

Antecedents of sustainable food waste management behaviour: Empirical evidence from urban households in Malaysia

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Abstract. *Under the sustainability domain, food waste is a significant global challenge receiving growing attention. The management of household food waste which relies heavily on landfilling, is predominantly ineffective and unsustainable. To implement sustainable food waste management, an understanding of the individual behaviour is needed since psychological effects often undermine technological solutions. This study direct its investigation on urban households' sustainable food waste management behaviour by extending the Theory of Planned Behaviour. An online survey was utilized for data collection. Using Partial Least Squares Structural Equation Modelling, assessments were made on the determinants of intention and behaviour of 520 households in the Klang Valley. The analysis support two factors that influence attitude positively, while five factors positively influence intention to implement best practices of reusing leftovers, separating household waste, and doing home composting. However, although the households have positive intentions, yet their composting practices seem to be the least adopted compared to the other sustainable elements. Addressing the lack of participation requires a holistic approach via dissemination of educational materials, social media coverage, and awareness campaigns. It is also suggested that composting be incentivized and be included in reward schemes similar to recycling. This study paves the way to enhance understanding of the factors to adopt sustainable food waste management among households in the urban areas. The findings provide insights for policy makers and other stakeholders on what type of information to consider when designing effective food waste management campaigns and urban development strategies, supporting the opportunity for consumer behavioural change.*

Keywords: food waste, household, sustainable, TPB, PLS-SEM, composting.

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Introduction

Sustainability-related issues are the main challenges of the 21st century (Martin et al., 2016). Among these is the widespread issue of managing food waste, which raises serious environmental, economic, and social issues (Banks et al., 2018; Foley et al., 2011). One third of the food produced each year, or close to 1.3 billion tonnes, is lost or wasted, costing the world economy an estimated USD 1 trillion yearly (FAO, 2015; Kaza et al., 2018). Additionally, due to population growth and dietary changes, the world's demand for food is predicted to increase by 60 to 110 percent between 2005 and 2050 (Hiç et al., 2016; Tilman et al., 2011). If safeguard measures are not taken, this could worsen the problem of food waste, compromise food security, and have a detrimental effect on the environment and human health. Sustainable food waste management is therefore essential for enhancing ecological benefit, resource availability, and public health (Shafiee-Jood & Cai, 2016; Zan et al., 2020).

According to recent estimates in Septianto et al. (2020), the amount of food that is wasted on a global scale each year is equal to USD 1 trillion. This not only results in financial difficulties but also instability over food availability. According to Aamir et al. (2018), many developing nations produce roughly USD 310 billion worth of food waste annually, which has a direct impact on how efficiently food is produced along the supply chain. Resources lost in the food supply chain will have a negative effect on the GDP of a country and show signs of food insecurity (Heidari et al., 2020). Food waste has a significant impact on people's food security from a societal standpoint as well (Geislar, 2019; Saijo, 2020), especially when it was estimated that more than 800 million people are undernourished or hungry globally (Bravi et al., 2020). Among others, Galli et al. (2019) assert that reducing food waste is one way to solve issues with food security. In fact, food waste harms the environment in addition to causing issues for the economy and society. Due to the lack of resources like water, soil, and labour as well as the excessive use of pesticides and fertilisers throughout the food production process, the ecosystem suffers (Bravi et al., 2020). Additionally, according to Thyberg & Tonjes (2016), food waste in landfills decomposes into hazardous leachate and greenhouse gases like methane, which has a 25-fold greater potential to contribute to global warming than carbon dioxide over a 100-year period.

The Sustainable Development Goals (SDG 12.3), which intends to reduce per capita global food waste by half by 2030, contain a goal to address the problem of global food waste. The Malaysian government is also committed to achieve the SDG 12.3 whereby it emphasizes its regional commitment to reducing food waste along the value chain in the National Agrofood Policy 2021-2030 (NAP 2.0). All economic actors in Malaysia, notably the household, must embrace this policy to prevent food waste (Rozana et al., 2021). The household food waste generation recorded by the Ministry of Agriculture and Food Industries in 2018 showed the highest percentage of more than 50 percent as compared to small and medium enterprises, and hospitality services sector (MAFI, 2021). The advancement of living standard alter the habits and attitudes of Malaysians which leads to an increase in waste generation. Moreover, the households contribute a higher amount of food

waste during festive celebrations every year (MAFI, 2021). Household food waste is projected to have an increasing trend (MAFI, 2021) due to economic development, population growth and urbanization.

