



Willingness to Use Reverse Vending Machine in Plastic Bottle Waste Management

Ari Nurfikri¹, Dwi Nowo Martono²

¹Applied Health Department, Vocational Education Program, Universitas Indonesia, Indonesia

²School of Environmental Science, Universitas Indonesia, Indonesia
arinurfikri@ui.ac.id

Abstract. Plastic bottles take a long time to decompose by nature. In contrast, plastic bottle waste in Indonesia is disposed of uncontrolled, which can affect public health and the environment. Indonesia has started digitizing plastic bottle recycling with a circular economy approach to address this problem. Plasticpay is a social movement based on a digital platform that invites people to change plastic waste, which initially damages the environment, to become economically helpful. Plasticpay has collaborated with various parties, including the University of Indonesia Vocational Education Program, in managing plastic waste. However, field studies show that the Reverse Vending Machine has not been widely used. This study explores the challenges to acceptance and willingness to use Reverse Vending Machines. The identified variables include attitude, subjective norms, and behavioral control. The survey was designed, and data was collected from 80 respondents to understand their views. Structural Equation Modeling is used to test the conceptual model. The firm results show that behavioral control factors influence the willingness to use Reverse Vending Machines. Willingness of using a high Reverse Vending machine requires ease of use and increased rewards.

Keywords: Plasticpay, Reverse Vending Machine, UI GreenMetric

1 Introduction

The discovery of plastic bottles, considered cheaper and safer than glass and metal, has sparked the beverage industry's growth, which produces large volumes of plastic bottle waste (1). The increase in consumption of soft drinks in the last decade is the leading cause of plastic pollution. If the rate of goods production and waste production is not reduced, the total mismanaged waste worldwide will double by 2050 (2). Disposal of plastic waste without implementing sustainable concepts ends up in the sea or landfill affecting the food chain, which is detrimental to living things. Policies to reduce plastic consumption in several countries have proven ineffective. Recycling plastic bottle waste is a solution to reduce plastic production (1). Countries in Asia account for 71%

© The Author(s) 2023

D. V. Ferezagia et al. (eds.), *Proceedings of the International Conference on Vocational Education Applied Science and Technology (ICVEAST 2023)*, Advances in Social Science, Education and Humanities Research 783,
https://doi.org/10.2991/978-2-38476-132-6_62

of plastic mismanagement in the world. Four countries, such as China, Indonesia, Vietnam, and the Philippines, are the top countries contributing to waste management on the Asian continent. In Indonesia, plastic waste collection is managed by the formal and informal sectors. The formal sector collects four times more plastic waste than the informal sector, but only 1% of plastic waste managed by the formal sector is recycled; the rest is buried in the ground or burned, while plastic waste managed by the informal sector is more for recycling, but not sufficient the need for plastic recycling results so that Indonesia imports 320,000 tons of plastic (3).

The linear economy harms the environment, so many sectors are turning towards an environmentally friendly circular economy. Recycling is an effective way to reduce plastic waste. Recycled plastic can be used as a raw material for the automotive, concrete, and textile industries (2). Plastic bottle waste can be processed into products that have economic value (4). Even though plastic waste recycling has been proven effective in reducing plastic waste, it still faces challenges in its implementation. Public awareness of recycling plastic waste still needs to be higher due to unavailability of time, lack of knowledge, lack of adequate infrastructure, unable to find convenient recycling facilities and still considers recycling of plastic waste unimportant. Efforts to follow up on the challenge of recycling plastic waste are by increasing public awareness with innovation (1). Technological advances enable digitization to bring practical solutions to encourage the growth of the plastic waste processing business by recovering resources more efficiently (5). Collecting plastic waste and motivating communities to recycle requires systematic, low-cost techniques and incentive-based systems. Reverse Vending Machine is a medium for incentivizing people who collect plastic bottle waste (2). Several countries have attempted to implement Reverse Vending Machines to manage plastic waste. Norway has successfully implemented an incentive system through cash or reduced public bills. Japan partnered with the company to provide Reverse Vending Machines. The company benefits through its brand image and positions itself as an environmentally friendly institution. Japanese society still needs to receive a better plastic waste management incentive scheme with Reverse Vending Machines. Reverse Vending Machines in India has been around since 2016, but public acceptance still needs to be higher due to the absence of an incentive system, so people who are aware of the importance of recycling will use Reverse Vending Machines. Reverse Vending Machines in Russia has been around since 2019 with the concept of giving discounts for every purchase of drinks using Reverse Vending Machines. Finland imposes a tax policy on beverage manufacturers who use plastic bottles. The government will reduce the tax if producers actively participate in the recycling community. Public awareness in Finland is good, so they don't apply an incentive system. The German government's approach is to cooperate with supermarkets that sell drinks to collect plastic bottles from drinks sold. In Khazakstan, although public awareness is relatively low, there is a public desire to use Reverse Vending Machines. The government is trying to educate the public, placing Reverse Vending Machines in locations that are easily accessible and providing incentives in the form of discounts, bonuses, and card top-up balance (1).

