



Analysis of Waste Separation Drivers in Urban Centers Using the Theory of Planned Behavior and the Norm Activation Model

Meilinda F.N. Maghfiroh^{1,2*}, Muqimuddin³, Widya Sartika⁴, Anak Agung Ngurah Perwira Redi⁵, Bayu Nur Abdallah⁴, Glenardo Antoi Hutahaean³, Ratna Agil Apriani²

¹ Faculty of Transport and Logistics, Muscat University, Muscat, Oman

² Industrial Engineering, Faculty of Industrial Technology, Universitas Islam Indonesia, Jogjakarta, Indonesia

³ Industrial Engineering, Industrial and Process Department, Institute Technology of Kalimantan, Balikpapan, Indonesia

⁴ Digital Business, Mathematics and Information Technology Department, Institute Technology of Kalimantan Balikpapan, Indonesia

⁵ Industrial Engineering, Sampoerna University, Jakarta, Indonesia

Corresponding email: mmaghfiroh@muscatuniversity.edu.om

ABSTRACT

Urban centers worldwide are grappling with complex waste management challenges, including efficient collection, transportation, processing, and an over-reliance on landfills. A promising approach to mitigate these issues lies in bolstering public participation in waste separation, which could significantly improve recycling efforts. To effectively encourage this practice, it is crucial to understand the underlying factors that motivate community engagement in waste segregation activities. This study utilizes the Theory of Planned Behavior and the Norm Activation Model to identify and analyze determinants influencing individuals' propensity to separate waste in the sampling area of Balikpapan City, Indonesia. Balikpapan, one of the cities in Indonesia, is currently facing several distinct challenges related to waste management. Through the empirical validation of eight hypotheses, it becomes apparent that the presence of market facilitators (H3) and the influence of past behavior (H5) play pivotal roles in shaping the intention to engage in waste separation. The findings suggest that providing accessible, well-maintained market facilities and initiatives designed to enrich the public's waste separation experience are essential strategies. Implementing these strategies could significantly improve waste separation practices within specific urban contexts such as Balikpapan, Indonesia, and other cities facing similar environmental management challenges.

ARTICLE INFO

Article History:

Received 08 Jan 2023

Revised 24 Jan 2024

Accepted 24 Feb 2024

Available online 01 Apr 2024

Keywords:

Behavior,
Norm Activation Model (NAM),
Theory Planned Behavior (TPB),
Waste Management,
Waste Separation.

1. INTRODUCTION

Waste significantly contributes to greenhouse gas emissions, releasing approximately 1,580 billion tons of CO₂ (Ritchie & Roser, 2020). This amount is equivalent to 3.2% of the total global CO₂ emissions. According to the provisions outlined in the Paris Agreement, it is imperative to achieve a reduction of 45% in total emissions across all sectors, including the waste sector, by the year 2030, emphasizing the importance for every country, including Indonesia, to develop strategies for waste management. According to the data provided by the Indonesian Central Bureau of Statistics (BPS) in 2020, urban centers in Indonesia generated a daily waste output of approximately 8 million metric tons in 2019 (Badan Pusat Statistik (BPS) Indonesia, 2021). The average daily municipal solid waste (MSW) generation per capita in around 384 major cities in Indonesia ranges from 2.2 to 2.7 kilograms (Broto-susilo & Handayani, 2020).

The substantial waste generated in Indonesia necessitates further land allocation for landfills, which, in the long term, could create a long-term viability threat to the country's environment. Landfilling, while a cost-effective and straightforward method of waste disposal, can pose significant environmental contamination risks if not properly managed (Kim & Owens, 2011). A study by Sun et al. (Sun et al., 2024) shows that many landfills contribute to microplastics, polluting water and land around landfills. In Indonesia, many landfills have been exceeding their capacity, resulting in greater danger for workers and the environment (Abidin et al., 2023; Trihadiningrum et al., 2023). Indonesia is currently challenged with various difficulties in waste management, from collection and transport processing (including composting and recycling) to reliance on landfills. The number of landfills in the country

could not match the rate at which garbage was being generated. Indonesia's MSW mainly comprises organic waste, plastic, paper, and glass materials (Sudibyo et al., 2017) from residential and non-residential areas. Data from the Organization for Economic Co-operation and Development (OECD, 2022) shows that around 79% of post-consumer waste (PW) worldwide is disposed of in landfills without proper management, with 9% of plastic waste recycled. According to Ismawati et al. (2022), the recycling rate stood at 14% due to informal waste sorting practices, while 45% was disposed of in landfills.

Municipal solid waste management (MSWM) in Indonesia is generally delegated to local government and municipalities, although it is frequently addressed in a disintegrated and uncoordinated custom (Kurniawan et al., 2022). Consequently, it is imperative to prioritize the implementation of comprehensive strategies and allocate resources, including manufacturers, transporters, related government, and recyclers, towards waste management effectively to tackle the escalating issue of MSW production, especially for waste that can be recycled. This collaboration will be essential in achieving better MSWM. Despite the advancements in managing municipal solid waste (MSW), there is a crucial need for coordinated efforts to address the socio-economic dimensions of waste management (Pieroni et al., 2021).

Nevertheless, for MSWM to be conducted efficiently, individuals must make conscientious efforts to handle and recycle waste. Implementing waste sorting at the household level is vital, as it has numerous advantages and mitigates the volume of waste destined for landfills. The management and recycling of garbage is a collective responsibility that necessitates the active participation of every person. In solid nonorganic waste, it is possible to recycle each category using dedicated recycling

processes, provided proper separation is carried out. Classifying household waste is significant as it facilitates the recycling process. According to Saptaputra et al. (2023), Indonesian individuals' level of understanding and awareness regarding waste sorting is considerably elevated, which shows potential for household sorting management.

