A PROFILE OF MALAYSIAN HOUSEHOLD SOURCE SEPARATION BEHAVIOUR DRIVERS: A CONJOINT ANALYSIS

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Abstract: This study aims to develop a profile of household source separation behaviour in Malaysia by identifying the influencing drivers as robust situational factors that have a significant effect. Household waste is claimed to be the main contributor to the substantial generation of solid waste, which remains a challenge to the Malaysian government in achieving sustainable development goals. To pursue sustainable solid waste management by improving the implementation of recycling among households, it is essential to improve their source separation behaviour. A total of 472 empirical data collected through a questionnaire survey were analysed using the choice-based conjoint analysis, performed using Sawtooth Software. The PEST model is adopted as the fundamental basis for the theoretical framework to identify the drivers influencing the facilitation of source separation behaviour among households. Four drivers influencing the source separation behaviour among households in Malaysia were identified. Each of the drivers is made up of two to three sub-drivers. The results indicate that the main driver influencing source separation behaviour among households is infrastructure support. The findings may assist the government and authorities in the formulation of relevant strategies to foster source separation behaviour- in the country.

Keywords: Household, drivers, source separation behaviour, conjoint analysis.

Introduction

The increase in waste generation rates have had adverse effects on all regions of the world, mainly environmental degradation due to growing populations, advancing economies and rapid urbanisation. Source separation behaviour is essential to support the global trend towards reducing waste generation. It involves public commitment, and needs to be accessible to ensure consistent participation. In developing countries, efforts have been made to improve household source separation behaviour, covering policy instruments, information campaigns, incentive instruments, and supporting infrastructures.

The growing rate of waste generation in Malaysia is parallel with rapid urbanisation, the growing population and economic development, which are affecting household consumption patterns and lifestyle. Household waste is claimed to be the main contributor to the substantial generation of solid waste, which remains a challenge to the Malaysian government in achieving sustainable development goals. To pursue sustainable solid waste management by improving the implementation of recycling among households, it is essential to improve their source separation behaviour. Appropriate solid waste management has become crucial at the household level. A massive amount of waste is dumped into landfills, making it difficult to be recycled, and the waste is usually incinerated, which is hazardous to the environment. In Malaysia, the main method of waste disposal is by landfill. However, with the increasing trend of solid waste generation in the country, Malaysia is facing land scarcity for landfills. In Malaysia, recycling is one of the means of sustainable waste management. Tremendous efforts have been introduced by the Malaysian government to increase the nation's recycling rates. To encourage public participation, the Solid Waste Management Act 2007 was introduced by the Ministry of Housing and Local Government to encourage waste minimisation, and "reduce and reuse, and recycle" (3Rs) campaigns were raised. Prior to that, Malaysia implemented the

Action Plan for a Beautiful and Clean Malaysia in 1987 to manage solid waste, leading to the introduction of the country's first and second national recycling programmes in 1993 and 2000, respectively. The National Recycling Day has also been observed annually on November 11 in Malaysia since 2000. the first national recycling programme was claimed to be ineffective due to a lack of efforts to sustain recycling programmes, inadequate recyclable collection services, ineffective awareness programmes, and a lack of public acceptance and participation (Moh & Abd Manaf, 2014). This prompted the creation of the second national recycling programme in 2000 to promote the 3Rs habit. However, public participation in recycling remains less encouraging despite the many public awareness campaigns carried out over the years (Moh & Abd Manaf, 2016). Malaysians remain reluctant to separate their waste for recycling. Following that, with the enactment of the Solid Waste Management and Public Cleansing Act 2007, source separation has been enforced at the end of 2015 (Moh, 2017).

Source separation is the disposing of waste material according to the type of waste for collection. Source separation produces high-quality cleaner materials for relatively worthwhile recycling (Nguyen *et al.*, 2015; Rousta *et al.*, 2015). Critical efforts are needed to recover recyclable materials from the waste generated in the country (Cimpan *et al*., 2015). The Malaysian government encourages households to practise source separation behaviour at home to overcome the growth and complexity of the waste generated. To further increase public participation in source separation practices, the Malaysian government made it mandatory to separate solid waste at the source on September 1, 2015. This mandatory source separation is aimed at achieving a higher recovery of recyclable materials and an expansion of the operating capacity of landfill sites. Solid waste and recyclables are collected weekly according to fixed schedules. Malaysia is implementing a "2 + 1" concept in terms of its waste collection system: waste collectors collect residual waste twice a week, and recyclables once a week. By enforcing solid waste separation at source, Malaysia has committed to improving solid waste management towards achieving sustainable development. However, the mandatory solid waste separation at source implemented does not seem to be taken seriously by residents(Rahim, 2021). Following the multiple efforts by the Malaysian government towards sustainable waste management, the rate of solid waste separation at the source increased slightly, and the current national recycling rate is reported to be 28% (Leoi, 2019).