One application for managing plastic bottle waste that offers points that can be converted into e-wallet balances is Plasticpay. Unlike other applications, Plasticpay encourages the public to send plastic bottle waste into drop boxes or Reverse Vending Machines available to partners who have worked together. The reward that Plasticpay users get is one plastic bottle that gets 56 points which can be converted into a cooperating bank account balance or e-wallet (5).

Plasticpay implements Reverse Vending Machines in Indonesia to manage plastic bottle waste with literature studies from various countries that have already implemented it. Plasticpay partners with companies in providing Reverse Vending Machines places Reverse Vending Machines in locations that are easily accessible to the public, and provides incentives in the form of e-money balances that can increase public awareness of using Reverse Vending Machines.

Like Finland, the Indonesian government will reduce taxes for companies actively participating in environmental management. Bank Syariah Indonesia has a policy of providing corporate social responsibility related to the green economy. In implementing Corporate Social Responsibility, Bank Syariah Indonesia cooperates with Plasticpay in promoting the green economy movement, one of which is by making Reverse Vending Machines placed at several points that have the potential to support the movement (6). In the Jabodetabek area, Bank Syariah Indonesia and Plasticpay have collaborated with 21 partner institutions, namely four educational institutions of the University of Indonesia Vocational Education Program, Cirendeu Labschool School, Bina Nusantara Anggrek Campus, and ACS School Jakarta; eight shopping centers namely Grand Indonesia, Supermall Karawaci, Living World Mall Tangerang, Cibinong City Mall, AEON Mall Tanjung Barat, AEON Mall BSD, AEON Mall Sentul, AEON Mall JGC Jakarta; three places of worship namely the Istiqlal Mosque, Asy-Syarif Al Azhar BSD Mosque, At-Thohir Mosque; two apartments namely the Taman Rasuna Kuningan Apartment and the Bina Nusantara Apartement; two office complexes namely the Office 8 Senopati SCBD Building and the International Financial Center Tower; as well as two public facilities namely Bogor City Square and Taman Ismail Marzuki Bogor Regency (7).

The University of Indonesia's Vocational Education Program is the first institutional partner to work with Bank Syariah Indonesia and Plasticpay to manage plastic bottle waste. The University of Indonesia, through the Vocational Education Program, seeks to become a campus role model at the national level that can manage plastic waste through the use of Reverse Vending Machines in collaboration with Bank Syariah Indonesia and Plasticpay.

Reverse Vending Machines in the Vocational Education Program at the University of Indonesia has existed since 6 March 2023, but awareness of using it is still low. From 6 March to 26 June 2023, 80 participating communities and 228,592 points collected have been collected (8). Given the large population studying and working in the Voca-

tional Education Program at the University of Indonesia, the enrollment rate of 80 people still needs to be higher. Universite de Lome in Togo has been managing waste since 2017, which generates income for the campus from composting, biogas, and circular economy movements from plastic bottle waste(9). The low participation of the Vocational Education Program community in managing plastic bottle waste through the Reverse Vending Machine is worrying about the efforts of the University of Indonesia in the green metric program and promoting circular economic movements within the campus environment. Only some studies on acceptance and willingness to use a Reverse Vending Machine can enrich the literature on the acceptance of digitalization technology for plastic bottle waste management.

