	109	62%
	Often (6-10 times)	50	29%
	Always (>10 times)	16	9%
The OFD application used	Go-Food	91	52%
	Grab-Food	24	14%
	Shopee-Food	60	34%
Food waste frequency	Never (0)	64	37%
	Rarely (<5 times)	100	57%
	Often (6-10 times)	10	6%
	Always (>10 times)	1	1%

3.3 Assessment of Validity and Reliability

Convergent validity analysis was used to measure or see the ability of indicators to describe construct variables. This analysis could be done by looking at the values of outer loadings. Based on Figure 2, all indicators met the minimum validity value requirements (>0.5), showing that these indicators validly reflected construct variables. Furthermore, the analysis was carried out by examining the AVE (average variance extracted) value.

3.4 Value of AVE

Based on Table 3 it could be seen that the AVE value in this study was > 0.5 and it could be concluded that all variables could describe a good study model. The discriminant validity assessment was evaluated using the Fornell Larcker Criteria, and the analysis of the results could be found in Table 4. The results of the analysis showed that the criteria were met, showing that all variables had passed the discriminant validity test.
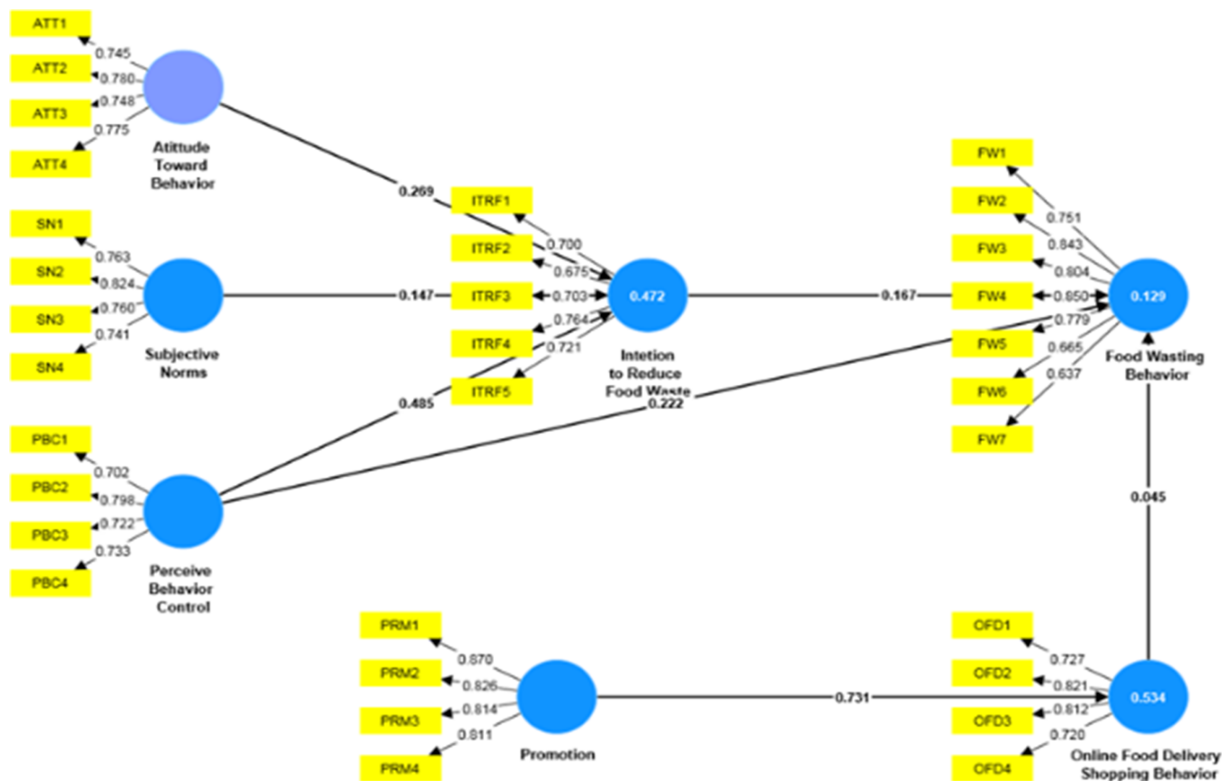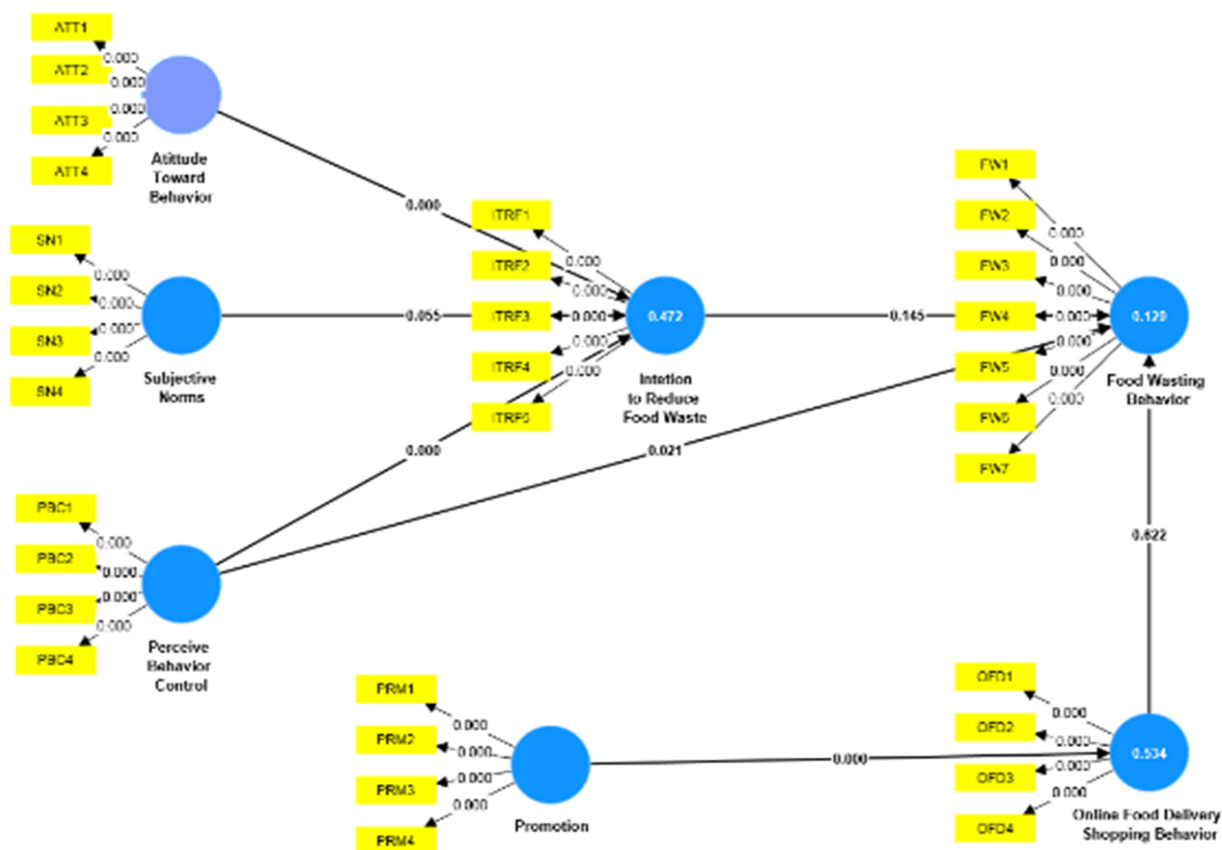
Figure 2: Outer-loadings value