Identifying drivers that have the potential to influence source separation behaviour is crucial. Previous studies have identified various drivers potentially influencing source separation behaviour. For example, past pro-environmental practices, satisfactory local facilities, and infrastructures by the government (Stoeva & Alriksson, 2017; Xu *et al.*, 2017a, 2017b; Ali *et al.*, 2018; Almazán-Casali *et al.*, 2019), recycling information and monetary incentive (Gan, 2018; Mahayuddin *et al.*, 2020), as well as increasing environmental awareness at the local community level all contribute to the enhancement of participation in recycling *(*Afolabi *et al.*, 2018). A lack of separation and collection services for recyclable waste has significant potential to deviate people away from recycling (Padilla & Trujillo, 2017; Manomaivibool *et al*., 2018). The economic driver (provision of incentives) has increased the rates of participation in source separation behaviour among households in South-West China *(Xu et al.*, 2015). A review study of source separation behaviour conducted by Xevgenos *et al.* (2015) highlighted the availability of a kerbside collection scheme, economic incentives and legal instruments as among the drivers influencing recycling. A study held in Suzhou, China, has identified five drivers that are most significant in influencing household source separation and recycling, including publicity and education, the convenience of recycling facilities, accessibility to waste separation facilities, willingness to participate in waste separation and environmental awareness (Meng *et al.*, 2019).

Generally, identifying the drivers influencing source separation behaviour is challenging since the practice of source separation varies among individuals (Saladié & Santos-Lacueva, 2016; Sukholthaman & Sharp, 2016)both quantitatively and qualitatively. Several factors influence people behavior to recycling and, consequently, they play an important role to achieve the goals proposed in the management policies. People can improve separate collection rates because of a wide range of causes with different weight. Here, we have determined the uplift in probability to improve separate collection of municipal waste created by the awareness campaigns among 806 undergraduate students at Universitat Rovira i Virgili (Catalonia. The drivers influencing source separation behaviour vary based on the typical characteristics of a given region. More initiatives to foster solid waste separation among households in Malaysia are essential to enhance the solid waste management needs of the nation. As suggested by Fadhullah *et al.* (2021), programmes that are tailored to the needs of the targeted community are crucial to improve sustainable solid waste separation practices. A profile of source separation behaviour drivers will promote recycling and contribute to the country's transition towards a sustainable waste management system. Therefore, the present study aims to develop a profile of source separation behaviour drivers in the household context. The drivers in this context point to potential remedies likely to facilitate source separation behaviour among households. The research question that arises is: What are the drivers influencing source separation behaviour among households in Malaysia? The following section highlights literature review insights into Malaysian household source separation behaviour, and drivers influencing household source separation behaviour. The third section explains the research methodology. Then, the fourth section shows the results obtained from the choice-based conjoint analysis, along with a discussion. Finally, a conclusion as well as suggestions for future research are presented.

Drivers Facilitating Household Source Separation Behaviour

Source separation behaviour involves individual sorting of waste according to type. The aim of source separation is to improve recycling value and enable efficient and economical treatment for waste, which, consequently, leads to a minimisation of the impacts on the environment. Household source separation is one of the most widely proposed ways to overcome the increasing trend of waste generation and low recycling rates that affect the complexity of collecting recyclable materials versus landfill disposal. Households are the targeted groups and they play an essential role in participating in source separation behaviour at home as part of long-term efforts to reduce environmental degradation. The present study focuses on the situational factors facilitating source separation behaviour among households.

