Study on the Contributing Factors in e-hailing Waste Management Systems for Mobile Application Adoption and Usage

Ozioma Alex Nwaogwugwu[1][(✉)] and Nazrita Ibrahim[2] ![ORCID]

[1] College of Graduate Studies, Universiti Tenaga Nasional, Kajang, Malaysia
[2] Institute of Informatics and Computing in Energy, Universiti Tenaga Nasional, Kajang, Malaysia

Abstract. Efforts to curb household waste in Malaysia have been unsatisfactory despite numerous policies and regulations. With technological advancements, participation rates can be increased in communities if utilized. This study looks at the current e-hailing waste management technology being used in Malaysian's solid waste management, especially mobile applications usage. Additionally, the study investigates factors that can influence Malaysians to adopt and use e-hailing waste management technology in order to increase recycling participation rates in communities. A survey was carried out with recycling practitioners in Kuala Lumpur to identify their recycling interests, challenges faced while recycling and opinion on e-hailing waste management service. The data was analyzed using a descriptive statistical and thematic analysis methodology and findings from the study showed that the respondents were keen on reducing waste in communities. Based on findings, a design framework was established to boost participation rates and improve awareness in Malaysian communities. Therefore, in order to reduce household waste, it is advised that technologies such as e-hailing waste management be used to channel recyclable household waste to proper destination and cut off landfill dumping.

Keywords: e-hailing · Mobile application · Waste management · Recycling · Solid waste

1 Introduction

Waste generation in Malaysia is increasing as the country's population, both rural and urban, grows. The current municipal waste management system in Malaysia has created inconveniences and a difficult situation, particularly for households that want to recycle. Malaysia current waste separation is divided into four categories: food waste, recyclable waste, scheduled waste, and other waste. These four types of waste can be collected in various ways, including communal containers where collector workers are expected to pick up, house-to-house scheduled collection, and fixed time fixed location.

For effective waste management system, several studies [1–3] have suggested that recycling is the best strategy to minimize waste because of the economic, environmental, and social benefits it provides to a country. The cost of recycling must be low, and

there must be an easy way to collect recyclables. People must also know how to recycle and be motivated to recycle in order for recycling to be successful. Ineffective dissemination of recycling information on what, where and how to recycle is lacking despite the government putting efforts in policies to drive waste minimization. Additionally, [4] also provided strategies and clear direction to spearhead the initiative to manage waste holistically in Malaysia.

Since E-hailing system is popular amongst Malaysian, implementing a similar system for waste management will not be strange to residents. The adoption of e-hailing amongst Malaysian would be a stimulant to adoption of sustainability lifestyle in Malaysia. Although a few applications bearing this concept had been introduced, not many studies have been carried out to understand what are the elements required in the application that can promote usage adoption among users.

Therefore, given the issues above, this study will review the current e-hailing waste mobile application and identify the factors that can encourage adoption of e-hailing waste management for application adoption and usage for promoting recycling in communities.

2 Literature Review

2.1 Situational Analysis of Municipal Solid Waste in Malaysia

Solid waste management is Malaysia's most pressing environmental concern, with landfilling serving as the primary disposal mechanism for the country's annual rise in solid waste generation. Malaysia depends on landfilling as a waste disposal method. Municipal Solid Waste (MSW) disposal via landfilling is becoming increasingly difficult as new landfill sites fill up. More specifically, constructing a new location would be difficult due to a lack of available land, an increase in land prices, and high demand, particularly in urban areas due to population growth [5]. Waste generated increased in 2018 from 30,987 tonnes to 31,089 in 2019 based on [6]. The reported increase in waste is a clear indication that waste generation will continue to rise by the year and the storage or disposal mechanism may be overloaded; hence, environmental hazard could happen.

In managing the household waste problem, several studies supported recycling as a practice. To reduce waste generation, [7] believe that it is critical to raise public awareness for behavioral change, recycling facilities and collection systems, according to [8], could be made more convenient and easily accessible which was supported by [9]. Besides that [10] identified that some households do not have adequate storage bins. Furthermore, there are no recycling bins for households to separate different types of waste. Residents needed to have a proper storage facilities to avoid waste being dumped besides the collection point or bin. Collections are done either by fixed time fixed location or communal bin being placed a centralized location or house-to-house collection across Malaysia [10, 11]. Hence, to improve the collection rate, proper container has to be assigned which will increase the participation and recycling rates in Malaysian communities. Another good strategy to increase participation in recycling is by the reward system. According to [12], rewards could be either monetary incentives received from recycling or a virtual reward system implemented to drive participation.