Until now, the ineffectiveness of traditional approaches in promoting environmental sustainability has led to the recognition of digitalization as a crucial avenue for addressing existing challenges in the MSWM. The enhancement of municipal solid waste management (MSWM) through implementing circular economy (CE) principles highlights the necessity of digital transformation in addressing waste management issues. One of the digital transformations in the waste sector is the development of digital platforms that connect residents with waste recycling companies. The platform provides digital solutions to facilitate garbage sorting, collection, and management for households in Indonesia. Nevertheless, without active participation from families, the availability of waste management platform might not be used to its best potential. The Theory of Planned Behavior, or TPB, is a theory developed by Ajzen (1991) that considers conduct and identifies a person's sense of control over events resulting from behavior. Because most activities have plans based on different scenarios, the theory is focused on anticipating individual behavior (Al-Mamary & Alraja, 2022). A study by Pongpunpurt et al. (2022) in Thailand using TPB indicates that knowledge and subjective norms are significant factors that strongly influence respondents' intention regarding household waste separation behavior. The study's results in Ghana provide evidence that subjective norms, information dissemination, perceived behavioral control, and attitude directly and

positively influence the prediction of residents' intentions to adopt household waste separation (Tang et al., 2023). The study in Vietnam demonstrates that only attitude and subjective norms positively impact people's intention for waste separation (Thi Nguyen, 2015). Many other studies related to waste separation intention have also been conducted using the TPB framework in the context of Asia countries and confirmed different results, including studies in China (Zhang et al., 2021) (Hu et al., 2021), Malaysia (Razali et al., 2020), India (Vijayan et al., 2023), and Bangladesh (Jia et al., 2023), among others.

Nevertheless, the use of TPB to understand the motivation for Indonesians to separate their waste is limited. Thus, this study focuses on understanding factors relevant to their willingness to do household solid waste separation/sorting. Incorporating the extended Theory of Planned Behavior (TPB) and Norm Activation Model (NAM), this study analyzes how attitudes, subjective norms, perceived behavior control, and consequences shape Indonesian's choice to separate their waste.

Although the Theory of Planned Behavior (TPB) framework has been successful in examining the determining factors in different settings, scholars have argued that it may not be sufficient for explaining more intricate behaviors by having additional variables integrated into the framework (Ajzen, 1991, 1993, 2002; Davies et al., 2002). In Indonesia itself, many studies have attempted to use TPB, which relates to environmental concerns, including PET bottles (Amirudin et al., 2023); food waste among generation Z (Kristia et al., 2023); waste management in coastal communities (Simmons & Fielding, 2019); and smartphone refurbishment purchase intention (Chun et al., 2022).

Consequently, this study attempts to gain insight into the various external elements, which include the market facilitator (digital platform, government, private sector), mistrust towards the MSWM, and their past behavior, that have an impact on an individual's behavior and level of participation in waste sorting activities. This research also determines whether the "inconvenience of waste collection system" impacts waste separation behavior. Consequently, this study also attempts to gain insight into the various external elements, which include the market facilitator (digital platform, government, private sector), mistrust towards the MSWM, and their past behavior, that have an impact on an individual's behavior and level of participation in waste sorting activities. This research also determines whether the "inconvenience of waste collection system" impacts waste separation behavior.

2. LITERATURE REVIEW AND MODEL DEVELOPMENT

2.1. Attitude

In waste management cases, many studies have tried to understand the determinants of why people decide to separate or sort waste from their households. Three important determinants from TPB, including attitude, subjective norm, and perceived behavior control, are expected to expose the significant determinants of how people will act in this waste context. According to Fishbein & Ajzen (2009), *attitude* towards specific behavior pertains to individual cognitive views and subjective appraisal of the behavior. According to Reijonen et al. (2021), this attitude constitutes their environmental concern in waste management. Valle et al. (2005) showed that an inclination towards pro-environmental behavior could result in more consistent recycling. According to previous research (2016), it is probable that salient

ideas on environmental issues directly impact waste separation behavior. Accordingly, the following hypotheses can be concluded:

Hypothesis 1 (H1).

Attitude toward waste source separation positively affects behavioral intentions for waste separation.

2.2. Subjective Norms

Many believe that individual motivation to adhere to one behavior depends on that personal perception of expectations from others that hold significance to an individual, such as family, friends, peers, and neighbors. The subjective norms factor refers to the individual's decision to behave in a certain way based on perceived social pressure (Ajzen, 1991). Individuals who believe others recycle are more inclined to recycle themselves (Miliute-Plepiene et al., 2016). Conversely, when neighbors fail to sort their waste, it prevents others from engaging in waste-sorting activities (Ordoñez et al., 2015). A study by (Keuschnigg, M., & Kratz, F. 2017) shows how subjective norma and environmental concerns reassure waste separation behavior. Thus, our second hypothesis is:

Hypothesis 2 (H2).

Subjective norms positively affect behavioral intentions for waste separation.

2.3. Perceived Behavior Control

Perceived behavior control (PBC) pertains to an individual's subjective assessment of their self-efficacy, encompassing their perceived level of effort and skill about engaging in a particular behavior (Ajzen, 1991).

One initial approach to enhance home sorting and recycling behavior frequently involves disseminating information. The provision of recycling information has the potential to improve recycling proficiency. Suppose individuals perceive recycling as

too demanding or need more knowledge to engage in recycling practices. In that case, they will likely take action based on their environmental concerns and consequently fail to sort their waste correctly. According to Iyer and Kashyap (2007), implementing informational intervention programs has increased recycling participation. This assortment of information enhances comprehension and, thus, internalizes preferred behaviors by influencing attitudes and modifying behavior through increased perceived behavioral control (Dai et al., 2016). Accordingly, the following hypothesis is proposed.

Hypothesis 3 (H3).

Perceived information positively affects behavioral intentions for waste separation.