The present study incorporates the PEST model and a review of previous literature in developing the profile of source separation behaviour drivers. The PEST model was designed in 1967 by Francis Aguilar and is popularly known as a strategic management tool that identifies external variables related to the business and market environment that one intends to enter or which one is currently in. The model classifies the drivers influencing a business environment into four dimensions: (1) political; (2) economic; (3) social; and, (4) technological. In the context of pro-environmental behaviour, particularly source separation behaviour, the PEST model is adapted with modifications. This study uses the model to identify situational factors that influence source separation behaviour among households. The political dimension refers to decision-making by the government in enforcing source separation through regulations and policies. The economic dimension refers to the costs and benefits derived from source separation. The social dimension refers to household participation in source separation, while the technological dimension refers to infrastructure innovations that promote the ability to improve source

separation. The PEST model has been adopted in previous studies to investigate the solid waste management in various countries (Iyamu *et al.,* 2020; Khalid *et al.,* 2020).

Several studies have confirmed that in different contexts, such as offices, commercial centres and universities, different drivers contribute to the improvement of source separation behaviour. Drivers such as collection services at the office affect source separation behaviour (Edjabou *et al.*, 2015). A study conducted among households in Cork, Ireland, reported that it is crucial to provide food waste bins within a community, and raising awareness continually through education and media is essential for improving households' food waste separation practices (Jamal *et al.*, 2019). An investigation conducted at university campuses in the city of Beijing, China, on source separation behaviour among students found that information on source separation is one of the main drivers closely related to the students' source separation behaviour (Zhang *et al.,* 2017). By investigating the role of women in municipal solid waste management in Tehran, Zand and Heir (2020) found that face-to-face training has a positive influence on women's practice in solid waste recycling and source separation. A study held in Shanghai found that the implementation of a policy on compulsory waste separation in July 2019 successfully facilitated the formation of source-separating habits in the region (Lu & Sidortsov, 2019). According to a study observed in the Source Separation of Waste programme in Tabriz, Iran, infrastructure barriers have prevented households from participating in source separation (Babazadeh *et al.*, 2018). A lack of knowledge and facilities could prevent community participation in implementing the solid waste 3Rs programme (Trihadiningrum *et al.*, 2015). Household source separation behaviour considers a variety of influencing drivers. Encouraging community participation in source separation as part of the daily routine can have a direct impact on a successful waste management system (Hellwig *et al.*, 2019). The use of the adapted PEST model in this study is expected to systematically identify the drivers

influencing source separation behaviour among households. To obtain an overview of publication scenarios regarding drivers influencing source separation behaviour among households, a literature search was conducted using the two scientific databases, Scopus and the Web of Science. Keyword searches from both databases include "waste separation", "recycling", "solid waste" and "household". The results obtained are relevant to the context of this research, showing a total of 70 articles. After obtaining information from the scientific databases, content analysis was performed. It enabled the identification of the main drivers and sub-drivers related to source separation behaviour. The drivers identified as the main four categories likely to influence source separation behaviour are (1) regulation, (2) incentive, (3) information and (4) infrastructure support, as shown in Figure 1. Each driver is associated with a set of sub-drivers. The details of each driver are presented in the following subsections.

