

Household waste separation intention and the importance of public policy

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Household
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Abstract

Purpose – The key challenge that urban cities in most developing and transitional economies is confronting is municipal solid waste (MSW) management. Waste separation is a critical component to successful recycling management in terms of enhancing the quality of recyclables, reducing MSW and optimizing incineration. The urge to actualizing sustained waste separation behavior has been hindered by potential barriers. This study aims to examine the influences of external and internal stimuli of targeted households' waste separation intention in parts of China.

Design/methodology/approach – A multifactor framework predicting the process that leads to waste separation attitude and behavioral intention is proposed. SEM analysis is conducted in SmartPLS based on 371 survey questionnaires collected in Nanning city in China.

Findings – Policy regulation is the biggest determinant of attitude among external stimuli, while awareness of consequence has the strongest relationship with an attitude among internal stimuli. Facilitating conditions, subjective norms and moral norms are all significant predictors of attitude. As a result, increasing positive attitude leads to enhance waste separation lifestyle.

Research limitations/implications – This study adopts a cross-sectional design to investigate the waste separation intention of local households. Data collection is restricted to one point in time for every individual. A mixed method is recommended. Quantitative research can examine variables provided in existing literature with numerical analysis. Qualitative research might be helpful to identify other unknown factors. Also, the survey questionnaires employ a self-reported manner, and respondents might be overrating to avoid embarrassment.

Practical implications – Future research is recommended to engage observation at houses or at the waste-collecting points for actual waste separation behavior. Moreover, this study measures intention toward household waste separation, but whether this intention will eventually lead to waste separation behavior is not a guarantee. Future study is recommended to examine whether intention translates into actual waste separation behavior.

Originality/value – Emphasizing the importance of policy element as a direct influence toward attitude, this paper focuses on the waste separation attitude accumulated from external and internal stimuli, and, concurrently, waste separation behavioral intention is influenced by accumulated attitudes. The study provides relevant policy development information of three Asian countries to enhance their present and future policy directions for a sustainable household waste separation management process

Keywords Municipal solid waste, Household waste separation intention, External stimuli, Internal stimuli, Municipal governments

Paper type Research paper

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1. Introduction

Municipal solid waste (MSW) is one of the life-threatening issues. The key challenge of MSW management confronting urban cities in most developing and transitional economies has become a priority for governments all over the world (Sukholthaman and Sharp, 2016). Currently, the world generates approximately 1.3 billion tons of MSW a year and is expected to increase to 2.2 billion tons by 2025 (World Bank, 2012). We need to predict the pollution output levels and at the same time have the abilities to manage waste in countries.

One of the key solutions is recycling. It will reduce MSW, as waste separation is a critical component to a successful recycling management in terms of enhancing the quality of recyclables, and will optimize incineration (Zhuang *et al.*, 2008). The government has promoted the importance of recycling to the general public, and some developed countries have already achieved success in recycling. For instance, MSW recycling rate in Singapore was 61%, South Korea 58%, Iceland 55.8%, Australia 42.1%, Germany 47.8%, Belgium 34.3% and the USA 34.6% (Kaza *et al.*, 2018). However, developing countries still produce a million ton of MSW. Governments from developing countries have tried implementing waste separation policy, but these policies cannot be a success without the keen participation of households in a continuous act of waste separation processes.

To dwell deeper into the understanding the participation of households in waste separation schemes, previous studies have been conducted various analyses. Researchers found that demographic factors such as socio-economic background or dwelling types (Berglund, 2006; Vicente and Reis, 2008), or influence of personal characteristics such as education, awareness of consequence or moral norm (Williams and Taylor, 2004; Shirahada and Fisk, 2014) result in waste separation behavioral patterns, where the majority of them directly connect internal stimuli to their waste separation behavioral decision.

On the other hand, behavioral decision can be better explained as a result caused by external stimuli such as punishment, economic incentives (i.e. cash, vouchers, discount coupons and goods) (Bernstad, 2014; Shirahada and Fisk, 2014) or society influences (Xu *et al.*, 2017).

Although several studies suggested a strong direct relationship between such factors and waste separation behavior, practitioners or public policy-makers knew there would be difference between their expectation and the reality about household's attitude and their behavioral intention toward waste separation management. According to the ABC theory (attitude, behavior and conditions), closer facilitating condition will result in high participation rates, independent of attitudes, while inadequate accessibility will result in low participation rate despite the positive attitude toward waste separation (Hage *et al.*, 2008). Behavioral attitude and intention toward waste separation are different, and hence this study will focus on the waste separation attitude accumulated from external and internal stimuli and on waste separation behavioral intention which is influenced by accumulated attitudes.

Among external stimuli, the interesting stimulus is the extent an individual accepts the policy and the perceived effectiveness of policies designed to promote such pro-environmental behaviors, which, in turn, would also influence the intention to engage in waste separation behavior. Especially, China is a country with strong centralized power, and the top-down authority has issued a series of public policies which are meant to guarantee the success of sustainable waste separation management. Public policy is a very important driving force to trigger people's environmental behavioral change. However, even with a strong authority like China trying to enforce waste separation policies, the separation of waste is not happening at the ground level.

In this context, this study examines the possibility of active participation in waste separation through the investigation of the external and internal stimuli of targeted household in parts of China where 190 million tons of MSW is produced, which accounts for 29% of the world's MSW (The World Bank, 2012). China is supported with an authoritarian

central government, which might guarantee the success of a sustainable waste separation management. The issue here is bringing MSW to ground-level acceptance and immersion. The results of this study will provide relevant authorities in China and other developing countries with information to enhance their present and future policy directions for a sustainable household waste separation management process.