2.4. Perceived inconvenience

According to the study by Tonglet et al. (2004), situational factors, including perceived inconvenience, could impact recycling habits, the level of effort required, and the availability of recycling facilities. According to the latest study by Vassana-dumrongdee & Kittipongvises (2018), perceived inconvenience had a significant negative influence on waste separation intention. This may be linked to insufficient storage capacity for household separation, excessive time demands, or perceived recycling-related hazards. The study by Reijonen et al. (2021) also concluded that the higher the level of convenience in trash management, the greater the likelihood of individuals engaging in recycling practices. Accordingly, the following hypotheses can be concluded:

Hypothesis 4 (H4).

Perceived inconvenience negatively affects behavioral intentions for waste separation.

2.5. Awareness of consequences

The norm activation model of altruistic behavior (NAM) was initially formulated for use in the domain of pro-social behavior (Schwartz, 1977). The NAM has posited a theoretical framework wherein human behavior can be comprehensively elucidated by four fundamental factors: personal norms, social norms, awareness of consequences, and ascription of responsibility.

Chen and Tung (2009) incorporated a moral norm into their investigations on recycling behavior. This standard pertains to an individual's ethical and social responsibility considerations when engaging in a specific behavior. According to Davies et al. (Davies et al., 2002), an increased level of awareness regarding the positive effects associated with specific behaviors can lead to a stronger intention to engage in recycling activities. The significance and direct predictive nature of this component concerning recycling behavior were demonstrated in previous studies (Tonglet et al., 2004; Chen and Tung, 2010) that applied the Theory of Planned Behavior (TPB). The latest study by Wan et al. (2014) concluded that awareness of environmental consequences positively affects waste separation intention. Thus, our hypothesis is:

Hypothesis 5 (H5).

Awareness of Consequences positively affects waste separation behavior.

2.6. Market Facilitator

Market facilitators refer to the entities responsible for separating recyclable materials, which might exist in a formal or informal recycling market. Including several recyclable categories and the proximity of recycling facilities offer a convenient solution for households to manage their waste through recycling effectively. This is particularly crucial because even if individuals express a solid intention to engage in recycling, they may still perceive trash separation as inconvenient and abandon their

efforts to engage in the desired behavior. In other words, additional waste collection sites close to residential areas might offer people the convenience of segregating their waste (Scheinberg et al., 2011). According to Babaei et al. (2015), when recycling facilities are located close to residential areas, there is an observed rise in individuals' inclination to engage in recycling practices.

Xu et al. (2017) study shows that the availability of both private and government facilitators and monetary incentives significantly affect waste separation behavior.

Hypothesis 6 (H6).

The availability of market facilitators positively affects behavioral intentions.

2.7. Past Experience

Various research studies have provided evidence suggesting that prior experiences directly impact intention and conduct without being influenced by factors included in the theoretical framework (Tonglet et al., 2004). The study by White and Hyde (White & Hyde, 2011) also examines the influence of previous activity on an individual's behavior and intention to engage in recycling. The results indicate a significant relationship between attitude, subjective norm, self-identity, past behavior, and individuals' recycling intention. A

study by Vassanadumrongdee and Kittipongvises (2018) also shows the same result, with past behavior and habitual waste separation significantly influencing more waste separation.

Hypothesis 7 (H7).

Past behavior positively affects behavioral intentions. One particular barrier for waste separation is mistrust towards waste management (Vassanadumrongdee & Kittipongvises, 2018). There is a high probability of an unclear recycling process for the waste even after the separation. Furthermore, in many situations, even after the waste separation, it will be collected together with other waste during the waste transportation process. The study conducted by Wan et al. (2014) examines recycling behavior. It defines perceived policy efficacy as the subjective perception of a particular policy measure, specifically referring to individuals' opinions on the government's ability to implement effective and sufficient regulations.

Hypothesis 8 (H8).

Distrust of waste collection systems negatively affects behavioral intentions.

3. RESEARCH METHODOLOGY

We offer a conceptual model (Figure 1) for studying the waste separation practices of the Balikpapan City

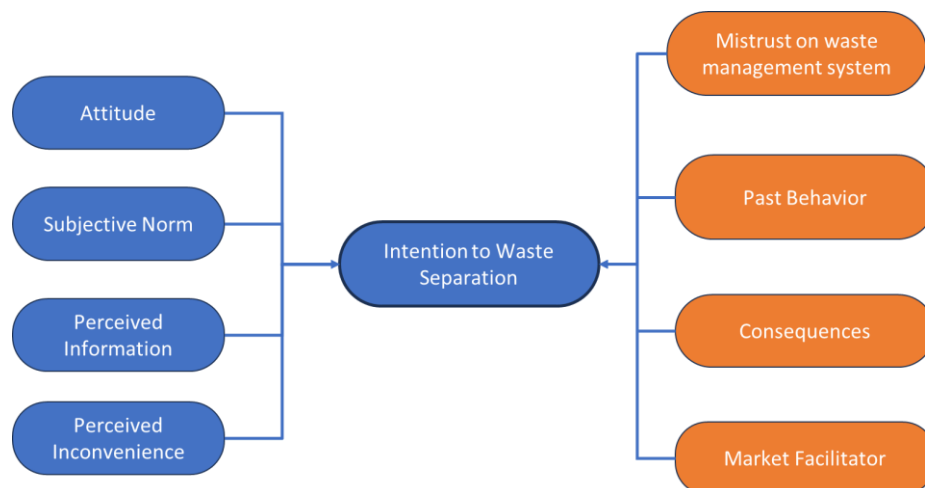


Figure 1 Conceptual framework variables

community based on hypotheses built on section 2.

Nine variables form the conceptual framework: attitude, subjective norm, perceived information, perceived inconvenience, consequences, market facilitator,

past behavior, mistrust of waste separation, and intention to waste separation. These variables are adopted from previous studies, with some modifications and adaptations (Wan et al., 2014), (Vassanadumrongdee & Kittipongvises, 2018), (Reijonen et al., 2021), (Ma et al., 2018)..