Driver 1: Regulation

Regulation focuses on institutional power to enhance cooperation regarding source separation behaviour at all levels. Currently, regulation comprises policies and legislation related to source separation behaviour. In this context, regulation is made up of two sub-drivers, namely mandatory source separation and enforcement, and pay-as-you-throw programmes. Mandatory source separation and enforcement is significant in driving the desired behaviour. Policy choices are based on an assessment of consumer needs and behaviours, so it is important to change consumer behaviours to increase the focus on recycling to reduce waste generated for landfills or incinerated (Kirakozian, 2016). Recent studies have indicated the importance of regulation in overcoming challenges to municipal solid waste management (Zhou *et al.*, 2019; Xiao & Dong, 2020; Xiao *et al.*, 2020). In Malaysia, solid waste separation at the source falls under the Solid Waste and Public Cleansing Management Act 2007. Mandatory source separation and enforcement is needed for source separation behaviour to be practised in the local context.
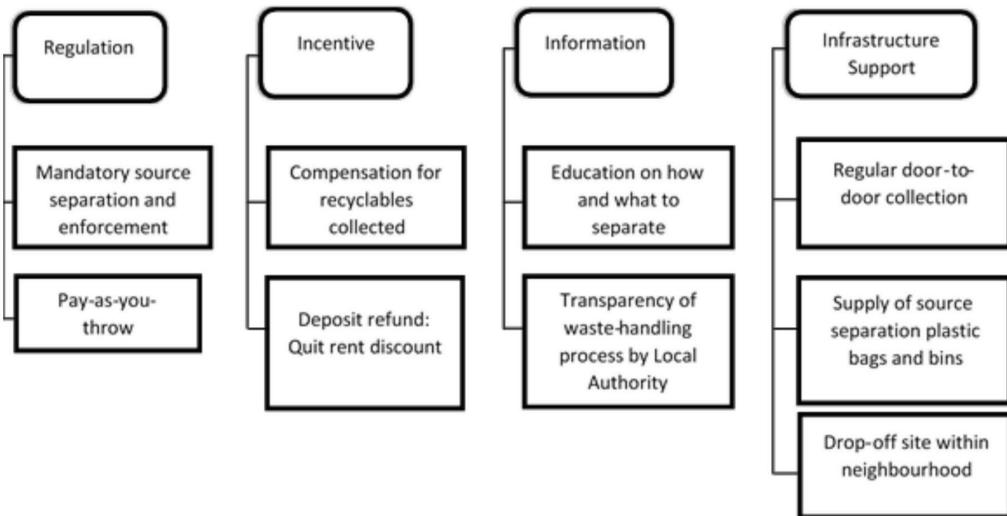
Figure 1: The theoretical framework of the drivers influencing source separation behaviour

Pay-as-you-throw programmes emphasise the "polluters pay" principle, which refers to a situation whereby an individual will be imposed charges for each item of waste disposed without separation; this is one of the schemes that most developed and developing countries have adopted to reduce overall waste generation (Watkins *et al*., 2012). One study highlights the principle of zero waste in Aceh, Indonesia, that emphasises the pay-as-you-throw programme, and that led to the financing of waste management programmes and charging users who throw away more waste to control the amount of waste generated (Nizar *et al.,* 2018). In Changsha, China, the "polluters pay" principle has been implemented as a pay-as-you-throw programme, which depends on household water consumption, whereby the amount of household waste generated per month is estimated on the basis of the household water consumption (Chen *et al.,* 2017). The implementation of the programme increased household concerns regarding water conservation. In this study, pay-as-you-throw refers to the charges imposed by the government on consumers who dispose of waste without separating it at the source. In particular, households that place waste in the provided household bins or dispose waste at collection points without separating it at the source will be imposed a penalty.

Driver 2: Information

Information is needed to help participants do the right thing in the right way in terms of source separation behaviour. This driver is formed of two sub-drivers, namely education on how and what to separate, and transparency on waste handling processes by the local authority. Education on how and what to separate needs to be addressed in the form of information on sorting as it educates people and changes their behaviour accordingly (Kirakozian, 2016). Information on why and how to sort the waste decrease missorted packagings and, consequently, households will act accordingly if the facilities are near to their homes *(*Rousta *et al.*, 2015). For example, a study investigating better management of electrical and electronic equipment waste in Lithuania has suggested that providing information on what constitutes electrical and electronic equipment waste, how it should be separated, and where to dispose obsolete electrical and electronic equipment is necessary in the effort to foster electrical and electronic equipment waste recycling behaviour among students (Dagili & Zabulionis, 2019). As highlighted in a study by Kattoua *et al.* (2019) conducted among households in Palestine, the lack of the right information on recycling is one of the factors hindering households' recycling practices. Thus, the dissemination of the right

information is essential in driving household source separation behaviour.

Transparency on the waste handling process conducted by the local authority helps improve household source separation behaviour. A study in Nur-Sultan city in Kazakhstan suggested that a well-organised collection system and the employment of an effective awareness campaign by the authorities are expected to improve household source separation behaviour (Sarbassov *et al.,* 2019). Jamal *et al.* (2019) also mentioned that the role of the local authority in implementing and increasing source separation of food waste in both commercial and residential premises is important, as site inspections of the premises to remind individuals to separate their food waste encourages the engagement of the public in participating effectively in food waste recycling schemes. According to Sato *et al.* (2020), a study on solid waste management with an implemented technical cooperation project in Sri Lanka through the evaluation of the separation of sources by the local authorities has led to the expansion of recycling promotions to other areas related to waste reduction and resource recovery, and a decrease of the final disposal amounts.