Since the technology era and use the use of mobile application has become the norm of the day, an application that would encourage and motivate the complete implementation of reduce, reuse and recycle (3R) would be needed to encourage residents to embrace sustainability lifestyle. E-hailing systems are widely used in Malaysia for ride –sharing or online food delivery. However, the same concept can be implemented in waste management application, as demonstrated by [12] who develop an application that uses e-hailing concept to monitor the level of waste in rivers and surrounding areas. Based on this recent development, driving recycling through e-hailing system could be an alternative solution to help improve the recycling lifestyle of Malaysians.

Table 1 shows the summary of four existing e-waste applications and feature supported by them. The four applications are RIIICYCLE, RECIRCLE, Gargeon and Internet Waste of Things (iOWT). The applications were selected based on the following selection criteria: Locally available in Malaysia, Used for waste collection and Mobile application.

Table 1. Review of existing e-waste application features.

	Reward / Incentives	Location Map	Redemption	Recycling Data Report	Educational Campaign	Request Pickup	Charges	Availability
RIIICYCLE	√	√	√	X	√	X	X	√
RECIRCLE	√	√	√	√	√	√	X	√
Gargeon	X	√	X	√	X	√	√	√
iOWT	√	√	√	√	√	X	X	√

Legend: X - Not available, √ - Available

Based on the review, it can be observed that there are eight (8) common features/functions provided by these apps.

Rewards/Incentives. It is believed that daily reward programs encourage the involvement of residents in waste recycling. According to various studies on human motivating factors to participate in waste management, reward is a motivating factor [13, 14].

Location Map. Solid waste management involves multiple steps, starting from the stage in which the waste is created before it reaches its final destination or at a stage in which the environment is no longer threatened. Therefore, it is important to implement a location map that makes it easier for its users to quickly and conveniently drop waste.

Redemption. Redemption refers to features, which allow users to Redeem reward points into vouchers, send cash to their bank account, or donate cash to the charity home [15]. There are several ways in which reward points can be turned. This is will also motivate users to recycle more and redeem their choice redemption.

Recycling Data Report. Tracking performance behavior is one type of motivation that can encourage individuals to continue participating in the waste reduction exercise, thereby increasing the rate of community participation. Tracking progress increases emotional and cognitive sense of actions [16].

Educational Campaign. With the era of mobile technology advancement, the awareness of residents should be easy and the way waste is handled should be improved. Recently, some campaigns are now using mobile apps as a way to engage users in improving waste recycling [17].

Request Pick Up. Humans always want a convenient way to do things. Convenience is a key factor in encouraging residents to participate in recycling activities [18]. If users are able to request the collection of waste at their convenience, there will be encouragement in the communities, and therefore a reduction in waste and increased participation rate.

Charges. The flat-rate charging model does not encourage households to reduce the amount of waste [19]. Although some users may be willing to pay for good quality of service. With 'Pay as you throw policy,' educating consumers on how to reduce waste is important from the point of view of municipalities, because they pay for landfills and waste disposal services. A minimal charge would encourage users to pay and recycle which could be regained by earning rewards and convert back into monetary value.

Availability. Service readiness and availability also encourages users. All the mobile applications reviewed above are available for use in Malaysia but may need to expand and engage more with the local councils for more awareness.

Efforts have been made in Malaysia to reduce waste, but many people are unaware of how waste management can be accomplished. Among the issues identified are a lack of storage facilities, a lack of awareness, insufficient collection, and environmentally unfriendly disposal methods. Implementing e-hailing system to boost the waste management in Malaysia could be the next smart move towards encouraging recycling among the residence. However, although the current features of the current system have been reviewed, it is unclear which factors are required to promote usage and adoption of the e-hailing waste application. The goal of this study is to identify the factors that encourage residents to use and adopt an e-hailing waste application, which would increase community recycling participation rates.

3   Methodology

The methods used in this research were Primary Data Collection through survey and Secondary Data Collection through literature review. In the secondary data collection, official papers, posts, newspapers, legal records, published and unpublished literature, and case studies are all included in desk studies. Four different e-hailing waste mobile applications were reviewed.