According to the theory of planned behavior, there are three antecedents: attitudes that reflect judgment, subjective norms that describe the views of relatives, friends, or specific groups, and behavioral control, namely easy or challenging to mediate a person's intention to carry out certain behaviors (10). Research in India concluded that adopting Reverse Vending Machines could have been more effective due to a lack of awareness and involvement. Still, convenience and incentive factors drove citizens' desire to adopt recycling methods using Reverse Vending Machines (11).

This reserach examines the determinants of intention to recycle plastic bottle waste among Vocational Education Programs at Universitas Indonesia by integrating habits into leading models that predict people's behavior for acceptability and willingness to use reverse vending machines. This research is a preliminary study of implementing a circular economy in managing plastic bottle waste in Indonesia. This study used a quantitative approach by distributing questionnaires to the Vocational Education Program community of 80 respondents to see their willingness to use the Revised Vending Machine. In general, this paper consists of an introduction in the first part, methods in the second part, results and discussion in the third part, and finally, the conclusion.

2 Method

The research method uses a quantitative approach with primary data from distributing questionnaires to 80 respondents. The questionnaire consists of two parts. The first part consists of the demographics of the respondents, namely occupation and gender. The second part consists of questions categorized based on attitudes, subjective norms, and behavioral control with a Likert scale where four points are selected. Convenience sampling was used for pilot and primary studies because the respondents had to be willing to participate. The target audience is the University of Indonesia Vocational Education Program community consisting of lecturers, education staff, students, cleaning staff, and canteen tenants. This study uses Structural Equation Modelling (SEM) to analyze the relationship between variables. Researchers use Smart PLS 4.0 software to analyze the measurement and structural models (12).

According to the theory of planned behavior, a person's intention to perform a specific behavior is mediated by attitude, subjective norms, and behavioral control (10). Based on the conceptual model, the following are three hypotheses proposed to be tested using Structural Equation Modeling (SEM).

1. H1: Attitude influences intention of willingness to use a Reverse Vending Machine.
2. H2: Subjective norms affect the intention of willingness to use a Reverse Vending Machine.
3. H3: Behavioral control influences the intention of willingness to use a Reverse Vending Machine.

3 Result

3.1 Characteristics of Respondents

Of the 80 respondents willing to fill out the questionnaire, which was distributed online, it was found that the respondents were dominated by women (67.5%) and men (32.55). The proportion of respondents based on the work of most students (69%), followed by canteen tenants (13%), cleaning services (8%), education staff (6%), and lecturers (5%).

3.2 Dashboard Reverse Vending Machine

The Figure 1 below is the dashboard of a reverse vending machine for the period 6 March to 22 June 2023, in collecting and recycling plastic bottles at the University of Indonesia Vocational Education Program, consisting of 73.23 kg of plastic bottles collected, 4,613 pieces of plastic bottles collected, 80 people participating, 294 transactions and 219,296 points sent. The Figure 2 below is the dashboard of a reverse vending machine for the period 6 March to 22 June 2023, in collecting and recycling plastic bottles at the University of Indonesia Vocational Education Program, consisting of 73.23 kg of plastic bottles collected, 4,613 pieces of plastic bottles collected, 80 people participating, 294 transactions and 219,296 points sent. Figure 2 shows a downward trend in the collection of plastic bottles from March to June 2023. The highest collection of plastic bottles occurred on 13 March, with 887.11 pcs, and the lowest was on 29 May, with 0 pcs. The most transactions were on Wednesday, with 75 transactions, and the lowest was on Sunday, with two transactions. Figure 3 shows a users using the highest RVM on March 26 were 26, and the lowest was on May 29, with 0 users. The highest transaction on March 26 was 55 times, and the lowest was on May 29, 0 times.