Driver 3: Incentive

Incentive involving the benefits achieved while preserving the environment, producing a win-win situation among stakeholders in source separation practices. Incentive comprises two sub-drivers, namely compensation for recyclables and deposit refund: quit-rent discount. Compensation for recyclables refers to cash rewards for each recyclable item. Compensation for recyclables is on a monetary or cash basis to increase household production in recyclables and the practising of source separation behaviour (Owusu *et al.*, 2013). In China, residents are offered payment for depositing their spent batteries at a local collection point (Sun *et al*., 2015). Similarly, a study in Shanghai, China, pointed out that selling recyclables for money can contribute to recycling participation among households

(Kattoua *et al.,* 2019). Hence, compensation for recyclables refers to compensating households for their efforts in source separation behaviour.

Deposit refund: quit-rent discount refers to payment offered to households returning recyclables for waste management. In the present context, households are offered a tax deduction in the quit-rent payment when engaging in source separation behaviour at home. It is a similar to the concept to "bottle bills", or container deposit laws, wherein the buyer will get reimbursement from buying packaging products and buyers are encouraged to reuse containers and, at the same time, reduce packaging product consumption (Xevgenos *et al*., 2015). The deposit-refund system positively affects the achievement of satisfactory high recycling rates, where consumers return their recyclables to earn a refund in lieu of collection (Mwanza *et al.*, 2018). Deposit-return schemes have been implemented by 10 countries in Europe, namely Croatia, Denmark, Estonia, Finland, Germany, Iceland, Lithuania, the Netherlands, Norway, and Sweden. Deposit-refund schemes require the consumer to pay a small amount of money initially, to be returned to them later when they bring the container to the collection point after they have finished using it. The returned container will be recycled and converted into secondary raw materials. In general, deposit-refund schemes can be operated by government entities or independent bodies. They are responsible for overseeing the scheme from start to finish, from the installation of the necessary infrastructure to the monitoring of the fee deposit circuit that moves from manufacturer to retailer and from retailer to consumer (Plastic Smart Cities, 2020).

Driver 4: Infrastructure Support

Infrastructure support focuses on convenience and accessibility to the infrastructure that facilitate households' source separation behaviour. This comprises three sub-drivers: drop-off sites within the neighbourhood, supply of source separation plastic bags and bins, and regular door-to-door collection services. Drop-

off sites within neighbourhood refer to easy access to a recycling point, which is a recycling station that allows the community to drop their recyclables at their convenience. In a study conducted by Akbar *et al.* (2015), it was found that close proximity of recycling bins within walking distance of residents' home will increase their willingness to practise source separation and recycling (Akbar *et al.*, 2015). Enhanced accessibility of recycling facilities would lower behavioural costs and hence encourage the public to take up said action (Zhang *et al*., 2016).

The supply of source separation plastic bags and bins reminds households to handle waste disposal efficiently. An inadequate supply of bins will discourage residents' from undertaking source separation as addressed in a study conducted in Shanghai, China *(*Zhang *et al*., 2012). Placing a recycling bin in the lobbies of buildings was found to increase household recycling awareness and recycling rates in multi-residential buildings in Ontario, Canada (Lakhan, 2016). Sarbassov *et al*. (2019) suggested that waste separation containers placed in close proximity to the population have increased the accumulation of recycled materials among households in Nur-Sultan city, Kazakhstan. Indeed, Malaysia, has required households to separate recyclables into a separate bag and place it next to the waste bin, while all wet rubbish should be in a plastic bag and be put in the rubbish bin. The local authority supplies only a single bin for domestic waste.

The regular door-to-door collection service refers to the collection of recyclables from a home location to the collection point for ease of convenience. In Malaysia, door-to-door collection services for residential premises are performed once a week. A regular door-to-door collection service is about the availability of kerbside pick-ups of recyclables, rather than "bring" systems, where consumers must transport recyclables to central collection points (Czajkowski *et al.*, 2014). Previous studies have shown positive evidence of regular door-to-door collection services increasing the collection of recyclables. For instance, the door-to-door collection service programme implemented in Aveiro, Portugal, has successfully influenced households to sort their food and kitchen waste (Dias-Ferreira, 2015).