The Primary Data Collection was based on a survey of some households in the Klang Valley geographic area who were given online questionnaires. The study's target

audiences are waste management/recycling practitioners of various genders, age group, working schedule, and housing property type from urban and rural settings. The target audience was selected due to their understanding of waste management. The questionnaire link was sent via instant message groups of focused group, face to face was avoided due to covid-19 situation. The survey was conducted between 1st June–30th June 2020.

Total of 61 respondents responded to the survey. The survey had five sections which include both the open-ended and closed-ended questions: Sect. 1 (Demography), Sect. 2 (To understand what motivates individuals to participate in waste management.), Sect. 3 (To understand what hinders individuals to participate in waste management), Sect. 4 (To identify issues with existing e-hailing services) and Sect. 5 (To gather views on the introduction of e-hailing waste management systems to participants). The closed ended was analyzed using descriptive analysis while open ended questions were analyzed using thematic analysis.

A design framework will be constructed based on the analyzed results and the framework will be discussed.

4 Data Analysis and Results

4.1 Demography

The number of female respondents is higher than male with 32 participants (52%) are female, and 29 participants (48%) are male. The majority of participants are between 41 and 50 years of age, with 24 participants (39%) in the group. There are 21 participants (34%) aged between 51 and above, 8 participants (13%) aged between 31 and 40 years, 6 participants (10%) aged between 25 and 30 years. Finally, 2 participants (3%) aged between 17 and 24 years participated in this study. Working schedule were considered in order to understand what a flexi working hour and a fixed time working hour residents may prefer. The participants with a flexible working hour will be able to make collection requests anytime at their convenience while those with the fixed working schedule time participants would only be able to request collection at a specific time due to their work schedule. Thirty-three participants (54%) have a flexible working schedule while twenty-eight participants (46%) have a fixed working schedule. Thirty-nine participants (64%) reside in a landed property kind of housing and twenty-two participants (36%) reside in condo/high rise apartments.

4.2 To Understand What Motivates Individuals to Participate in Waste Management

Based on the Pareto chart in Fig. 1 and 2, with 80/20 rule, 80% of those who recycle do so because they care about the environment, decreasing waste impact on the environment and reducing landfill waste. While 80% of those who do not recycle say they are unable to do so due to the dispiriting and inconvenient nature of the process, incapacity to recycle, and the unfriendliness of the overall process. 80% of residents would be motivated if rewards and elements that can instill environmental consciousness are provided in Fig. 3. Two important findings that can be used as a basis for the proposed e-hailing

waste management design are: reward recognition system that would motivate those who recycle to continue recycling and quick tips that can assist those who find it difficult to recycle, to learn the easy way to recycle.
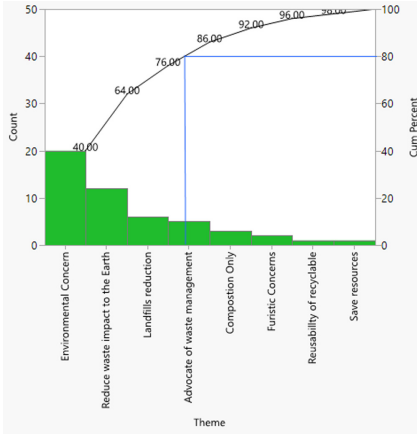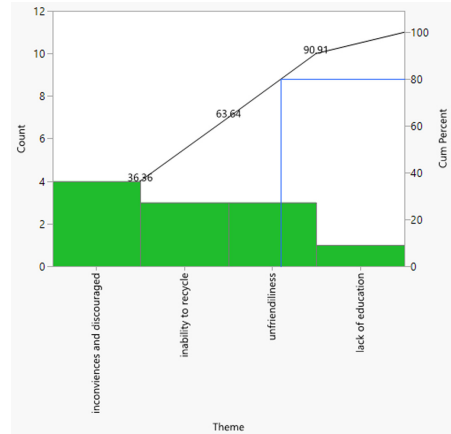