2. Literature review

2.1 *Waste management policies in Asia*

Waste management is a life-threatening issue, and waste management needs to become more sustainable; it needs to be environmentally effective, economically affordable and socially acceptable (McDougall, 2005). Source separation for recycling is one of the most crucial methods to achieving sustainable household waste management. Most countries especially in Asia, despite intense efforts to cultivate waste separation behavior, continue to grapple with the low level of source separation practice. Under current situation, separating waste at source requires a behavioral change, and regulative element is essential so that government authorities aim to achieve an increase in correctly sorted recyclables and a decrease in missed-sorted waste through their public policy (Sukholthaman and Sharp, 2016).

2.1.1 Waste management policy in Malaysia. The ABC Plan (Action Plan for a Beautiful and Clean Malaysia) in 1987 was a notion of the beginning of national waste management plan in Malaysia (Moh, 2017). This plan attempts to decrease waste generation but has no specific legal instrument to actualize it. With the lead of ABC Plan, two more recycling programs were introduced in 1993 and 2000 (Moh, 2017). But these recycling programs did not transfer into sustained waste separation or recycling behavior. With the introduction of the Solid Waste and Public Cleansing Management Act 2007(also known as ACT 672), municipal solid waste (MSW) management is now standardized and obligatory waste separation and recycling is officially promoted in Peninsular Malaysia since 2011 (Fauziah *et al.*, 2012; Moh, 2017).

In order to carry out the mandatory waste separation by households, the SWCorp Strategic Plan 2014–2020 is introduced (Moh, 2017). This comprehensive plan develops eight core strategies to realize and consolidate waste management step by step. These steps are to be executed by order (1) to change public's mindset toward building a cleaner environment, (2) to establish sustainable 3R behavior and culture, (3) to improve solid waste management services and public cleansing, (4) to actualize policy enforcement and regulation, (5) to ensure financial resources stability, (6) strengthen waste management technology system and facilities, (7) to strengthen law enforcement and (8) to strengthen delivery system (SWCorp Malaysia, 2014; Moh, 2017). However, without appropriate supporting system, facilities and equipment, this comprehensive strategic plan cannot be properly implemented. Thus, the promotion of citizen's source separation of household waste in Malaysia is still an unfilled plan.

2.1.2 Waste management policy in Korea. With persistent efforts for the last three decades, Korea's overall recycling rate for all wastes is as high as 80%, and the total generation of household waste per person is as little 1 kg/day. (Yang *et al.*, 2015). The accomplishment of this success begins with the establishment of Environmental Protection Agency and the introduction of Environmental Protection Law in 1978 (Yang *et al.*, 2015). Consequently, the Waste Management Law was enacted in 1986 to integrate different waste management systems into one, and this laid the foundation of waste classification for further development. Currently, a series of amendments are made to actualize the 3Rs and waste separation for recycling. These amendments include Act on Resource Saving and Recycling Promotion (1992), Act on Waste Treatment Facilities Promotion and Support Surrounding Area (1995) and amendment of separating collection of recyclables (Yang *et al.*, 2015).

Due to the separate treatments toward household waste and industrial wastes, the law for which was enforced in 1996, and the introduction of the volume-based garbage rate system (i.e. households have to pay to discharge waste by weight), household waste generation has dropped rapidly and sustains at 1 kg/day since 1995 (Yang *et al.*, 2015). Overall, the success of waste management in Korea can be attributed to the implementation of a series of waste management laws and continuous efforts on enforcement of specialized acts. In order to target toward a zero-waste society in the future, new laws are in the planning stage.

2.1.3 Waste management policy in China. China's urbanization is a great success on many counts. However, the massive shift to consumeristic lifestyle has also produced tremendous waste, which is increasing with the population growth. "China surpassed the US as the world's largest waste generator in 2004 (World Bank, 2012)." Central government in China has attached unparalleled importance to household waste separation implementation. Beijing, Shanghai, Nanjing, Hangzhou, Guilin, Guangzhou, Shenzhen and Xiamen were first chosen to promote household waste separation in 2000.

After 19 years of effort, the results have indicated that pilot programs failed to encourage active participation at source separation in these cities. The Chinese government intensified its effort by introducing the "Domestic Waste Separation System Implementation Plan" in 2017, which called for the obligatory implementation of waste separation in 46 cities (Xiao *et al.*, 2018). The government of China has shown great determination to achieve sustainable household waste management. This plan stated that compulsory waste separation needs to be implemented; the targeted recycling rate of domestic waste is about 35% by the end of 2020. In addition, a system of laws, regulations and standards related to waste separation should be established in every targeted city.

2.2 Household recycling and waste separation

2.2.1 Waste separation intention. Household participation is essential to the success of a waste separation scheme. Whether individuals are willing to engage in such scheme is measured by waste separation intention. Intention is the sole predictor for behavior in the theory of planned behavior (TPB) and often described as an "attempt to perform a behavior" (Ajzen, 1985). There are five basic constructs in TPB: attitude, subjective norm, perceived behavioral control, intention and behavior. It implies that a person's act is a deliberative process which is determined by one's intention and perceived behavioral control. Ajzen (1985) described intention as an "immediate determinant (p. 12)" of an action that is preceded by three psychological determinants, which are attitude, subjective norm and perceived behavioral control. The TPB connects cognitive and normative variables to explain people's intention and behavior.

Intention is also a predictor of behavior in Triandis' interpersonal behavior model (Triandis, 1977) and is defined as "a conscious plan to carry out a behavior." Intention links the cognitive constructs and behavior performance of an individual together (Pee *et al.*, 2008). Intention has been found to be an important factor accounting for waste separation behavior in previous studies (Ofstad *et al.*, 2017; Zhang, Huang, *et al.*, 2015). However, intention does not always predict the actual performance of behavior (Kumar, 2012; Chung and Leung, 2007). To investigate how psychological and cognitive factors relate to household's waste separation intention, there is a need to understand the decision-making process behind these.