Methodology

This study adopts a quantitative approach with a questionnaire survey distributed to households in Malaysia. The choice-based conjoint analysis is adopted to identify the most favourable driver of source separation behaviour among households. The scope of this study is households in Langkawi Island, Malaysia. Langkawi Island is a district of Kedah located in the north of Peninsular Malaysia. The island is made up of six districts and this study was conducted in the community areas within the districts.

Measures and Procedures

A face-to-face questionnaire survey was conducted among the targeted respondents using the convenience sampling technique. Questionnaire pretesting was conducted to avoid technical errors. The choice-based conjoint questionnaire consisted of two sections: Sections A and B. Section A consisted of the demographic profile of the respondents, including gender, race, area of residence, age, household annual income, source separation behaviour and frequency of source separation at home. Section B consisted of the choice-based conjoint choice tasks. In the choice-based conjoint analysis, a limited number of profiles are shown to the respondents at one time, hence the respondents are not overloaded with information in indicating which profile they preferred. A total of 10 versions of the questionnaire with different combinations of choice tasks were generated. Each questionnaire comprised 12 choice tasks. Each choice task consisted of one sub-driver from each driver category. In total, 480 questionnaire forms were collected. After incomplete responses had been excluded, the number of valid responses was 472. All the empirical data collected was submitted for choice-based conjoint analysis. Figure 2 shows a sample of the choice-based conjoint questions.

	PACKAGE 1	PACKAGE 2	PACKAGE 3	PACKAGE 4
Regulation	Mandatory source separation and enforcement	Mandatory source separation and enforcement	Pay-as-you-throw	
Incentive	Compensation for recyclables collected	Quit-rent discount if source separation is practised	Quit-rent discount if source separation is practise	
Information	Education on how and what to separate	Transparency on waste handling processes by the local authority	Education on how and what to separate	**NONE:** I wouldn't choose any of these
Infrastructure Support	Drop-off sites within the neighbourhood	Supply of source separation plastic bags and bins	Regular door-to-door collection services	

Figure 2: Sample of choice-based conjoint questions

Choice-Based Conjoint Analysis

The choice-based conjoint analysis is conducted by using the Sawtooth software. The analysis expresses the respondents' preferences by choosing their preferred profile from sets of profiles rather than rating or ranking them. Part-worth utilities by Hierarchy Bayes estimation were adopted to determine the relative importance of the attributes. Part-worth utility is an indication of the preferences for each attribute level based on how often the levels are selected, which indicates the households' preferences for each of the attribute levels. The higher the utility, the higher the preference (more desirable) for the level (Orme, 2011), which means the more the level is preferred by the households in enabling them to practise source separation behaviour. A similar methodology was found in past studies, such as one that involves renewable energy investment behaviour (Loock, 2012), preferred social marketing mix in energy conservation behaviour (Sheau-Ting *et al.,* 2013), and preferred electrical product (Kaenzig *et al.,* 2013).

Two results are reported in the choice-based conjoint analysis: (1) average utility values and (2) average importance values. In the choice-based conjoint study, the utility values are scaled sum to 0 within each driver category (zero-centred). This indicates that the negative value within the driver category does not mean that the subdriver was unattractive, but just that it is less desirable than the other subdrivers within the attribute. The utility values can be used to compare favourable subdrivers within the same driver category, not across another driver category. Secondly, the average importance values show the values of each driver category in facilitating source separation behaviour in terms of percentage. The average importance value reflects the degree of importance of the drivers in influencing households to practise source separation. The average importance is a percentage calculated with reference to the ranges between the attribute's part-worth utility values; hence, a set of attribute importance values is obtained that total up to 100 (Orme, 2011). The average importance is in terms of ratio. Therefore, the data can be interpreted to

say that a driver with an average importance value of 30 is twice as important as one with an average importance value of 15.

Results

Respondents' Demographic Profile

Overall, a total of 472 households were involved in this study, consisting of 76% females and 24% males. The race respondents were 94.5% Malay, 4.2% Chinese, 0.9% Indian and 0.4% other races. The majority (70%) of the respondents were from suburban areas and 30% were from urban areas. Also, 42% of the respondents were aged 31–40, followed by 33% aged 40–50, 17% aged 21–30 and around 8% aged 50 and above. Furthermore, about 50.3% of the households stated that they practised source separation of waste once a week, while 20% practised source separation twice a week, 16% daily, and 13.7% once a month.