Fig. 1. Reason why people recycle
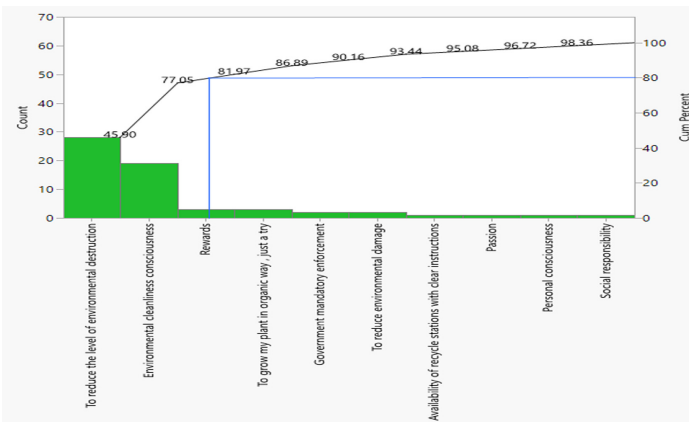

Fig. 2. Reason why people do not recycle

Fig. 3. Motivation to do recycling

4.3 To Understand What Hinders Individuals to Participate in Waste Management

Based on the Pareto chart in Fig. 4, with 80/20 rule, 80% of the participants face barriers of inadequate bins, poor educational awareness and poor collection timing, which hinders their involvement in participating in waste management. There is a significant hindrance within the 20% which does not know the waste final destination as it would motivate more participation. Several important findings that can be used as a basis for the

proposed e-hailing waste management design are: Easy geotag location access to collection points/bins or pick up locations, waste end-of-life destinations data and educational awareness program.
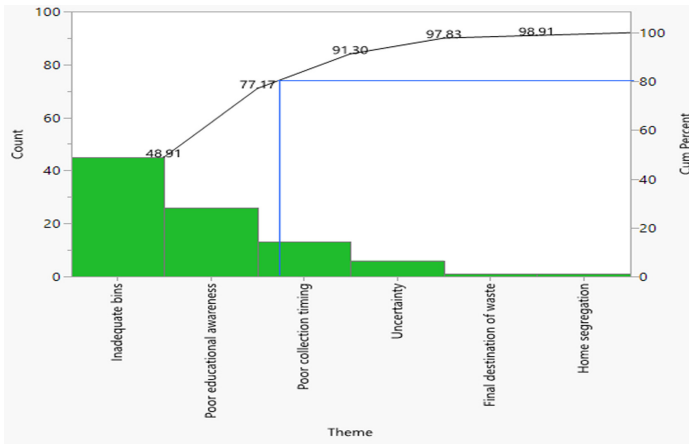

Fig. 4. What hinder participant from doing recycling

4.4 To Identify Issues with Existing e-hailing Services in Malaysia

Based on the Pareto chart in Fig. 5, with 80/20 rule, 80% of the participants believes the current e-hailing services in Malaysia is high cost, driver late arrival time, rider location inconsistencies and unfriendly user mobile application.

Based on Fig. 6, 39% uses certain hailing service due to its trustworthiness and reliability, 20% uses certain hailing services because it's the only common available hailing application, 8% uses certain hailing services due to its user friendliness and simplicity, 7% uses certain hailing services because of the delivery service functionality and 2% participants uses the application because of the regular coupon shared on the hailing service platform.

Therefore, three key findings that can be used as the basis for the proposed e-hailing waste management design are as follows: Collector punctuality, Easy to use application and Moderate cost.

4.5 To Gather Views on the Introduction of e-hailing Waste Management Systems to Participants.

Based on the pie chart in Fig. 7, 31% of participants would like to have user friendly application, 30% would like to have good collection service, 11% would like to have traceable waste data, 3% wants to see news feed on the application, 2% recommends a reduced fee and 23% are undecided about what should be in the application.
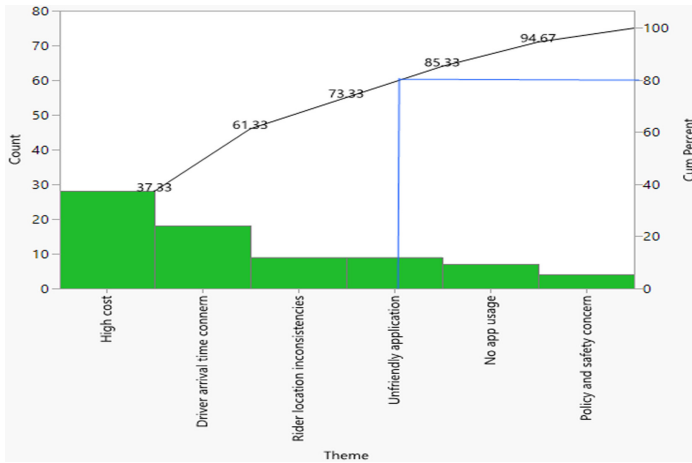
Fig. 5. Issues with current e-hailing service
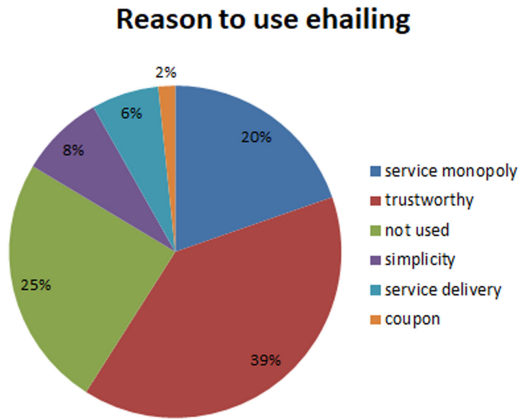
Reason to use ehailing