Table 1 The List of Questions

Variable	Code	Indicator	Source
Awareness of consequences	CON1	The municipal solid waste (MSW) problem in our country is worsening, affecting the environment and human health.	(Wan et al., 2014)
	CON3	Source separation can help mitigate global warming.	
Environmental Attitude	ATT2	If things continue on their present course, we will soon experience a major ecological catastrophe.	(Wan et al., 2014)
	ATT4	Dealing with the problem of climate change should be a priority, even if it causes slower economic growth and some loss of jobs.	
Subjective norms	SN1	If things continue on their present course, we will soon experience a major ecological catastrophe.	(Wan et al., 2014)
	SN2	I feel that source separation is an essential responsibility for me	
	SN3	I would feel guilty if I did not do source separation according to the rules.	
	SN5	If I see my neighbor doing source separation, I will do it, too.	
Perceived information level on source separation	PIL2	you received information on source separation from the government's district office	Reijonen et al., 2021
	PIL3	you received information on source separation from the media (TV/radio/ newspaper)	
	PIL4	government public relations could help increase your knowledge of source separation	
Perceived inconvenience	PI1	Source separation is time-consuming and useless	(Reijonen et al., 2021),
	PI2	Source separation is too complicated	
	PI4	Source separation does not add value.	
Mistrust of MSW collection	MT1	Even if I do source separation, garbage collectors would mix sorted waste with other waste.	(Vassanadumrongdee & Kittipongvises, 2018)
	MT3	Even though the environmental quality is getting worse, I still think that the economic problem outweighs the environmental problem	
	MT4	Solving the solid waste problem is the duty of the government and municipalities, not me.	
Intention To Waste Separation	ITWS1	I am willing to do garbage separation if there is a garbage collection service (specific for dry waste only)	(Wan et al., 2014), (Vassanadumrongdee & Kittipongvises, 2018), (Xu et al., 2017), (Reijonen et al., 2021),
	ITWS2	I am willing to separate garbage if people buy separate waste.	
	ITWS3	I am willing to do garbage separation if there are scheduled pick-up services for the separated waste	
Market facilitator	MF1	I can easily sell potential recycling waste to recycling waste collection companies (sell to recycling companies, district's recycling waste provider)	(Xu et al., 2017)
	MF2	There are recycling waste collection companies that are willing to take in waste (plastics/cardboard/etc.)	
	MF3	There are waste separation bins provided by the government/other parties	
Past behavior	PB1	I have been regularly separating the garbage	(Ma et al., 2018).
	PB2	I have a sense of initiative in sorting and recycling household waste.	
	PB3	I am committed to recycling waste as much as possible.	
	PB4	I prioritize recycling measures when managing waste in my home.	

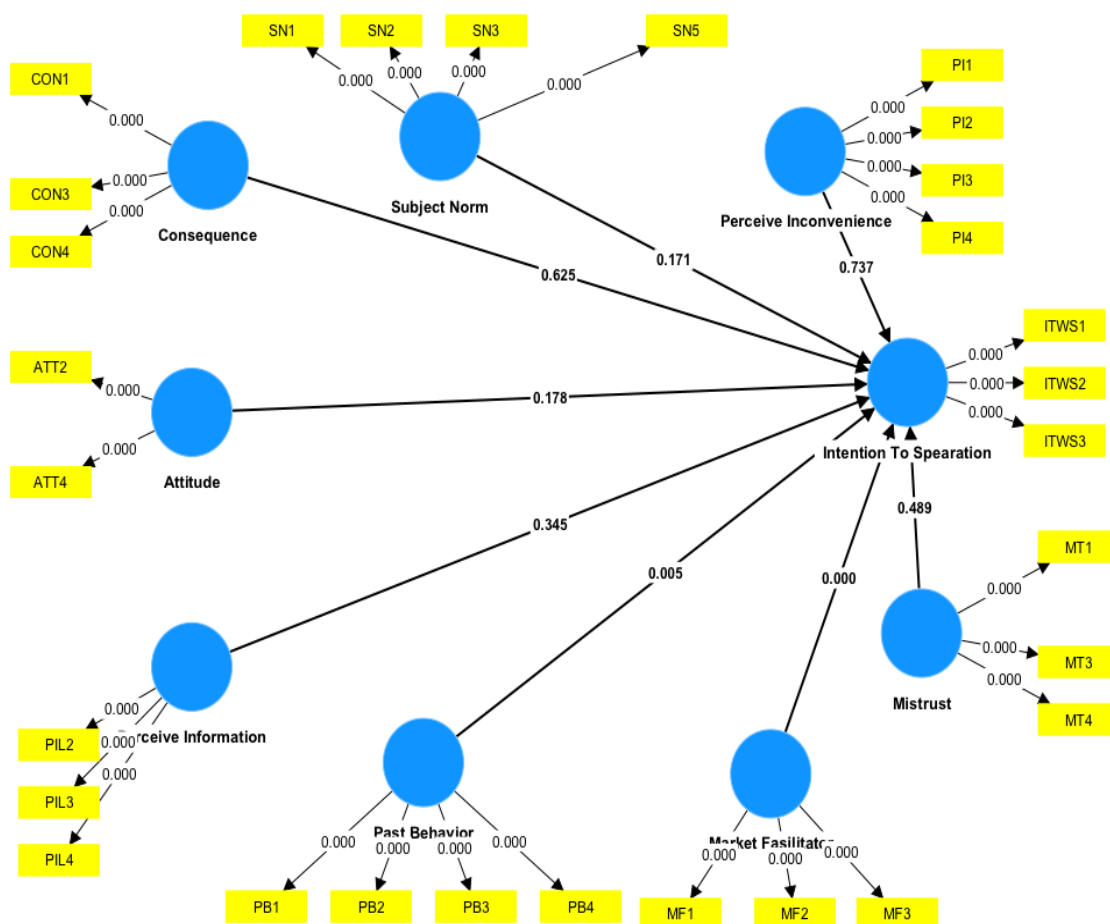


Figure 2. SEM PLS model output

Data collection for this research was conducted in Balikpapan City, Indonesia, with respondents consisting of the general public, and random sampling was employed as the sampling technique. Respondents were presented with 28 questions rated on a scale from 1 (strongly disagree) to 5 (strongly agree), depicting all nine variables for this research. The list of questions can be found in **Table 1**.