Dashboard Reverse Vending Machine in Collecting & Recycling Plastic Bottle



Fig. 1. Dashboard Reverse Vending Machine for Collecting and Recycling Plastic Bottle at Vocational Education Program Universitas Indonesia for the period 6 March to 22 June 2023

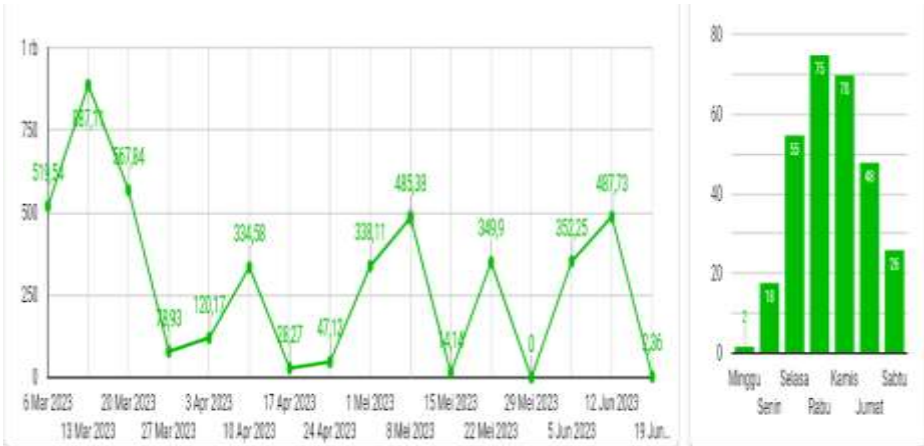


Fig. 2. Trends in Plastic Bottle Collection per week in pcs and transaction per day at Vocational Education Program Universitas Indonesia for the period 6 March to 22 June 2023

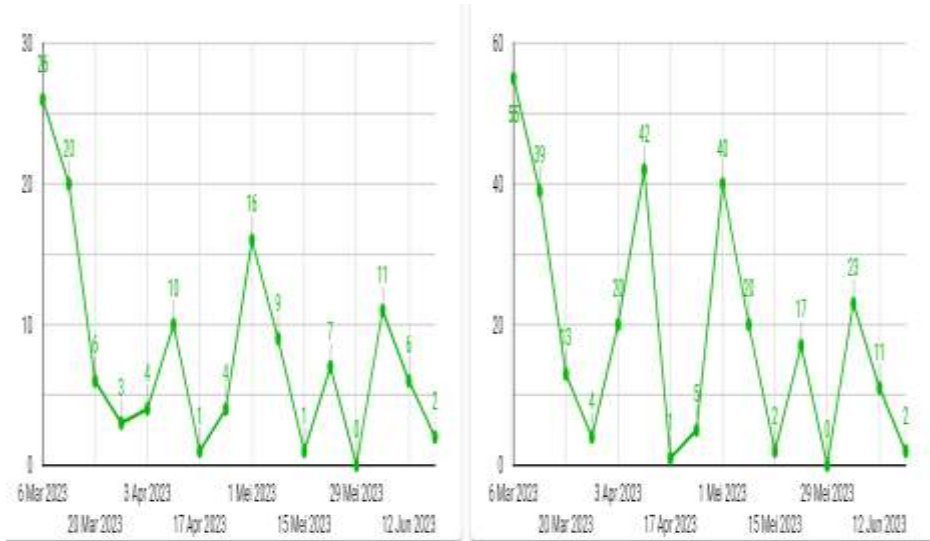


Fig. 3. Trends in Users and Transactions per week and transaction per day at Vocational Education Program Universitas Indonesia for the period 6 March to 22 June 2023

3.3 The Measurement Model

The researcher used composite reliability to assess the reliability of internal construction, with a value above 0.6. The data shows sufficiently high internal consistency to ensure that the item measures the latent variable accurately. Below is Table 1, which presents construct validation data.

Table 1. Construct Validation

Laten Variabels	Composite Reability
Attitude	0,706
Subjective Norms	0,742
Behavioral control	0,709
Intention	0,667

3.4 The Structural Model

Model measurements show promising results, and the next step is to assess the structural model, which begins with checking collinearity to ensure that the regression results are not biased. The value seen is the VIF which ideally should be lower than 3. The following is Table 2, which presents VIF data.