Numerous studies have identified relationship between attitude, subjective norms, perceived behavioral control and intention by adopting the psychological TPB framework (Karim Ghani *et al.*, 2013; Stoeva and Alriksson, 2017; Khan *et al.*, 2019; Lizin, Tonglet *et al.*, 2004; Van Dael and Van Passel, 2017; Liao *et al.*, 2018). Some researchers pointed out that the role of attitude seemed to be more prevalent in determination of intention (Barr *et al.*, 2013). According to Shove (2010), the ABC model (attitude-behavior-choice) suggests a rational,

linear and, more importantly, a simplistic approach to understand intention. A person's attitude toward targeted behavior is constituted by one's experience, understanding, knowledge and conception about a certain behavior. As a result, attitude can be determined by various factors. These factors, in sum, will lead to a positive or negative attitude toward targeted behavior in general. Thus, this study undertakes the attitude-intention approach to investigate the waste separation decision-making process of households.

2.2.2 Attitude toward waste separation. Waste separation attitude is the subjective assessment an individual holds toward waste separation. There is ample support that attitude is a strong predictor for intention. [Stoeva and Alriksson \(2017\)](#) found that strong positive attitude toward waste separation leads to waste separation at home among 223 students from Sweden and Bulgaria. Attitude is found to significantly influence residents' willingness to pay for improving recycling facilities in a study in Thailand ([Vassanadumrongdee and Kittipongvises, 2018](#)). [Karim Ghani et al. \(2013\)](#) also find significant evidence to support that positive attitude was the best determinant to predict intention to practice waste separation at home. [Chen and Tung's \(2010\)](#) study also supports a positive significant relationship between attitude and intention to recycle. Recent waste separation study confirmed that attitude is a significant determinant toward intention ([Liao et al., 2018](#)). In other words, positive attitude toward waste separation tends to lead to higher intention to act in the future. Thus, this study postulates the following hypothesis:

H1. Attitude toward waste separation has positive impact on intention to waste separation.

2.3 Motivation of waste separation

Waste separation is not a new concept in developed economies. However, it is a newly enforced scheme promoted in developing economies. Waste separation requires behavioral changes by all participants. Behavioral change theories suggest that motivations are essential to reinforce people's attitude, and thus leads to changes of behavior. Researchers argue that motivation can come from both internal and external stimuli ([González Pérez et al., 2000](#); [Haddad et al., 1981](#); [Virvilaitė et al., 2011](#)). In studies of waste separation, studies have shown that external stimuli such as accessibility to waste separation facilities, monetary incentives and policy regulations are equally important as psychological stimuli derived from one's cognitive perceptions ([Bernstad, 2014](#); [Hage et al., 2008](#)).

Unlike waste separation schemes in developing economies, the public in developed countries is familiar with knowledge of waste separation and internally motivated to participate in source separation. Furthermore, facilities for separation provided by governments have been developed into a more adequate level in terms of both quality and quantity. In contrast, in developing economies, waste separation schemes are still at an immature stage, and there are several barriers to the realization of waste separation. For instance, citizens have not fully accepted the concept of waste separation yet, many external motivational instruments are not properly provided by government and households are not skilled in waste separation. To realize the successful promotion of waste separation schemes in China, it is not only important to understand the decision-making process of intention, but it is also vital to distinguish whether these influencing elements are internal or external, so as to design specific policy interventions to eliminate existing barriers.

Thus, this study develops a research framework combing external and internal stimuli as motivational determinants of one's waste separation attitude, and ultimately how these factors are reflected in households waste separation intention.

2.3.1 External stimuli of waste separation. *2.3.1.1 Policy regulation.* The purpose of pro-environmental public policy is to stimulate pro-environmental intentions and actual behavioral change ([Steg and Vlek, 2009](#)). Recycling, waste separation and other programs

that involve behavioral change to encourage pro-environmental behavior are often the purpose of public policy. As a country in which political power is strongly centralized, the top-down waste separation schemes of China's local governments are expected to be successful. However, despite intense efforts to cultivate waste separation behavior, many cities continue to grapple with a low level of source separation. Despite the waste separation opportunities provided, people do not participate in the program. As the focus of this study is on households who carry out the actual waste separation at source, it is important to understand residents' perceptions of the waste separation policy implemented by the Chinese government. Residents' perceptions could, in turn, influence their attitude to engage in pro-environmental actions.

The effectiveness of policy intervention was introduced into waste separation studies in recent years. Policy regulation measures the perceived effectiveness of waste separation policy by participants of an environmental scheme. [Wan et al. \(2014\)](#) reported the positive direct relationship between perceived policy effectiveness and intention to separate waste in Hong Kong. [Liao et al. \(2018\)](#) also reported a positive relationship between PPE and waste separation intention in rural areas in China. [Steg and Vlek \(2009\)](#) pointed out that policies interventions can be targeted to influence person's attitude. If an individual considers the waste separation policies as effective or if they are in favor of current waste separation policies, their attitude would be positive and will encourage them to their participate. Hence, the following hypothesis is proposed:

H2a. Policy regulation has positive influence on attitude to separate waste at source.