We conducted online and several offline surveys involving surveyors to approach respondents for assessment. Data collection took place over two months, starting in August 2023. To avoid bias, the survey was conducted with an explanation to respondents within the questionnaire regarding the confidentiality of their identity and the purpose of the survey. From the data collection results, 224 questionnaires were collected. Two hundred

twenty-two were further analyzed, while two others were eliminated from the data collection.

Regarding respondents' characteristics, they are as follows: 44% are male, and 57% are female. Based on their occupational status, 61% are students. 19% are homemakers. 11% are Civil Servants. 5% are Private Sector Employees. 4% are self-employed.

The structural model proposed in this study consists of 8 constructs that independently relate to the cause and effect of a dependent variable, "Intention to waste separation." The causal relationship among variables is analyzed by employing SmartPLS tools, which can produce output that includes Cronbach's alpha and composite reliability (CR) as references to assess

the reliability. **Figure 2** shows SEM PLS model output.

From the analysis results, both Cronbach's alpha and CR have values above 0.7, which indicates that the model's reliability has been achieved. Therefore, the respondents' assessment results can be used for further analysis. To ensure the indicators' validity, the loading factor values for each indicator can be examined. A loading factor > 0.7 can indicate that the indicator positively represents the constructed variable (Edeh et al., 2023). Based on the testing results shown in **Table 2**, all indicators have met the validity criteria, as their loading factors are above 0.7.

As indicated by the T-statistic and P-value output in **Table 2**, based on a significance level of 5%, it shows that two variables significantly influence the intention to separate waste. In contrast, the other six variables do not significantly impact the intention to separate waste. The variable "attitude" does not have a significant effect on the intention to separate waste (H1 is not supported), with a P-value < 0.05. Other variables that do not have a significant impact include "consequence" (H2 is not supported), Mistrust in the waste

management system (H4 is not supported), "Perceived Information" (H6 is not supported), "Perceived Inconvenience" (H7 is not supported), and "Subjective norm" (H8 is not supported). Each of these variables has a P-value < 0.05. On the other hand, the other two hypotheses for the two variables, H3 (market facilitator) and H5 (past behavior), significantly influence the intention to separate waste.

4. RESULTS AND DISCUSSION

The survey on the behavior of the Balikpapan City community has been conducted and analyzed using SEM PLS. This analysis provides insights for stakeholders, especially waste management authorities in Balikpapan. Therefore, it can serve as a reference for decision-making. The analysis results show that two variables have been proven to influence the intention of the Balikpapan City community to separate waste. The other six variables do not significantly affect the intention to separate waste. Several significant findings from the empirical testing results can be highlighted.

Table 2 Output T-Statistic & P-Values

<i>Relationship between latent variables</i>	<i>Coefficient</i>	<i>T-Statistics</i>	<i>P-Values</i>
<i>Attitude -> Intention to Waste Separation</i>	0.09	1.347	0.178
<i>Consequences -> Intention to Waste Separation</i>	0.035	0.489	0.625
<i>Market Facilitator -> Intention to Waste Separation</i>	0.49	7.934	0.000
<i>Mistrust on Waste Management System -> Intention to Waste Separation</i>	0.041	0.691	0.489
<i>Past Behavior -> Intention to Waste Separation</i>	0.211	2.824	0.005
<i>Perceived Inconvenience -> Intention to Waste Separation</i>	-0.021	0.336	0.737
<i>Perceived Information -> Intention to Waste Separation</i>	-0.058	0.943	0.345
<i>Subjective Norm -> Intention to Waste Separation</i>	0.103	1.369	0.171

First, the availability of market facilities influences the intention of the community to waste separation (Xu et al., 2017). This aligns with the findings of this research, which demonstrate a significant impact of market facilities on the intention of the Balikpapan City community to separate waste. This indicates that the people of Balikpapan have an orientation towards the availability of market facilities. The analysis also states that the market facilitator variable has the highest influence compared to other variables. The presence of companies that can accept separated waste will motivate individuals to engage in waste separation, especially if the separated waste has economic value for them. According to Xu et al. (2018), the incentives or economic value for individuals can drive them to participate in waste separation. Facilities are not just waste disposal sites; they are facilities that provide value to the community. Waste management authorities, including private and government, should ensure facilities' adequacy, such as waste banks' availability in specific areas. The authorities in charge should ensure the provision of facilities for residents to separate waste, considering timing and location to minimize difficulties for the community in this regard (Cudjoe et al., 2020).

Furthermore, it is essential to ensure the ease of use and quality of these facilities for the community. Chen & Lee (2020) explained that government policies can influence the community's intention to separate waste. This motivates individuals to engage in waste separation at home and in public spaces.

Second, regular waste separation, self-initiative, commitment, and prioritizing actions in waste separation reflect a positive past attitude. This has a significant influence on the intention of the Balikpapan City community to separate waste. This means there are already

positive experiences within the community, and engaging programs are necessary to enhance these experiences. The challenge in this regard is maintaining the consistency of these past experiences, as they originate from individuals and require habitual practices, starting from the local community level.

Third, the results of this research conflict with some previous studies, as six research variables do not significantly affect the intention of the community to separate waste. Some studies, such as B. Chen & Lee (2020) state that the "attitude" variable is the one with the most significant influence on the intention of the community to separate waste. However, this research involves respondents with different characteristics. In their study, Brotosusilo & Handayani (2020) revealed that public awareness about widespread waste management contributes to a less pro-environment attitude. "Perceived information" and "perceived inconvenience" are also variables that have been proven to not significantly influence the intention of the Balikpapan City community to separate waste. The analysis results show that the coefficients have negative signs, meaning that an increase in information about these aspects impacts their reduced intention to separate waste.