Table 2. VIF Value

Items	VIF
AT1	1,072
AT2	1,127
AT3	1,126
BC1	1,022
BC2	1,022
INT 1_RVM	1,037
INT 2_RVM	1,037
SN1	1,052
SN2	1,052

The construct has been successfully validated in the measurement model as input for the structural model. Structurally a model regression line is drawn between the independent and dependent variables. The R Square value obtained is 0.558, which indicates the model is good. The following is Table 4, which presents the results of hypothesis testing.

Table 3. Research Hypothesis Result

Hypothesis	Value	Inference
H1 : Attitude influences intention of willingness to use a Reverse Vending Machine.	T statistic : 1,778 p value : 0,075	H1 is rejected, Attitude does not affect the intention willingness to use the Reverse Vending Machine.
H2 : Subjective norms affect the intention of willingness to use a Reverse Vending Machine.	T statistic : 1,855 p value : 0,064	H2 is rejected, Subjective norms does not affect the intention willingness to use the Reverse Vending Machine.
H3 : Behavioral control influences the intention of willingness to use a Reverse Vending Machine.	T statistic : 5,870 p value : 0,000	H3 is accepted, Behavioral control does not affect the intention willingness to use the Reverse Vending Machine.

Behavioral control is the only significant variable influencing the respondent's intention to accept and willingness to use a reverse vending machine. This behavior control includes the ease of use of the Reverse Vending Machine and the incentives provided by Plasticpay and BSI as service providers, in contrast to the results of research in India which found that the variables of involvement, convenience, and awareness are the main parameters that influence the use of Reverse Vending Machines. Respondents can

use the Reverse Vending Machine without expecting to get incentives (11). In another study in the UAE, attitudes and habits have significance in the younger generation's intention to recycle e-waste (10). Each government has its approach that suits its people's characteristics to play an active role in managing plastic waste. In Indonesia, especially in educational institutions, the ease of use and the incentives given will increase willingness to use reverse vending machines. Figure 4 below is the final model based on hypothesis testing using PLS-SEM. The behavior control contributes 0.521 to accept and are willing to use the Reverse Vending Machine.

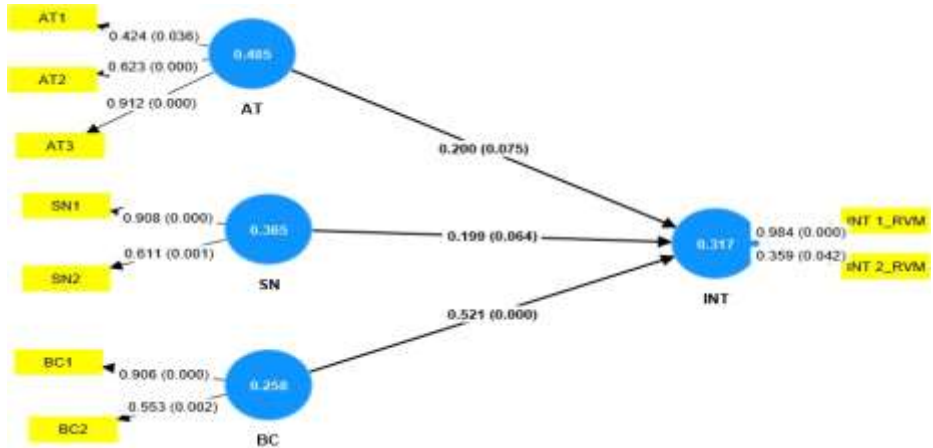


Fig. 4. Final Model

4 Conclusion

The collaboration of the University of Indonesia Vocational Education Program with Plasticpay and Bank Syariah Indonesia, starting from March 6, 2023, still needs a relatively low level of acceptance and willingness to use Reverse Vending Machines. As of June 22, 2023, 80 people were involved, and 4,613 plastic bottles were collected, equivalent to 73.23 kg, 294 transactions, and 219,296 points. The results of the PLS-SEM analysis show that the behavior control variable significantly affects the intention of willingness to use a reverse vending machine. This behavior control variable includes the ease of use and the amount of incentives received. To increase public participation, it is necessary to socialize massively, conventionally or through social media, regarding how to use a reverse vending machine and propose to Plasticpay and Bank Syariah Indonesia to increase the incentives provided through e-money balances.