2.3.1.2 Incentives. Economic incentives are measures often introduced to promote environmental behavior. Economic theory assumes that individuals are rational economic persons and their decisions are driven by reasonable evaluation of costs and benefits. The introduction of incentives acts as a motivational device for individuals to re-evaluate the cost of action. Incentives generally include rewards and punishments. Researchers state that economic incentives in recycling and in plastic waste collection are significant influencing factors that households react to ([Thøgersen, 2003](#); [Hage et al., 2008](#)). Studies suggest that rewards are usually more effective to facilitate pro-environmental action ([Geller, 2002](#); [Steg and Vlek, 2009](#)). [Yau \(2010\)](#) records that economic incentives work well to promote waste recycling in Hong Kong. A survey in Hong Kong reported that households were willing to return batteries on the condition that refundable deposit was promised. On the other hand, [Scott \(1999\)](#) did not find evidence to support that economic incentive significantly influences recycling.

In the current study, incentive scheme has not yet been introduced in Nanning city. The draft of regulation of introducing incentive measures on waste separation is still under discussion. There is a need to understand whether people favor incentive plans which will be enforced in the near future. This study investigates the impact of incentive plans on waste separation attitude. Thus, the following hypothesis is formulated:

H2b. Incentives have positive impact on attitude toward waste separation.

2.3.1.3 Facilitating conditions. Waste separation relies heavily on external conditions. The ABC theory (attitude, behavior and conditions) provided by [Hage et al. \(2008\)](#) suggest that without accessibility to recycling facilities, participation rate drops even in presence of positive attitude and high environmental awareness. [Barr et al. \(2013\)](#) and [Bernstad \(2014\)](#) assert that households' low participation rate in recycling is the result of constraints from external condition. Researchers pointed out that external constraints need to involve time, space and the convenience of recycling channels ([Karim Ghani et al., 2013](#)). Facilitating conditions in this study represent external constraints that facilitate or impede the intention to perform a specific behavior. [Chang and Cheung \(2001\)](#) reported facilitating conditions

established a positive and significant influence on intention to use the Internet at work. Facilitating conditions were found to positively impact intention to use Internet banking (Zolait, 2014). In a pro-environmental study (Liao *et al.*, 2018), facilitating conditions positively influenced intention to separate takeaway waste. In this study, it is assumed that with satisfactory external conditions, households' positive attitude toward waste separation will be stimulated. Hence, this study proposes that:

H2c. Facilitating conditions have positive impact on attitude toward waste separation.

2.3.1.4 Subjective norm. In the TPB model, subjective norm refers to "the perceived social pressure to perform or not to perform the behaviour (Ajzen, 1991, p. 188)." More specifically, it refers to the social pressure an individual perceives from his/her significant others, that is, family members, friends, partner and colleagues. Subjective norm is determined by normative beliefs that if a person's important others consider he/she should perform certain behavior, and he/she is motivated to comply with the social referents, then there is positive influence on subjective norm. Several studies recorded positive influence of subjective norm on intention, including waste separation intention (Tonglet *et al.*, 2004; Xu *et al.*, 2017; Vassanadumrongdee and Kittipongvises, 2018; Chen and Tung, 2010) and household food waste reduction intention (Graham-Rowe *et al.*, 2015). On the other hand, a person's attitude can be influenced by normative values of his/her social contacts. Hence, the following hypothesis is proposed:

H2d. Subjective norm has positive impact on attitude toward waste separation.

2.3.2 *Internal stimuli of waste separation.* Moral norm represents ethical concerns and perceived social responsibility associated with behaving in a pro-social manner. Moral norms are strongly internalized moral values; the stronger these moral values, the stricter the discipline applied to the self in terms of behavior. In behavioral studies, moral norm is often found to be an influential determinant on intention in behavior related to moral concerns. For instance, in pro-environmental behaviors, Botetzagias *et al.* (2015) reported that moral norms significantly influence attitude toward recycling. Chan and Bishop (2013) documented moral norm as a significant predictor of recycling attitude. A recent waste separation study which tests perceived moral obligation (PMO) as an antecedent of attitude found that PMO is a significant predictor of attitude (Xu *et al.*, 2017). Hence, the following hypothesis is proposed:

H3a. Moral norm has positive impact on attitude toward waste separation.

2.3.2.1 Self-efficacy. Self-efficacy represents the individual's perceived knowledge and effectiveness of performing targeted behavior and is one component of perceived behavioral control. The more knowledge about a specific action that one possesses, the more control and confidence one perceives. Previous studies show some connections between self-efficacy and behavioral intention through experiments and experimental tests. Jugert *et al.* (2016) conducted four experiments in Germany and Australia to show that self-efficacy was a fundamental basis to raise collective efficacy, and as a result to stimulate pro-environmental intentions. Sheeran *et al.* (2016) reviewed 204 experimental tests and concluded that changes in self-efficacy could lead to changes in health-related intention. Some researchers found direct influence of self-efficacy and intention through path analyses. A strong and significant effect of self-efficacy on recycling was documented in Spain (Taverners and Hernández, 2011). Hagger *et al.* (2001) reported a positive influence of self-efficacy on intention to participate in physical activity. Zolait (2014) confirmed that self-efficacy had direct influence on customer intentions to use Internet banking. High self-efficacy indicates that one is confident to have internal control over his/her action and thus leads to positive attitude to perform certain behavior. Hence, the following hypothesis is proposed:

H3b. Self-efficacy has positive impact on attitude toward waste separation.

2.3.2.2 Awareness of consequence. Awareness of consequence is operationally defined as “an individual’s knowledge of expected outcomes of waste separation.” Comprehensive knowledge of the outcomes of actions or behavior can shape a person’s understanding of the expected results. [Chen and Tung \(2010\)](#) report that the consequences of recycling positively influence consumers’ intention to recycle. [Wan et al. \(2014\)](#) state that awareness of consequence showed positive influence on recycling intention. A recent study in Bangkok reported that awareness of consequence showed significant positive influence on source separation intention ([Vassanadumrongdee and Kittipongvises, 2018](#)). [Tonglet et al. \(2004\)](#) noted that awareness of consequence represents the affective (experiential) element of attitude. Hence, the following hypothesis is proposed:

H3c. Awareness of consequence has positive impact on attitude toward waste separation.