Lastly, another conflict arises regarding mistrust in waste management, consequences, and subjective norms as variables that have been proven to not significantly influence the intention of the Balikpapan City community to separate waste. Pedersen & Manhice (2020) note that the community perceives that separating waste requires more effort than mixing it, requiring them to invest time, energy, and awareness. The consequences of waste separation behavior and the environmental examples around them are not strong enough to motivate them to separate waste. The coefficients for these two

variables are small, indicating that promoting waste separation among the community may not require significant emphasis based on these variables.

5. CONCLUSION

Based on the research results, the influence of 8 observed variables on the community's interest in waste separation was examined. Two variables have been proven to impact the Balikpapan community's intention to separate waste significantly. Market facilities are the variable with the highest influence among the others. This means that authorities should use this as a reference in determining policies and programs. Not only the government but also the private sector can participate in fulfilling this, making waste management in Balikpapan easier as waste separation behavior increases. Programs can also enhance the public experience in waste

management, including waste separation because this study demonstrates that experience is the second variable with a significant impact on the Balikpapan community's willingness to separate waste.

This research also shows that 2 variables negatively impact the interest in waste separation. These variables include Perceived information and perceived inconvenience. If these variables become the authorities' focus, they will decrease the community's interest in waste separation. Therefore, this should not be a concern for the authorities (government or private sector), especially in Balikpapan.

ACKNOWLEDGEMENT

This study was supported by KEDAIREKA with Contract Number 23/E1/PPK/KS.03.00/2023.

REFERENCES

- Abidin, A. U., Maziya, F. B., Susetyo, S. H., Yoneda, M., & Matsui, Y. (2023). Exposure particulate matter (PM2.5) and health risk assessment on informal workers in landfill site, Indonesia. *Environmental Challenges*, 13, 100795. <https://doi.org/10.1016/j.ENVC.2023.100795>
- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179–211. [https://doi.org/https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/https://doi.org/10.1016/0749-5978(91)90020-T)
- Ajzen, I. (1993). Attitude theory and the attitude-behavior relation. In Krebs, D. and Schmidt, P. (Eds), *New Directions in Attitude Measurement*, January 1993, 41–57.
- Ajzen, I. (2002). Residual Effects of Past on Later Behavior: Habituation and Reasoned Action Perspectives. *Personality and Social Psychology Review*, 6(2), 107–122. <https://doi.org/10.1207/S15327957PSPR0602>
- Al-Mamary, Y. H. S., & Alraja, M. M. (2022). Understanding entrepreneurship intention and behavior in the light of TPB model from the digital entrepreneurship perspective. *International Journal of Information Management Data Insights*, 2(2). <https://doi.org/10.1016/j.jjime.2022.100106>

- Amirudin, A., Inoue, C., & Grause, G. (2023). Assessment of factors influencing Indonesian residents' intention to use a deposit–refund scheme for PET bottle waste. *Circular Economy*, 2(4), 100061. <https://doi.org/10.1016/J.CEC.2023.100061>
- Babaei, A. A., Alavi, N., Goudarzi, G., Teymouri, P., Ahmadi, K., & Rafiee, M. (2015). Household recycling knowledge, attitudes and practices towards solid waste management. *Resources, Conservation and Recycling*, 102, 94–100. <https://doi.org/10.1016/J.RESCONREC.2015.06.014>
- Badan Pusat Statistik (BPS) Indonesia. (2021). *Statistik Lingkungan Hidup Indonesia 2022*. <https://www.bps.go.id/publication/2022/11/30/eb06d1c8e37285cac10c3086/statistik-lingkungan-hidup-indonesia-2022.html>
- Brotosusilo, A., & Handayani, D. (2020). Dataset on waste management behaviors of urban citizens in large cities of Indonesia. *Data in Brief*, 32. <https://doi.org/10.1016/j.dib.2020.106053>
- Chen, B., & Lee, J. (2020). Household waste separation intention and the importance of public policy. *International Trade, Politics and Development*, 4(1), 61–79. <https://doi.org/10.1108/itpd-03-2020-0008>
- Chen, M.-F., & Tung, P.-J. (2009). The Moderating Effect of Perceived Lack of Facilities on Consumers' Recycling Intentions. *Environment and Behavior*, 42(6), 824–844. <https://doi.org/10.1177/0013916509352833>
- Chun, Y. Y., Matsumoto, M., Chinen, K., Endo, H., Gan, S. S., & Tahara, K. (2022). What will lead Asian consumers into circular consumption? An empirical study of purchasing refurbished smartphones in Japan and Indonesia. *Sustainable Production and Consumption*, 33, 158–167. <https://doi.org/10.1016/J.SPC.2022.06.015>
- Cudjoe, D., Yuan, Q., & Han, M. S. (2020). An assessment of the influence of awareness of benefits and perceived difficulties on waste sorting intention in Beijing. *Journal of Cleaner Production*, 272. <https://doi.org/10.1016/j.jclepro.2020.123084>
- Dai, Y. C., Lin, Z. Y., Li, C. J., Xu, D. Y., Huang, W. F., & Harder, M. K. (2016). Information strategy failure: personal interaction success, in urban residential food waste segregation. *Journal of Cleaner Production*, 134(Part A), 298–309. <https://doi.org/10.1016/J.JCLEPRO.2015.12.104>
- Davies, J., Foxall, G. R., & Pallister, J. (2002). Beyond the Intention–Behaviour Mythology: An Integrated Model of Recycling. *Marketing Theory*, 2(1), 29–113. <https://doi.org/10.1177/1470593102002001645>
- Edeh, E., Lo, W.-J., & Khojasteh, J. (2023). Review of Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R: A Workbook. In *Structural Equation Modeling: A Multidisciplinary Journal* (Vol. 30, Issue 1). <https://doi.org/10.1080/10705511.2022.2108813>