Reference

1. Amantayeva A, Alkuatova A, Kanafin I, Tokbolat S, Shehab E. A systems engineering study of integration reverse vending machines into the waste management system of Kazakhstan. *J Mater Cycles Waste Manag* [Internet]. 2021 May 23;23(3):872–84.

- Available from: <https://link.springer.com/10.1007/s10163-020-01161-9>
2. Zia H, Jawaid MU, Fatima HS, Hassan IU, Hussain A, Shahzad S, et al. Plastic Waste Management through the Development of a Low Cost and Light Weight Deep Learning Based Reverse Vending Machine. *Recycling* [Internet]. 2022 Sep 22;7(5):70. Available from: <https://www.mdpi.com/2313-4321/7/5/70>
 3. Neo ERK, Soo GCY, Tan DZL, Cady K, Tong KT, Low JSC. Life cycle assessment of plastic waste end-of-life for India and Indonesia. *Resour Conserv Recycl* [Internet]. 2021 Nov;174:105774. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0921344921003839>
 4. Kristina HJ, Christiani A, Jobiliong E. The prospects and challenges of plastic bottle waste recycling in Indonesia. *IOP Conf Ser Earth Environ Sci* [Internet]. 2018 Dec 14;195:012027. Available from: <https://iopscience.iop.org/article/10.1088/1755-1315/195/1/012027>
 5. Kurniawan TA, Dzarfan Othman MH, Hwang GH, Gikas P. Unlocking digital technologies for waste recycling in Industry 4.0 era: A transformation towards a digitalization-based circular economy in Indonesia. *J Clean Prod* [Internet]. 2022 Jul;357:131911. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0959652622015219>
 6. Nanda Pratiwi D, Setiyowati A, Huda F. Quality of Corporate Social Responsibility (CSR) Services at Bank Syariah Indonesia (BSI) in 2021 in the Perspective of Islamic Social Reporting (ISR) Index and Maqashid Syariah Index (MSI). *Perisai Islam Bank Financ J* [Internet]. 2023 May 9;7(2):198–217. Available from: <https://perisai.umsida.ac.id/index.php/perisai/article/view/1643>
 7. Bank Syariah Indonesia. Lembaga Mitra Penempatan Reverse Vending Machine Jabodetabek. Jakarta; 2023.
 8. Plasticpay. Dashboard Reverse Vending Machine [Internet]. Tangerang Selatan; 2023. Available from: https://lookerstudio.google.com/u/0/reporting/024f6667-f8a7-4a7e-a7b0-adfe7e960bf0/page/p_9qyd1qhnmc
 9. Salguero-Puerta L, Leyva-Díaz JC, Cortés-García FJ, Molina-Moreno V. Sustainability Indicators Concerning Waste Management for Implementation of the Circular Economy Model on the University of Lome (Togo) Campus. *Int J Environ Res Public Health* [Internet]. 2019 Jun 25;16(12):2234. Available from: <https://www.mdpi.com/1660-4601/16/12/2234>
 10. Aboelimged M. E-waste recycling behaviour: An integration of recycling habits into the theory of planned behaviour. *J Clean Prod* [Internet]. 2021 Jan;278:124182. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S095965262034227X>
 11. S.K P, S.V M, Mhatre P, S AG, R D, U S. A Study on Challenges for Adoption of Reverse Vending Machine: A Case of North Bengaluru, India. In 2019. p. 15–29. Available from: <http://tiikmpublishing.com/data/conferences/doi/wcwm/26510251.2019.1202.pdf>
 12. Hair JF, Risher JJ, Sarstedt M, Ringle CM. When to use and how to report the results of PLS-SEM. *Eur Bus Rev* [Internet]. 2019 Jan 14;31(1):2–24. Available from: <https://www.emerald.com/insight/content/doi/10.1108/EBR-11-2018-0203/full/html>

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