Figure 3: Results of bootstrapping analysis

Table 3: Average variance extracted value

Latent variable	Average variance extracted
Attitude toward behavior (ATT)	0.581
Food waste behavior (FW)	0.585
Intention to reduce food waste (ITRF)	0.509
Online food delivery (OFD)	0.595
Perceived behavior control (PBC)	0.547
Promotion (PRM)	0.690
Subjective norms (SN)	0.597

Table 4: Fornell Larcker Criterion value

	ATT	FW	ITRF	OFD	PBC	PRM	SN
ATT	0.762						
FW	0.210	0.765					
ITRF	0.460	0.309	0.713				
OFD	0.121	0.107	0.208	0.771			
PBC	0.267	0.328	0.598	0.122	0.740		
PRM	0.131	0.180	0.218	0.731	0.145	0.830	
SN	0.420	0.188	0.396	0.120	0.281	0.262	0.773

Attitude toward behavior (ATT), Food waste behavior (FW), Intention to reduce food waste (ITRF), Online food delivery (OFD), Perceived behavior control (PBC), Promotion (PRM), and Subjective norms (SN)

Composite reliability analysis, the purpose of this analysis was to observe the consistency of the variables that were used in the study. Consistent variables were expected to have a composite reliability value above 0.6. From Table 5, it could be concluded that the composite reliability value in this study met the standard which showed that all the variables used could be considered reliable variables.