- Fishbein, M., & Ajzen, I. (2009). *Predicting and Changing Behavior: The Reasoned Action Approach* (1st editio). Psychology Press. <https://doi.org/https://doi.org/10.4324/9780203838020>
- Hu, J., Tang, K., Qian, X., Sun, F., & Zhou, W. (2021). Behavioral change in waste separation at source in an international community: An application of the theory of planned behavior. *Waste Management*, *135*, 397–408. <https://doi.org/10.1016/J.WASMAN.2021.09.028>
- Ismawati, Y., Septiono, M. A., & Proboretno, N. (2022). *Plastic Waste Management and Burden in Indonesia*. https://ipen.org/sites/default/files/documents/ipen-2021-indonesia-v1_1aw.pdf
- Iyer, E. S., & Kashyap, R. K. (2007). Consumer recycling: role of incentives, information, and social class. *Journal of Consumer Behaviour*, *6*(1), 32–47. <https://doi.org/https://doi.org/10.1002/cb.206>
- Jia, Q., Islam, M. S., Hossain, M. S., Li, F., & Wang, Y. (2023). Understanding residents' behaviour intention of recycling plastic waste in a densely populated megacity of emerging economy. *Heliyon*, *9*(8), e18921. <https://doi.org/10.1016/J.HELİYON.2023.E18921>
- Keuschnigg, M., & Kratz, F. (2017). Thou Shalt Recycle: How Social Norms of Environmental Protection Narrow the Scope of the Low-Cost Hypothesis. *Environment and Behavior*, *50*(10), 1059–1091. <https://doi.org/10.1177/0013916517726569>
- Kim, K. R., & Owens, G. (2011). Potential for Enhanced Phytoremediation of Landfills Using Biosolids – A Review. *Comprehensive Biotechnology*, 276–284. <https://doi.org/10.1016/B978-0-444-64046-8.00354-2>
- Kristia, K., Kovács, S., & László, E. (2023). Food delivery platform and food waste: Deciphering the role of promotions, knowledge, and subjective norms among Indonesian generation Z. *Cleaner and Responsible Consumption*, *11*, 100152. <https://doi.org/10.1016/J.CLRC.2023.100152>
- Kurniawan, T. A., Dzarfan Othman, M. H., Hwang, G. H., & Gikas, P. (2022). Unlocking digital technologies for waste recycling in Industry 4.0 era: A transformation towards a digitalization-based circular economy in Indonesia. *Journal of Cleaner Production*, *357*, 131911. <https://doi.org/10.1016/J.JCLEPRO.2022.131911>
- Ma, J., Hipel, K. W., Hanson, M. L., Cai, X., & Liu, Y. (2018a). An analysis of influencing factors on municipal solid waste source-separated collection behavior in Guilin, China by Using the Theory of Planned Behavior. *Sustainable Cities and Society*, *37*(September 2017), 336–343. <https://doi.org/10.1016/j.scs.2017.11.037>
- Ma, J., Hipel, K. W., Hanson, M. L., Cai, X., & Liu, Y. (2018b). An analysis of influencing factors on municipal solid waste source-separated collection behavior in Guilin, China by Using the Theory of Planned Behavior. *Sustainable Cities and Society*, *37*, 336–343. <https://doi.org/10.1016/j.scs.2017.11.037>

- Miliute-Plepiene, J., Hage, O., Plepys, A., & Reipas, A. (2016). What motivates households recycling behaviour in recycling schemes of different maturity? Lessons from Lithuania and Sweden. *Resources, Conservation and Recycling*, 113, 40–52. <https://doi.org/10.1016/J.RESCONREC.2016.05.008>
- Ordoñez, I., Harder, R., Nikitas, A., & Rahe, U. (2015). Waste sorting in apartments: integrating the perspective of the user. *Journal of Cleaner Production*, 106, 669–679. <https://doi.org/10.1016/J.JCLEPRO.2014.09.100>
- Pedersen, J. T. S., & Manhice, H. (2020). The hidden dynamics of household waste separation: An anthropological analysis of user commitment, barriers, and the gaps between a waste system and its users. *Journal of Cleaner Production*, 242, 116285. <https://doi.org/10.1016/j.jclepro.2019.03.281>
- Pieroni, M. P. P., McAlloone, T. C., & Pigosso, D. C. A. (2021). Circular economy business model innovation: Sectorial patterns within manufacturing companies. *Journal of Cleaner Production*, 286, 124921. <https://doi.org/10.1016/j.jclepro.2020.124921>
- Pongpunpurt, P., Muensitthiroj, P., Pinitjitsamut, P., Chuenchum, P., Painmanakul, P., Chawaloessphonsiya, N., & Poyai, T. (2022). Studying Waste Separation Behaviors and Environmental Impacts toward Sustainable Solid Waste Management: A Case Study of Bang Chalong Housing, Samut Prakan, Thailand. *Sustainability (Switzerland)*, 14(9). <https://doi.org/10.3390/su14095040>
- Razali, F., Daud, D., Weng-Wai, C., & Anthony Jiram, W. R. (2020). Waste separation at source behaviour among Malaysian households: The Theory of Planned Behaviour with moral norm. *Journal of Cleaner Production*, 271, 122025. <https://doi.org/10.1016/J.JCLEPRO.2020.122025>
- Reijonen, H., Bellman, S., Murphy, J., & Kokkonen, H. (2021a). Factors related to recycling plastic packaging in Finland's new waste management scheme. *Waste Management*, 131, 88–97. <https://doi.org/10.1016/J.WASMAN.2021.05.034>
- Reijonen, H., Bellman, S., Murphy, J., & Kokkonen, H. (2021b). Factors related to recycling plastic packaging in Finland's new waste management scheme. *Waste Management*, 131, 88–97. <https://doi.org/10.1016/j.wasman.2021.05.034>
- Reijonen, H., Bellman, S., Murphy, J., & Kokkonen, H. (2021c). Factors related to recycling plastic packaging in Finland's new waste management scheme. *Waste Management*, 131, 88–97. <https://doi.org/10.1016/j.wasman.2021.05.034>
- Ritchie, H., & Roser, M. (2020). *CO₂ and Greenhouse Gas Emission*. Website. <https://our-worldindata.org/co2-and-other-greenhouse-gas-emissions>
- Saptaputra, E. H., Bonafix, N., & Arafanda, A. S. (2023). Mobile App as Digitalisation of Waste Sorting Management. *IOP Conference Series: Earth and Environmental Science*, 1169(1). <https://doi.org/10.1088/1755-1315/1169/1/012007>