Based on the discussion, this study aims to establish the following research model (see [Figure 1](#)). External stimuli are motivational elements derived from external without one’s control, which include policy regulation, incentives, facilitating condition and subjective norm. Internal stimuli are motivations originating from one’s internal values, controls and cognition, which include moral norm, self-efficacy and awareness of consequence. This model proposes that these external and internal stimuli combine and influence individual’s attitude together and, in turn, affect one’s intention to separation waste.

3. Research methodology

3.1 Sample selection and measures

We proposed a framework predicting the process that leads to waste separation attitude and behavioral intention. The questionnaire is designed based on measurement items for all

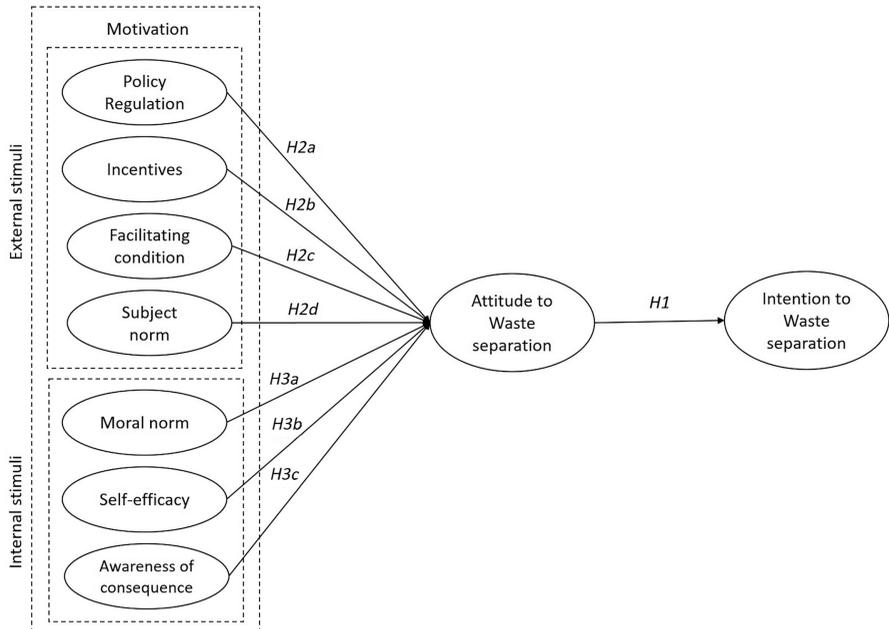


Figure 1. Research model in current study

constructs in the research framework. There are nine variables in total in the research framework: attitude, subjective norm, self-efficacy, facilitating condition, moral norm, awareness of consequence, incentives, policy regulation and intention to separate waste at source. All measurement items are adapted and modified from previous studies (Tylor and Todd, 1995; Chu and Chiu, 2003; Karim Ghani *et al.*, 2013; Wan *et al.*, 2014; Liao *et al.*, 2018). All items are measured on a five-point Likert scale, ranging from 1: “strongly disagree” to 5: “strongly agree.” The constructs and measurement items are tabulated in Table 1.

Data collection was conducted in Nanning city, the capital of Guangxi Zhuang Autonomous Region in China. It is located in the southern central part of Guangxi. Total area of the city is 9,835 km², with urban population about 3.32 million in 2017 (Nanning statistics yearbook, 2018). There are two major MSW processing facilities, with a daily processing capability of 3,200 tons. Local government has been promoting household waste separation scheme since 2014. It is also one of the 46 cities targeted in the domestic waste separation system implementation plan in 2017. The city has been progressing waste separation scheme to a number of residential communities since 2014. This scheme has covered about 768,000 households in the urban area in Nanning by October 2019 (Ling, 2019).

Following consultations from waste separation office in Nanning city, three residential communities were selected and permitted to distribute questionnaires. Data collection was conducted in July 2019. Questionnaires were distributed to households at the entrance of every residential community. The entire process of data collection was legal and complied with ethics requirements. Printed surveys were prepared, together with information letter and consent form. In order to avoid response bias, every respondent was notified that the survey was voluntary, anonymous and confidential. Those who are willing to fill out the questionnaire gave consent for the use of the survey information for aggregate analysis only. Questionnaires were pilot-tested and revised for final distribution.

A total of 579 questionnaires were collected. Among them, 371 were used for the analyses in this study. Among 371 respondents, 125 (33.7%) were male and 246 (66.3%) were female. With regard to respondents' age, majority of them were in their 30s (45%) and 40s (35%), whereas those under 30s (11.1%) and above 50s (8.9%) were few. In terms of education level, 212 (57.1%) acquired an undergraduate or equivalent degree, 124 (33.4%) acquired a high school or equivalent degree, 28 (7.5%) had primary and secondary school degree and 7 (1.9%) acquired postgraduate degree. Regarding the size of household, majority of them had three or more members; 109 (29.4%) had three members, 155 (41.8%) had four household member and 68 (18.3%) more than 5 members. Detailed demographic information is tabulated in Table 2.

3.2 Measure validation

The research model has eight constructs with interrelated dependence relationships or causal paths, requiring a structural equation modeling (SEM) analysis. SEM analysis requires constructs to be assessed rigorously to examine convergent and discriminant validity. PLS-SEM was chosen as data analysis method in the sample since this technique helps to provide prediction of target variables or identification of key drivers (Hair *et al.*, 2017). Path coefficient results were obtained using the software package SmartPLS.