Fig. 6. Why use hailing application

Based on the pie chart in Fig. 8, 51% of participants are willing to pay for such service if implemented, 34% are unwilling while 13% are still undecided and 2% would still prefer self-service.

Based on the Pareto chart in Fig. 9, with 80/20 rule, 80% of the participants highlighted potential issue that may be lacking or should be included such as professionalism of personnel, awareness program, user centric application and unwillingness to pay.

Based on the pie chart in Fig. 10, 69% of participants are willing to adopt the new e-hailing waste mobile application while 31% do not see the need for a mobile application.

Based on the results and observations in this section, five key findings that can be used as the basis for the proposed e-hailing waste management design are as follows:
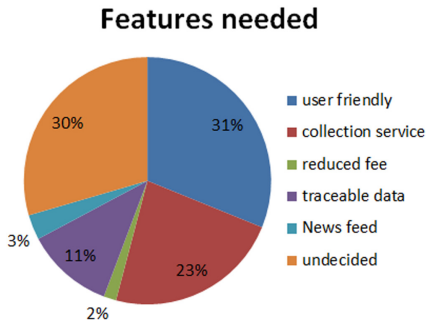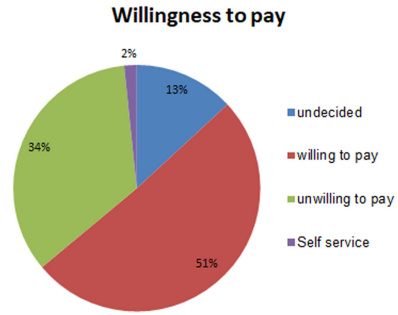
Fig. 7. What feature(s) are needed

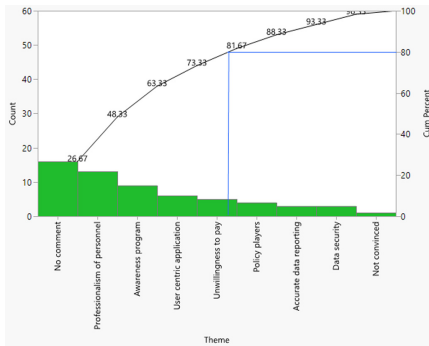**Fig. 8.** Willingness to pay for the service

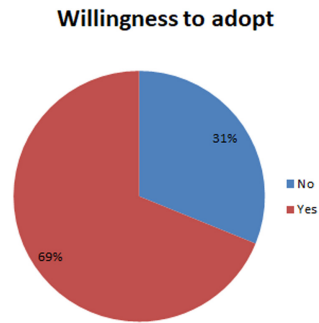**Fig. 9.** Concerns or suggestions of proposed system

Fig. 10. Willingness to adopt

Friendly User Interface, Collection service, Reduced charged fee, Traceable data and News Feed.