Landfills continue to be the foundation of Malaysia's traditional waste management system. According to the Department of National Solid Waste Management (Jabatan Pengurusan Sisa Pepejal Negara, or JPSPN), Malaysia has too many saturated landfills to continue relying on them. For instance, in Malaysia, 21 sanitary landfills out of 137 total landfills are still in use, whereas 174 have already been closed. In reality, it is essential to create a workable process to lessen food and other household waste. Reusing leftovers, separating food waste from non-food and other recyclables, as well as composting are all effective and sustainable ways to manage food waste that would greatly reduce their dependency on landfills. These methods are socially and economically acceptable as well as environmentally friendly.

Although several technological approaches and alternative materials (e.g. kitchen waste monitoring tool or delayed ripening technology) may have been proposed to combat food waste, these approaches alone cannot completely resolve this issue because psychological and behavioural traits typically hinder the effectiveness of technical solutions (Heidbreder et al., 2019). Or, to put it another way, boosting participation rates in household food waste management calls for both technology advances and deliberate human behaviour. A deeper understanding of human behaviour is thus needed to create effective policies for managing food waste.

The primary goal of this study is to identify the variables that have a significant impact on Malaysian households' behaviour to handle food waste sustainably. This study is anticipated to add to the body of knowledge on sustainable food waste management. Besides that, the viewpoints of households on how to manage food waste sustainably will also be considered to aid in urban planning and development. The key value of this study is that if the stakeholders have a better understanding of consumer behaviour, it will be able to create awareness and enforce regulations for the control of food waste especially at the household level.

Research model and hypotheses development

Sustainable food waste management behaviour

The definition of sustainable development offered by the United Nations places an emphasis on making sure that living things will continue to exist in the future. Sustainability policies play a significant part in achieving the goals of sustainable development, but citizens must also change their mindsets and adopt sustainable behaviours. In point of fact, although a technology can be developed with the intention of making it sustainable over the course of its full life cycle, user behaviours can have a significant impact on a technology's overall level of sustainability. According to Medeiros et al. (2018), sustainable behaviour is focused particularly on products created to encourage people to act more sustainably while using them and takes into account the potential impact that users may have on the environment while using a product. Similar adjustments could be made to sustainable behaviour, which emphasizes on behaviours that cover the three facets of sustainability – the environment, society, and economy (Joshi & Visvanathan, 2019).

Social concerns entail behaviours that are critical in bringing about the desired change. A modification of behaviour can be viewed as a response to an influence (Tromp et

al., 2011). An illustration was made on the significance of user behaviour in terms of environmental repercussions by providing an example, which led to the development of sustainable behaviour design. Wansink (2004) refers to behaviour that achieves desirable social outcomes. As an example, those who serve themselves on a smaller plate, tend to consume less food in general, compared to those who utilize larger plates. While the action of serving less does not have any social effects yet, the activity that follows does. The decision that one makes regarding what to do with their leftovers, may contribute to food waste. That action or behaviour, from a social perspective, might be considered a social concern.

In this study, behaviour is defined as the observable action taken (Aktas et al., 2018), whereby specifically in this study the behaviour refers to sustainable food waste management at the household level, comprises reusing leftovers, waste separation, and recycling or composting behaviour. These practices are in line with Hamid et al. (2012) who pointed out that all waste management methods should follow the hierarchy of waste management options (EPA, 2020; Cox et al., 2010), an approach of using resources efficiently and sustainably through its lifecycle.