3.2.1 Reliability and convergent validity. The assessment metrics provided for internal consistency reliability are Cronbach's alpha (α) and composite reliability (CR). Factor loadings values (also called indicator reliability) and average variance extracted (AVE) are criterions for convergent validity. The reliability value above 0.7 is satisfactory for both Cronbach's alpha and composite reliability tests. As shown in Table 3, Cronbach's alpha values range from 0.783 to 0.929, indicating satisfactory reliability for all constructs. The CR values are also satisfactory, ranging from 0.852 to 0.955. The factor loading values for all items are above 0.7, indicating each item is positively correlated with each other and

Construct	Item	Measurement items	Researchers
Policy regulation	PR1	The separation facilities (bins, waste collection pools) provided by the government are sufficient to facilitate separation	Liao <i>et al.</i> (2018)
	PR2	The government provides clear guidelines and examples on separation	
	PR3	The government's promotion clearly explains the benefits of separation	
Incentives	INC1	I am in favor of imposing economic rewards to facilitate waste separation	Miranda (1994)
	INC2	I am in favor of imposing credit points to record household waste separation performance	
	INC3	I am in favor of imposing fines on inadequate household waste separation performance	
Facilitating condition	FC1	There is enough space for me to separate my waste at home	Karim <i>et al.</i> (2013) Taylor and Todd (1995)
	FC2	I have time to separate my waste at home	
	FC3	I have convenient access to waste separation bins	
Subjective norm	SN1	Most people who are important to me think I should do waste separation	Wan <i>et al.</i> (2014)
	SN2	Most people who are important to me would approve of my waste separation behavior	
	SN3	My neighbors expect me to separate household waste	
	SN4	My friends expect me to separate household waste	
	SN5	My family expects me to separate household waste	
	SN6	My co-workers or schoolmates expect me to separate household waste	
Moral norm	MN1	I feel I should not waste anything if it could be used again	Wan <i>et al.</i> (2014)
	MN2	It would be wrong of me not to separate my household waste	
	MN3	I would feel guilty if I did not separate my household waste	
	MN4	Not separating household waste goes against my principles	
Self-efficacy	SE1	I know what waste should be separated	Chu and Chiu (2003)
	SE2	Knowing what waste should be separated is an important part of my decision whether to engage in this behavior	
Awareness of consequence	SE3	I know how to separate waste effectively	Wan <i>et al.</i> (2014)
	AC1	Waste separation reduces wasteful use of landfills	
	AC2	Waste separation conserves natural resources	
	AC3	Waste separation improves environmental quality	
	AC4	Waste separation saves energy	
Attitude to waste separation	AC5	Waste separation saves money	Liao <i>et al.</i> (2018)
	AT1	Waste separation is good	
	AT2	Waste separation is good	
	AT3	Waste separation is rewarding	
	AT4	Waste separation is responsible	
	AT5	Waste separation is sensible	
	AT6	Waste separation is hygienic	
AT7	Waste separation is beneficial		
Intention to waste separation	INT1	I intend to separate my household waste in the near future	Wan <i>et al.</i> (2014)
	INT2	I will separate my household waste every time I have it for disposal	
	INT3	I am willing to participate in the separation scheme in the near future	

Table 1.
Measurement items

Table 2.
Demographic
data ($N = 371$)

	Category	Frequency	(%)
Gender	Male	125	33.7%
	Female	246	66.3%
Age	18–30	41	11.1%
	31–40	167	45%
	41–50	130	35%
	>50	33	8.9%
Education level	Primary and secondary school	28	7.5%
	High school and equivalent	124	33.4%
	Undergraduate and equivalent	212	57.1%
	Postgraduate	7	1.9%
Household size	1	1	0.3%
	2	38	10.2%
	3	109	29.4%
	4	155	41.8%
	≥5	68	18.3%

representing common concept of the same variable (Hair *et al.*, 2017). The AVE value is above 0.5 for each construct. The outer loadings and AVE together demonstrate satisfactory convergent validity for all nine variables in this study.

3.2.2 Discriminant validity. For assessing discriminant validity in variance-based SEM, the result of heterotrait-monotrait ratio (HTMT) is provided. Its prominent sensitivity guarantees that it is effective to recognize the lack of discriminant validity (Henseler *et al.*, 2015). As suggested by Hair *et al.* (2017) and Henseler *et al.* (2015), the bootstrap confidence intervals of HTMT statistics are reported in Table 4. All heterotrait-monotrait correlations are below conservative threshold value of 0.85. Moreover, all confidence interval values are below value 1. Therefore, it is safe to conclude that the results establish discriminant validity in this study.

4. Empirical analysis

4.1 Assessment of collinearity issues

The VIF values were calculated by using consistent PLS algorithm with factor weighting scheme and 300 maximum iteration. All constructs display values less than the threshold VIF value of 5, which indicates there was no critical level of collinearity in this study (Hair *et al.*, 2017) (see Table 5).

4.2 Hypothesis test result

As shown in Figure 2, there are six significant relationships indicated in the path coefficient results. Five relationships are statistically significant at 1% level, and one relationship is significant at 5% level. Attitude has a positive impact on intention to separate waste at source (H1 is supported), with a coefficient of 0.47 ($p < 0.01$), which is the strongest correlation among all eight relationships. H2a that suggested a positive association between policy regulation and attitude is supported, with the coefficient of 0.297 ($p < 0.01$). Policy regulation is the strongest determinant among external stimuli elements. H2c proposes a positive relationship between facilitating conditions and attitude, and the coefficient of 0.181 ($p < 0.01$) indicates the result is statistically significant. So H2c is supported. Subjective norm displays a significant impact on attitude, with a coefficient of 0.148 ($p < 0.01$); H2d is supported.