Therefore, based on results in this study, participants would like to see proper educational awareness provided to households through campaign programs, monetary incentives should be considered, collection system that would ease collection from source to storages, viewing collected waste data is also important to participants for psychological effect, convenient scheduling and reduced charges. As a result, a convenient and simple-to-use e-haling waste mobile application would encourage residents of various working classes and ages to participate in waste management at their convenience.
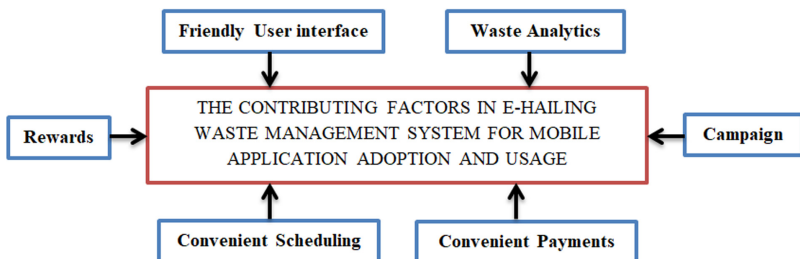
5   Discussion

This section is derived from data analysis. The responses of participants were collected and analyzed, yielding the following design framework shown in Table 2 to encourage adoption and usage of e-hailing waste management participation.

Based on this observation, six factors were proposed as framework for designing an e-hailing waste management for application adoption and usage in communities: Rewards, Friendly User Interface, Waste Analytics, News Feed, Convenient Scheduling and Convenient Payment as shown in Fig. 11.

Table 2. Design element for adoption and usage of e-hailing waste application in Malaysia

Factors	Design element
Rewards	a) Points b) Badges c) Merchant (allows rewards to be redeemed to products, monetary or donations) d) Leaderboard e) Levels
Friendly user interface	a) Input Controls (allow users to input information into the system) b) Navigation Components (help users move around the application) c) Informational Components (Share information with users.) d) Containers (hold related content together) e) Incorporate Clear Micro-Copy (small snippets of text that provide instructions to your audience.)
Waste analytics	a) Performance charts in graphical representations b) Waste destination tracking system via tabular representation
Campaign	Feed • Educational • Events • Announcement • Scoreboard ranking
Convenient scheduling	a) Schedule pick up b) Select vehicle size c) Calendar d) Upload photo
Convenient payment	Pay Now • Points • Bank transfer • Credit Card

Fig. 11. Proposed design framework for e-hailing waste management system for mobile application adoption and usage.

Rewards: Anything given in appreciation for service, effort, or achievement is referred to as a reward. Reward encompasses any type of incentive provided by the government or competent authorities for recycling (separating recyclable materials from waste at home). Element such as Monetary incentives is a direct rewards to user while badges, merchants, a scoreboard, or levels, to encourage users to progress, complete actions and compare their results with other users that engage in waste management.

Friendly User Interface: A simple to use mobile application, according to several participants in this report, would allow more users to use it. Participants must have a positive user experience in order to remain engaged and involved in the application. A clear User Interface (UI) provides users with discoverability and comprehension. The first experience of a product or service has a significant influence on the user's attitude and relationship with the product.

Waste Analytics: Analytic waste representation that will allow users to see the progress made on waste management in their communities. Performance charts like waste trends, waste recycled, and carbon dioxide savings are needed to track individual progress and the emotional attachments that come with helping to reduce waste sent to landfills. It is also crucial to have the waste final destination traceability (from household to final destination).

Campaign. Raising public awareness about waste prevention is a critical first step in encouraging behavioural change. Awareness campaigns that are well-designed and well-executed will help to address the two major obstacles to recycling: a lack of knowledge about proper waste segregation and shifting attitudes and expectations, as well as keeping people motivated to avoid and sort waste. Therefore, the campaign should be aimed at creating relevant awareness programmed to communities.

Convenient Scheduling. The ability to schedule hailing on a mobile device would promote community engagement. To achieve an economically and environmentally sustainable practice, providing a convenient hailing scheduling is the best way to enable users to engage in waste management.

Convenient Payment. A reduced service charge and easy payment method would encourage residents to be interested in using the mobile application. Therefore it is very important to create a convenient experience.

6   Conclusion

Recycling is a campaign that aims to reduce waste in Malaysia's communities, but residents are hesitant to engage for a variety of reasons, including lack of educational knowledge, collection facilities, motivation, storage facilities, and, more broadly, a lack of interest.

The current waste mobile applications have not answered those concerns comprehensively. A design framework was design in this study to address the issues why residents

do not participate in recycling. Incentives, points, badges, scoreboards, merchandize, and levels were recognized as reward element that can inspire a user to recycle more. A user interface that is easy to use for people of all ages. Waste analytics that can indicate a user's waste performance and trace waste dropped until it reaches its final destination have been shown to have a psychological impact to users. A public awareness program that disseminates information about waste management, recycling related events, public announcements to communities, and community rankings should be provided. Flexible scheduling is imminent to make recycling simple, as well as a simple payment option for costs incurred.