Table 5: Composite reliability values

	Cronbach's alpha	Composite reliability
Attitude toward behavior (ATT)	0.760	0.847
Food waste behavior (FW)	0.880	0.907
Intention to reduce food waste (ITRF)	0.759	0.838
Online food delivery (OFD)	0.772	0.854
Perceived behavior control (PBC)	0.723	0.828
Promotion (PRM)	0.851	0.899
Subjective norms (SN)	0.777	0.855

3.5 Explaining variance: Coefficient of determination

Analysis of the coefficient of determination was carried out to assess the extent to which the independent variables were able to explain the dependent variable. The higher the coefficient of determination, the better the ability of the independent variables to describe the dependent variable. In behavior study, the value of the coefficient of good determination was > 0.2.

Table 6: Value of the coefficient of determination

Variable	R square
Food waste behavior (FW)	0.129
Intention to reduce food waste (ITRF)	0.472
Online food delivery (OFD)	0.534

In Table 6, there were 3 coefficients of determination in this study. The results of the analysis showed that for the ITRF variable, the coefficient of determination was 0.478, which meant that the variables of attitudes towards behavior, subjective norms, and perceived behavior control could explain 47.2% of the intention to reduce food wastage. The result of the coefficient of determination for the OFD variable was 0.534, which meant that the promotion variable could explain 53.4% of OFD shopping behavior. As for the FW variable, the coefficient of determination was 0.129, showing that the intention to reduce food wastage could only explain 12.9%. The coefficient of determination for the ITRF and OFD variables was considered strong or good because it was greater than 0.2. However, the value of the coefficient of determination for the FW variable was considered weak because it was less than 0.2.

3.6 Results of hypothesis testing

Path coefficient analysis was carried out to observe the connections between the latent variables in this study. These could be identified through the bootstrapping step which produced information in the form of the original sample value, t-statistics, and p-value. The results of the bootstrapping analysis in this study could be found in Figure 3.

Based on the bootstrapping results, the t-statistic and p-value results were obtained. The criteria needed for a variable to have a significant relationship was to have a t-statistic value greater than the t-table (t table at a = 5%). Meanwhile, the p-value that met the criteria was a p-value <0.05. The original sample values, t-statistics, and p-values were presented in Table 7.

Table 7: Path coefficient values

	Original sample	T statistics	P values
Attitude toward behavior (ATT) → Intention to reduce food waste (ITRF)	0.269*	3.838*	0.000*
Intention to reduce food waste (ITRF) → Food waste behavior (FW)	0.167	1.456	0.145
Online food delivery (OFD) → Food waste behavior (FW)	0.045	0.493	0.622
Perceived behavior control (PBC) → Food waste behavior (FW)	0.222*	2.301*	0.021*
Perceived behavior control (PBC) → Intention to reduce food waste (ITRF)	0.485*	8.142*	0.000*
Promotion (PRM) → Online food delivery (OFD)	0.731*	14.506*	0.000*
Subjective norms (SN) → Intention to reduce food waste (ITRF)	0.147	1.919	0.055

*significant at α = 5 %

4 Discussion

The path coefficient results were shown in Table 7. The attitude toward food waste variable had a significant relationship to the intention to reduce food waste. This could be seen from the p-value of 0.0010 or <0.05 and the t-statistic value of 3.838 or > 1.96 (t-table at a = 5%) and the original sample value was 0.269. A positive original sample value meant that the greater a person's attitude toward food waste, the greater a person's intention to reduce food waste. Therefore, H1 in this study was accepted and a study

conducted by (Heidari *et al.* 2019; Soorani & Ahmadvand 2019) stated that a person's attitude towards food waste influenced a person's intention to reduce food waste in a positive and significant manner, meaning that the greater a person's positive attitude towards food waste and the environment could increase one's intention to reduce food waste.