On the other hand, moral norm among internal stimuli is positively related to attitude with a coefficient of 0.146 ($p < 0.01$); thus, H3a is supported. Also, awareness of consequence displayed a positive significant relationship with attitude (H3c is supported), with a

Variable	Items	Factor loadings	Cronbach's alpha	CR	AVE
Policy regulation	PR1	0.826	0.823	0.894	0.738
	PR2	0.874			
	PR3	0.876			
Incentives	INC1	0.932	0.926	0.953	0.870
	INC2	0.936			
	INC3	0.930			
Facilitating condition	FC1	0.732	0.865	0.902	0.756
	FC2	0.922			
	FC3	0.939			
Subjective norm	SN1	0.700	0.825	0.872	0.532
	SN2	0.762			
	SN3	0.702			
	SN4	0.715			
	SN5	0.772			
	SN6	0.724			
Moral norm	MN1	0.839	0.926	0.758	0.926
	MN2	0.901			
	MN3	0.860			
	MN4	0.882			
Self-efficacy	SE1	0.829	0.789	0.876	0.703
	SE2	0.846			
	SE3	0.840			
Awareness of consequence	AC1	0.708	0.783	0.852	0.535
	AC2	0.706			
	AC3	0.718			
	AC4	0.749			
	AC5	0.775			
Attitude to waste separation	AT1	0.767	0.862	0.894	0.545
	AT2	0.724			
	AT3	0.711			
	AT4	0.742			
	AT5	0.735			
	AT6	0.752			
	AT7	0.738			
Intention to waste separation	INT1	0.939	0.929	0.955	0.876
	INT2	0.946			
	INT3	0.922			

Table 3.
Reliability of the
measurement model

coefficient of 0.272 ($p < 0.01$). Awareness of consequence is the largest internal motivational element toward attitude in current model. Surprisingly, two relationships are not statistically significant. First, the relationship between incentives and attitude is not significant, with coefficient of -0.05 ($p = 0.143$); **H2b** is not supported. Second, self-efficacy has a coefficient of 0.017 ($p > 0.407$); hence, **H3b** is not supported.

In summary, there are interesting findings in this study. Policy regulation is the biggest determinant of attitude among external stimuli, and awareness of consequence has the strongest relationship with attitude among internal stimuli. In addition, facilitating condition, subjective norm and moral norm are also significant predictors of attitude toward waste separation. Attitude and intention to separate waste at source have the strongest relationship among all eight path coefficient results (see [Table 6](#)).

5. Discussion and limitations

The effect of two different stimuli aiming at increasing waste separation behavioral intention was assessed through an empirical study in Nanning city residential area in China. Nanning

	Awareness of consequence	Attitude	Facilitating conditions	Incentive	Intention	Moral norm	Policy regulation	Self-efficacy	SN
AC	-								
AT	0.652 CI.95 (0.546, 0.748)								
FC	0.513 CI.95 (0.422, 0.593)	0.240 CI.95 (0.171, 0.309)							
INC	0.469 CI.95 (0.386, 0.544)	0.280 CI.95 (0.199, 0.357)	0.487 CI.95 (0.406, 0.562)						
INT	0.670 CI.95 (0.603, 0.731)	0.518 CI.95 (0.437, 0.591)	0.494 CI.95 (0.414, 0.571)	0.465 CI.95 (0.391, 0.536)					
MN	0.790 CI.95 (0.729, 0.826)	0.609 CI.95(0.524, 0.686)	0.544 CI.95 (0.467, 0.613)	0.444 CI.95 (0.362, 0.524)	0.621 CI.95 (0.548, 0.687)				
PR	0.683 CI.95 (0.581, 0.772)	0.497 CI.95 (0.402, 0.584)	0.641 CI.95 (0.565, 0.713)	0.573 CI.95 (0.487, 0.644)	0.750 CI.95 (0.677, 0.810)	0.623 CI.95 (0.540, 0.695)			
SE	0.702 CI.95 (0.617, 0.773)	0.467 CI.95 (0.369, 0.552)	0.708 CI.95 (0.633, 0.773)	0.556 CI.95 (0.478, 0.631)	0.821 CI.95 (0.771, 0.866)	0.669 CI.95 (0.598, 0.731)	0.817 CI.95 (0.756, 0.874)		
SN	0.704 CI.95 (0.621, 0.777)	0.516 CI.95 (0.429, 0.592)	0.710 CI.95 (0.643, 0.770)	0.590 CI.95 (0.513, 0.661)	0.794 CI.95 (0.738, 0.843)	0.708 CI.95 (0.630, 0.772)	0.745 CI.95 (0.669, 0.813)	0.809 CI.95(0.745, 0.870)	-

Note(s): $n = 371$; AC refers to awareness of consequence, AT refers to attitude, FC refers to facilitating condition, INC refers to incentive, INT refers to intention, MN refers to moral norm, PR refers to policy regulation, SE refers to self-efficacy, SN refers to subjective norm

Table 4.
Discriminant validity
for HTMT

city has been experimentally promoting waste separation scheme in selected residential communities since 2014. The implementations of waste separation policy have been on and off at times. The experimental scale was small for the first two years, and the outcomes were not desirable. New adjustments were made gradually, and the experimental sites were expanded to more residential communities in the past few years. From the empirical results, we drew several intellectual important points of discussion.

First, this study divided determinants that affect the waste segmentation, into two different stimulations. Waste separation at source is subjectively done by individuals collecting recyclable or compostable materials and placing them at the disposal locations near their household (Sukholthaman and Sharp, 2016). Thus, voluntary participation is the vital key of success in waste separation; thus, we divide the factors of attitude toward waste separation into external stimuli from environment and internal stimuli by a person.