Average Utility Values of Household Source Separation Behaviour Drivers

The utility values for each sub-driver were computed, as shown in Table 2. For the driver of infrastructure support, among the three sub-drivers identified, households preferred the supply of source separation plastics bags and bins. This was followed by regular door-to-door collection services, and the least preferred sub-driver was the drop-off sites within the neighbourhood. For the second driver, regulation, mandatory source separation and enforcement is ranked higher than pay-as-you-throw. Households were more willing to accept mandatory enforcement rather than a new pay-as-you-throw scheme. Then, for the next driver of incentive, the households responded that compensation for recyclables can help facilitate their source separation behaviour better than the deposit refund: quit-rent discounts. Finally, the households prefer receiving information on how and what to separate than transparency on the waste handling process by the local authority.

Table 1: Overview of respondents' demographic profile

Demographic Variable	Options	N, %
Gender	Female	358 (76%)
	Male	114 (24%)
Race	Malay	446 (94.5%)
	Chinese	19 (4.2%)
	Indian	5 (0.9%)
	Other races	2 (0.4%)
Area	Suburban	330 (70%)
	Urban	142 (30%)
Age	31–40	198 (42%)
	40–50	156 (33%)
	21–30	80 (17%)
	50 and above	38 (8.0%)
Source separation practices	Once a week	237 (50.3%)
	Twice a week	94 (20%)
	Daily	76 (16%)
	Once a month	65 (13.7%)

Table 2: Drivers and sub-drivers level of ranking

Drivers and Their Level	Average Utilities Values	Ranking
Driver 1: Infrastructure Support		
Drop-off sites within the neighbourhood	-23.49	3
Supply of source separation plastic bags and bins	27.56	1
Regular door-to-door collection services	-4.06	2
Driver 2: Regulation		
Mandatory source separation and enforcement	31.65	1
Pay-as-you-throw	-31.65	2
Driver 3: Incentive		
Compensation for recyclables	24.42	1
Deposit refund: Quit-rent discount	-24.42	2
Driver 4: Information		
Education on how and what to separate	11.15	1
Transparency on waste handling process by the local authority	-11.15	2

Average Importance Values of Household Source Separation Behaviour Drivers

Figure 3 shows the profile of household source separation behaviour drivers with the average importance values for each driver. These values state the size of each driver. The higher the importance value, the larger the contribution of this driver in influencing a household's source separation behaviour. In choice-based conjoint analyses, the total average importance of all the influencing drivers added up to 100%. What stands out in Figure 3 is that infrastructure support (33%) is ranked as the most preferred driver in facilitating source separation behaviour. This result is consistent with Akbar *et al.* (2015), who found that Abadan residents were likely to commit to source separation behaviour if the local government provided containers and have 85.7% of acquisition of services, such as waste collection services. Subsequently, regulation (29%) is the second-ranked driver of source separation behaviour among Malaysian households. This is followed by incentives (23%). A study conducted in Ghana has showed that more than half of the respondents were likely to accept cash incentives to participate in source separation (Owusu *et al*., 2013). This result indicated that economic drivers need to be present to instil source separation behaviour.

Interestingly, information (15%) was the least preferred. Typically, a lack of information provided to a targeted group will prevent people from practising the desired behaviour. While people may be aware that recycling programmes exist, those that lack information do not seek it out, and studies have suggested that a lack of information on recycling decreases the rate of recycling (Von Borgstede & Andersson, 2010). In general, the result implies that Malaysian households do have the knowledge to separate their wastes at home. Indeed, providing a ready infrastructure would enable them to do so more actively and effectively.

Discussion

This research focuses on measuring the relative preference of households towards the drivers of source separation behaviour through choice-based conjoint analysis. The results of this study identified the drivers that play a major role in source separation behaviour among households in Malaysia. The conjoint analysis results suggest that households' preferred infrastructure support, regulation, incentive and information to encourage source separation behaviour. Infrastructure support gained the highest number of preferences at 33%, with information being