According to the results of the path coefficient shown in Table 7, the subjective norms variable did not have a significant effect on the intention to reduce food waste. This could be seen from the p-value of 0.055 or > 0.05, and the t-statistic value of 1.919 or <1.96 (t-table at a = 5%). Therefore, H2 in this study was rejected and the study (Visschers *et al.* 2016) stated that subjective norms had no significant effect on a person's intention to avoid leftover food and reduce the amount of food wasted. The study of Stefan *et al.* (2013) found that there was no significant relationship between subjective norms and a person's intention to protect the environment from food waste.

According to the results of the path coefficient shown in Table 7, the variable perceived behavior had a significant positive effect on the Intention to reduce food waste, and H3 in this study was accepted. This could be seen from the p-value of 0.000 or <0.05, the t-statistic value of 8.142 or > 1.96 (t-table at a = 5%), and the original sample value of 0.485. A study conducted by (Jia *et al.* 2022; Bleši *et al.* 2021) stated that perceived behavior control had a significant positive relationship with one's intention to reduce food waste.

Perceived behavior control variable had a significant positive effect on food-wasting behavior. Therefore, H4 in this study was rejected, and it could be seen from Table 7 which showed a p-value of 0.021 or <0.05, a t-statistic value of 2.301 or > 1.96 (t-table at a = 5%), and an original sample value of 0.222. The study of (Jia *et al.* 2022) stated that perceived behavior control had a significant positive relationship with food waste behavior.

The intention to reduce food waste variable had no significant effect on food-wasting behavior variable. In Table 7 it could be seen that the p-value was 0.145 or > 0.05, and the t-statistic was 1.456 or < 1.96 (t-table at a = 5%). A study conducted by Stancu *et al.* (2016) and Stefan *et al.* (2013) stated that the intention to reduce food waste did not contribute significantly or was sufficient to influence food-wasting behavior. Therefore, H5 in this study was rejected.

In Table 7 it could be seen that the p-value was 0.000 or <0.05, and the t-statistic was 14.506 or > 1.96 (t-table at a = 5%) and it could be said that the promotion variable had a significant positive effect on the OFD shopping behavior variable. Therefore, H6 in this study was accepted, and the greater the promotions offered by restaurants and OFD applications, the greater the number of consumers using these services. A study conducted by Upadhayay *et al.* (2020) and Tobing *et al.* (2022) stated that a person's purchase decision was significantly influenced by the promotion variable. This could be seen from an increase in purchases caused by an increase in promotions given.

OFD variable had no significant effect on food-wasting behavior, and H7 in this study was rejected. This could be seen from the path coefficient value in Table 7. The p-value was 0.622 or > 0.05, and the t-statistic value was 0.493 or <1.96. A study conducted by Shankar *et al.* (2022) found facts in the field that most consumers did not believe that the use of OFD applications could affect adding food waste.

5 Conclusion

In conclusion, the study highlighted several key results regarding food-wasting behavior among Muslim Generation Z in the context of OFD. In addition, it showed that the intention to reduce food waste was significantly shaped by an individual's attitude toward behavior and perceived behavior control, while subjective norms did not play a substantial role. Promotion strategies had a strong influence on OFD shopping behavior, which, in turn, did not significantly affect food-wasting behavior. However, food-wasting behavior was positively and significantly influenced by perceived behavior control.

For policymakers and investigators, the results underlined the importance of focusing on behavior attitudes and control mechanisms to promote responsible consumption among Muslim Gen-Z populations. Government initiatives could focus on increasing awareness about food waste through culturally and religiously tailored campaigns that resonated with Gen-Z Muslims, emphasizing stewardship and moderation principles in Islam. Promotion strategies for OFD services must also align with sustainable consumption practices, ensuring that incentives did not inadvertently encourage over-ordering or wasteful behavior.

Future studies must broaden the range of variables, such as religious motivation, environmental consciousness, and family influence, to provide deeper insights into the unique behavior patterns of Muslim Gen-Z. Expanding the demographic and geographic scope of the study could further strengthen the applicability of these results to diverse Muslim communities worldwide. This could support the development of targeted interventions to mitigate food waste in an era of rapidly growing OFD systems.

Conflict of Interest

The authors declare no conflict of interest.

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