According to the study, a convenient waste management system, such as an e-hailing waste management system with mobile application adoption, would improve community participation in recycling exercises. Thus, this helps to reduce waste sent to landfills, promote a sustainable lifestyle, increase the amount of recyclable material recycled through proper channels and promote circular economy.

References

1. Chen, H.L., Nath, T.K., Chong, S., Foo, V., Gibbins, C., Lechner, A.M.: The plastic waste problem in Malaysia: management, recycling and disposal of local and global plastic waste. SN Appl. Sci. **3**(4), 1–15 (2021). https://doi.org/10.1007/s42452-021-04234-y
2. Mentek, M.: Solid waste management in Malaysia: towards a holistic approach. In: International Solid Waste Association (ISWA) World Congress. Ministry of Urban Wellbeing (2017). Housing and Local Government. http://www.swcorp.gov.my/docfile/kertas-taklimat/TowardsaHolisticApproach.pdf
3. Jereme, I.A., Alam, M.M., Siwar, C.: Waste recycling in Malaysia: transition from developing to developed country. Indian J. Educ. Inf. Manage. **4**, 1–14 (2015)
4. Solid Waste Management Lab (2015). https://jpspn.kpkt.gov.my/resources/index/user_1/fileupload/slaid_dapatan_makmal.pdf. Accessed 23 May 2021
5. Yatim, S.R.M., et al.: Study on waste generation and composition in rapid residential development of sub urban area in Kuala Selangor District, Selangor. J. Wastes Biomass Manage. (JWBM) **1**(1), 1–5 (2019)
6. Compendium of Environment Statistics, Malaysia (2020). https://www.dosm.gov.my/v1/index.php?r=column/pdfPrev&id=TjM1ZlFxb3VOakdmMnozVms5dUlKZz09. Accessed 23 May 2021
7. Taušová, M., et al.: Analysis of municipal waste development and management in self-governing regions of Slovakia. Sustainability **12**(14), 5818 (2020)
8. Geiger, J.L., Steg, L., van der Werff, E., Ünal, A.B.: A meta-analysis of factors related to recycling. J. Environ. Psychol. **64**, 78–97 (2019)
9. Starr, J., Nicolson, C.: Patterns in trash: Factors driving municipal recycling in Massachusetts. Resour. Conserv. Recycl. **99**, 7–18 (2015)
10. Ali, N.E., Siong, H.C., Mokhtar, K., Talmizi, N.M., Saleh, A.A.: Solid waste management in Shah Alam city residential area. J. Sustain. Sci. Manage. **13**(1), 211–227 (2018)
11. Saipul, N.I.L., et al.: Parties and their roles in solid waste separation at the source: an example from Malaysia's award-winning residential area. J. Tourism **2**(6), 10–21 (2017)
12. Rohana, S., Abdamia, N., Mohd, M.: Developing a pollution free environment framework through technology integration (e-hailing app). Environ. Behav. Proc. J. **4**(10), 161–167 (2019)

13. Mahpour, A., Mortaheb, M.M.: Financial-based incentive plan to reduce construction waste. J. Constr. Eng. Manag. **144**(5), 04018029 (2018)
14. Amini, F., Ahmada, J., Ambalia, A.R.: The Influence of reward and penalty on households' recycling intention. APCBEE Proc. **10**, 187–192 (2014)
15. Abd Wahab, M.H., Abdul Kadir, A., Md Tomari, M.R., Jabbar, M.H.: Web-based reward and redemption system for smart recycle system (2015)
16. Goh, D.H.L., Pe-Than, E.P.P., Lee, C.S.: Perceptions of virtual reward systems in crowdsourcing games. Comput. Hum. Behav. **70**, 365–374 (2017)
17. Bonino, D., Alizo, M.T.D., Pastrone, C., Spirito, M.: WasteApp: smarter waste recycling for smart citizens. In: International Multidisciplinary Conference on Computer and Energy Science 2016 (2016)
18. Mutang, J.A., et al.: Recycling motivations and barriers in Kota Kinabalu, Malaysia. Int. J. Psychol. Behav. Sci. **9**(8), 2911–2915 (2015)
19. Salminen, S.: Value of Waste Flow Monitoring Service for House Managers in Municipal Solid Waste (MSW) Management (2016)