Second, among the relationships between external stimuli and attitude, policy regulation is the biggest determinant of attitude, while awareness of consequence has the strongest

Table 5.
Collinearity
assessment

	Attitude (VIF)
Awareness of consequence	2.076
Facilitating conditions	1.968
Incentive	1.510
Moral norm	2.156
Policy regulation	2.230
Self-efficacy	2.400
Subjective norm	2.464

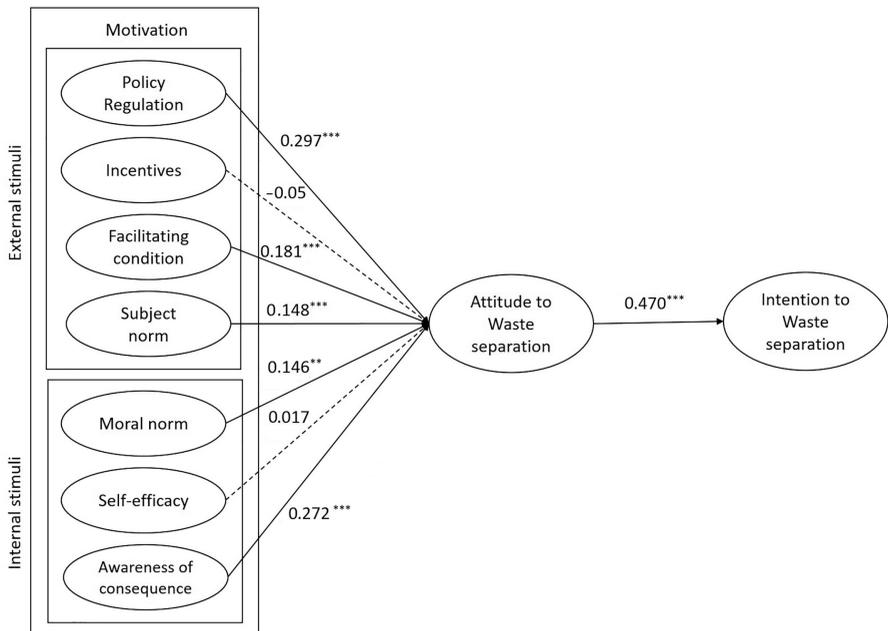


Figure 2.
Results of
research model

Note(s): ** $p < 0.05$, *** $p < 0.01$

	Coefficient	SD	t-value	p-value	Result
Attitude → Intention	0.470***	0.043	10.922	0.000	Supported
Policy regulation → Attitude	0.297***	0.058	5.139	0.000	Supported
Incentives → Attitude	-0.050	0.047	1.066	0.143	Not supported
Facilitating conditions → Attitude	0.181***	0.052	3.475	0.000	Supported
Subjective norm → Attitude	0.148***	0.062	2.396	0.008	Supported
Moral norm → Attitude	0.146**	0.072	2.038	0.021	Supported
Self-efficacy → Attitude	0.017	0.073	0.236	0.407	Not supported
Awareness of consequence → Attitude	0.272***	0.071	3.811	0.000	Supported
R^2 for Attitude			0.385		
R^2 for Intention			0.220		

Note(s): ** $p < 0.05$, *** $p < 0.01$

Table 6.
Path coefficient results

relationship with attitude among internal stimuli. These findings have provided valuable implications to policy-makers. As a top-down public policy targeted to trigger pro-environmental behavioral change of citizens, at the early stage of a waste separation scheme, policy strategies ought to be designed to influence people's positive attitude toward waste separation. For instance, we can learn the success case of waste management in Korea. Korea government has implemented a series of waste management laws and exercised continuous efforts on enforcement of specialized acts so that waste separation behavior of Korean household has been changed slowly. This reflects that policy-makers should highlight the importance of waste separation to enlighten household, by implementing the strong policy regulation continuously.

Third, policy-makers ought to provide adequate facilities in both quantity and quality. Supply of sufficient facilities like waste containers should be guaranteed. Facilities like waste bins inside residential communities should be evenly distributed. Convenient access and usage of such facilities, as well as cleanness and maintenance of these facilities, is also very important.

Fourth, results from the present study can be seen as conflicting with several previous studies, suggesting that neither incentives nor self-efficacy has any significant influence on attitude toward waste separation. According to Ekvall *et al.* (2010), even though economic incentives on residual waste have been suggested as an interesting strategy in order to increase recycling (Bisaillon *et al.*, 2009), policy-makers can see only a temporary effect. Moreover, the outcome of incentive is not necessarily positive, if resulting in illegal dumping. Also, such incentives are difficult to apply in multi-family, rental dwellings. It is hard to change the attitude toward waste separation habits.

Fifth, attitude toward the waste separation is a significant determinant of waste separation intention in this study. Even though households have positive attitude toward the waste separation, shown waste separation behavior could be different. This behavior has not yet developed into a high repetitive habitual routine. However, we found that increasing positive attitude led to enhancement of the behavioral intention of waste separation lifestyle.

5.1 Limitation and future study

This study adopts a cross-sectional design to investigate waste separation intention of local households. Data collection is restricted to one point in time for every individual. A mixed method is recommended. Quantitative research can examine variables which are provided in existing literatures with numerical analysis. Qualitative research might be helpful to identify other unknown factors. Also, the survey questionnaires employ a self-reporting manner.

Respondents might be overrating to avoid embarrassment. Future research is recommended to engage observation at houses or at the waste collecting points for actual waste separation behavior. Moreover, this study measures intention toward household waste separation, but whether this intention will eventually lead to waste separation behavior is not a guarantee. Future study is recommended to examine whether intention translates into actual waste separation behavior.

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