Figure 3: Profile of household source separation behaviour drivers

the least preferred at 15%. For household source separation behaviour, infrastructure support is needed to handle mixed solid waste (Daskal *et al*., 2018; Jamal *et al.,* 2019). The study showed a significant preference for theupply of source separation plastic bags and bins over regular door-to-door collection services and a drop-off site within the neighbourhood among respondents. In some countries, two bins are allocated for each household for recyclables and general waste. However, in Malaysia, only a single rubbish bin is provided to each unit of landed property. A lack of bins for recyclables has limited source separation behaviour among households. Malaysian households are more likely to engage in source separation behaviour if sufficient infrastructure support is available. Subsequently, the preferences for regulation at 29% for household source separation behaviour

were consistent with most previous studies (Chen & Lee, 2020; Wang & Jiang, 2020). Regulation is essential in most Asian countries for the authorities to overcome low-level source separation practices, which require behavioural changes to enable the people to correctly sort recyclables and reduce the missorting of waste (Sukholthaman & Sharp, 2016). According to Nordin *et al.* (2020), regulation is one of the recommended strategies for the separation of food waste among households in Malaysia, which is related to waste reduction and requires a change in the behaviour of people, both in terms of companies and individuals. In Malaysia, the government has made solid waste separation at the source mandatory under the Solid Waste and Public Cleansing Management Act 2007. Along with the implementation of the act for source separation practices, household

source separation behaviour is expected to increase. From the investigation, it was found that regulation for mandatory source separation and enforcement is preferred by respondents than pay-as-you-throw programmes. The study acknowledges that established regulation along with enforcement with regard to household source separation may effectively increase the overall recycling participation rates. In South Korea, several amendments made to the waste management policy to actualise the 3Rs and source separation for recycling have been successful. The country has enforced the law using a volume-based rubbish rating system for household waste since 1996, whereby it was compulsory for households to pay to discharge waste by weight. This has reduced household waste generation rapidly and has been maintained at 1 kg/day since 1995 (Park & Seo, 2014). In China, the government introduced the "Domestic Waste Separation System Implementation Plan" in 2017, which asserted the mandatory implementation of source separation in 46 cities to encourage active participation in source separation in these cities (Xiao *et al.*, 2018). Next, the preferences for incentive among respondents were slightly higher at 23%, compared with information at 15%. Respondents preferred economic compensation for providing recyclables over deposit refund: quit-rent discount for them to dispose of waste separately. The government has made efforts to provide economic incentives to motivate interest in participating in recycling and source separation (National Solid Waste Management Department, 2016). The study has shown that providing compensation for recyclables could encourage household participation in separating their waste. Therefore, households will be committed to participating in separating their waste if the government cooperates with the local municipality to provide incentives for waste separation. For instance, collecting for selling recyclable materials by households from lowland areas in Thailand has successfully motivated and driven changes in source separation behaviour among households (Suma *et al.*, 2019). Also, one of the successful

deposit refund scheme interventions can be seen in the Netherlands for small electric appliances and batteries, where the intervention led to some increases in the overall recycling rate (Linderhof *et al.,* 2019). Among the four driver categories, information recorded the lowest percentage at 15%. This reflects an encouraging scenario, in which Malaysian households already have the knowledge fn how and what to separate. Compared with the information on source separation and transparency on the waste handling process conducted by the local authority, households gave more weight to other drivers, such as the provision of infrastructure, incentives and regulation.

Conclusion

A profile of source separation behaviour drivers was developed in this study. A total of four categories of drivers were identified as essential in influencing and facilitating the practice of source separation behaviour among households in Malaysia. These four categories were associated with nine sub-drivers. From the choice-based conjoint analysis, the results on average importance show that the most favourable driver influencing source separation behaviour is infrastructure support, at 33%, followed by regulation at 29%, incentive at 23% and information at 15%. Out of the nine sub-drivers of source separation, the sub-driver that was perceived as most necessary for facilitating household source separation is supplying source separation plastic bags and bins. The results could provide a reference guide for policymakers in formulating strategies to improve the nation's source separation behaviour, and would be particularly relevant to the aspects of regulation, incentive, information and infrastructure support. The profile developed in the present study suggests a combination of drivers are essential to facilitate and motivate the source separation behaviour among households, and this can be seen in other nations, such as in Southeast Asia, that share a similar climate and context. However, this study is limited to the situational factors driving source

separation behaviour and no consideration was given to the psychological factors at the individual level. Hence, future research could broaden the scope of the current research by investigating the psychological factors of source separation behaviour among households. This study is limited in its scope as it only included respondents from Langkawi Island in Malaysia. Future studies should include a wider scope to enhance the overall results generalisation.

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