- Scheinberg, A., Spies, S., Simpson, M. H., & Mol, A. P. J. (2011). Assessing urban recycling in low- and middle-income countries: Building on modernised mixtures. *Habitat International*, 35(2), 188–198. <https://doi.org/10.1016/J.HABITATINT.2010.08.004>
- Schwartz, S. H. (1977). Normative Influences on Altruism. *Advances in Experimental Social Psychology*, 10(C), 221–279. [https://doi.org/10.1016/S0065-2601\(08\)60358-5](https://doi.org/10.1016/S0065-2601(08)60358-5)
- Simmons, E. C., & Fielding, K. S. (2019). Psychological predictors of fishing and waste management intentions in Indonesian coastal communities. *Journal of Environmental Psychology*, 65, 101324. <https://doi.org/10.1016/J.JENVP.2019.101324>
- Sudiby, H., Pradana, Y. S., Budiman, A., & Budhijanto, W. (2017). Municipal Solid Waste Management in Indonesia - A Study about Selection of Proper Solid Waste Reduction Method in D.I. Yogyakarta Province. *Energy Procedia*, 143(December), 494–499. <https://doi.org/10.1016/j.egypro.2017.12.716>
- Sun, H., Hu, J., Wu, Y., Gong, H., Zhu, N., & Yuan, H. (2024). Leachate from municipal solid waste landfills: A neglected source of microplastics in the environment. *Journal of Hazardous Materials*, 465, 133144. <https://doi.org/10.1016/J.JHAZMAT.2023.133144>
- Tang, D., Cai, X., Nketiah, E., Adjei, M., Adu-Gyamfi, G., & Obuobi, B. (2023). Separate your waste: A comprehensive conceptual framework investigating residents' intention to adopt household waste separation. *Sustainable Production and Consumption*, 39, 216–229. <https://doi.org/10.1016/J.SPC.2023.05.020>
- Thi Nguyen, N.-H. (2015). Quantitative Analysis of Ambulance Location-allocation and Ambulance State Prediction. In *Quantitative Analysis of Ambulance Location-allocation and Ambulance State Prediction*. <https://doi.org/10.3384/lic.diva-113346>
- Tonglet, M., Phillips, P. S., & Read, A. D. (2004). Using the Theory of Planned Behaviour to investigate the determinants of recycling behaviour: a case study from Brixworth, UK. *Resources, Conservation and Recycling*, 41(3), 191–214. <https://doi.org/10.1016/J.RESCONREC.2003.11.001>
- Trihadiningrum, Y., Wilujeng, S. A., Tafaqury, R., Radita, D. R., & Radityaningrum, A. D. (2023). Evidence of microplastics in leachate of Randegan landfill, Mojokerto City, Indonesia, and its potential to pollute surface water. *Science of The Total Environment*, 874, 162207. <https://doi.org/10.1016/J.SCITOTENV.2023.162207>
- Vassanadumrongdee, S., & Kittipongvises, S. (2018). Factors influencing source separation intention and willingness to pay for improving waste management in Bangkok, Thailand. *Sustainable Environment Research*, 28(2), 90–99. <https://doi.org/10.1016/J.SERJ.2017.11.003>
- Vijayan, R. V., Krishnan, M. M., Parayitam, S., Anantharaman Duraisami, S. P., & Saravanaselvan, N. R. (2023). Exploring e-waste recycling behaviour intention among the households: Evidence from India. *Cleaner Materials*, 7, 100174. <https://doi.org/10.1016/J.CLEMA.2023.100174>

- Wan, C., Shen, G. Q., & Yu, A. (2014). The role of perceived effectiveness of policy measures in predicting recycling behaviour in Hong Kong. *Resources, Conservation and Recycling*, 83, 141–151. <https://doi.org/10.1016/J.RESCONREC.2013.12.009>
- White, K. M., & Hyde, M. K. (2011). The Role of Self-Perceptions in the Prediction of Household Recycling Behavior in Australia. *Environment and Behavior*, 44(6), 785–799. <https://doi.org/10.1177/0013916511408069>
- Xu, L., Ling, M., Lu, Y., & Shen, M. (2017). External influences on forming residents' waste separation behaviour: Evidence from households in Hangzhou, China. *Habitat International*, 63, 21–33. <https://doi.org/10.1016/J.HABITATINT.2017.03.009>
- Xu, L., Ling, M., & Wu, Y. (2018). Economic incentive and social influence to overcome household waste separation dilemma: A field intervention study. *Waste Management*, 77, 522–531. <https://doi.org/10.1016/j.wasman.2018.04.048>
- Zhang, S., Hu, D., Lin, T., Li, W., Zhao, R., Yang, H., Pei, Y., & Jiang, L. (2021). Determinants affecting residents' waste classification intention and behavior: A study based on TPB and A-B-C methodology. *Journal of Environmental Management*, 290, 112591. <https://doi.org/10.1016/J.JENVMAN.2021.112591>