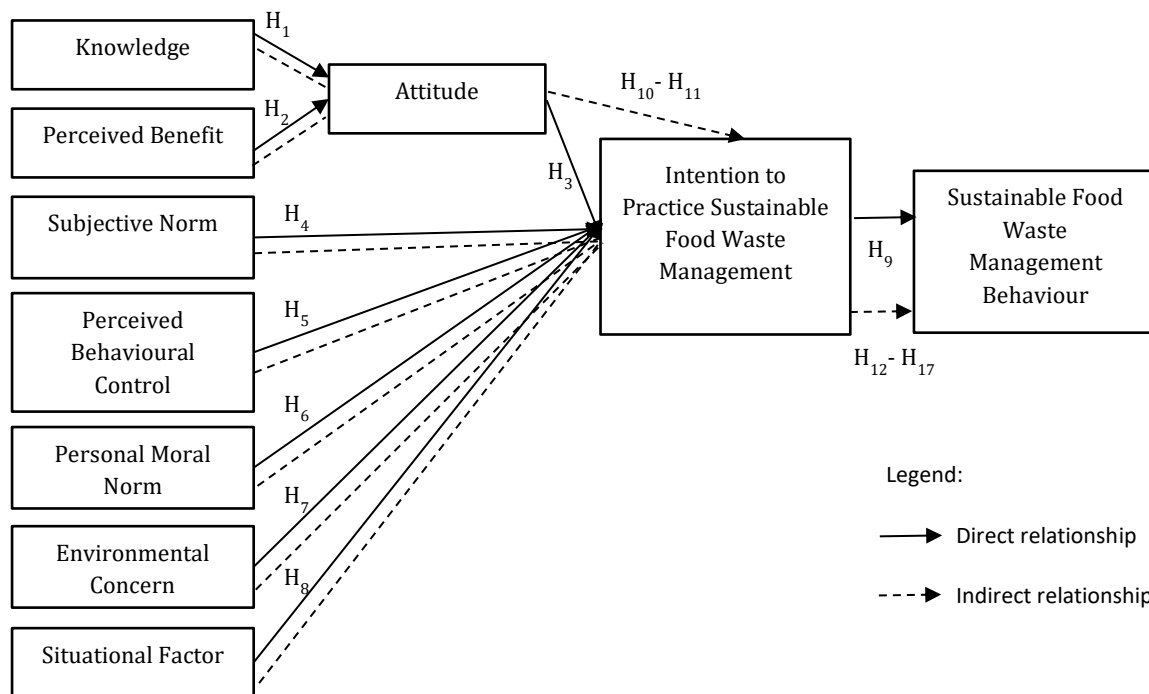


Figure 1. The Research Model

Source: Authors' own research.

Figure 1 displays the research model of this study. Modified items from the literature were used to measure the behaviour construct of this study. The scale's reliability was within the acceptable range. The items were chosen based on their accepted measurement criteria, which included factor loadings of 0.5 and above, AVE greater than 0.5, and CR bigger than 0.7 for their validity condition. The sustainable food waste management construct was measured via its dimensions using a total of 16 items. The majority of the measures were operationalized as multi-item constructs, and they were assessed using a Likert scale with a strongly disagree to strongly agree anchor.

Knowledge, perceived benefit, and attitude

According to Banyte et al. (2007), attitude is the way a person assesses anything in regard to a specific object as favourable or unpleasant, either positively or negatively. An individual's ongoing favourable or negative evaluations, feelings, and dispositions toward a concept or item are referred to as their attitude by Armstrong & Kotler (2011). According to Juniwati (2014), attitude also qualifies as evaluation because it has an evaluative component. These definitions likewise rely on the idea that attitudes are made up of people's emotions and assessments of a certain phenomenon or item, given that attitudes are evaluative responses to stimuli. It means that attitude may change together with the antecedent variable.

Several antecedent variables, including awareness, environmental concern, moral obligations, perceived advantages, perceived hazards, and knowledge, are thought to influence attitudes (Abbasi et al., 2020; Brand et al., 2020; Dorce et al., 2021; Heidari et al., 2018; Maichum et al., 2016; Ramayah et al., 2012; Xu et al., 2017). Therefore, to understand the acceptability or adoption of sustainable food waste management, it is required to understand the factors influencing attitude. Households were unable to sort, recycle, or compost due to a lack of knowledge or experience with the techniques (Dhokhikah et al., 2015). The literature also used the term eco-literacy to describe knowledge which is the ability to become ecologically driven and motivated to act pro-environmentally (Al-Mamun et al., 2018). It was pointed out that knowledge could positively improve the attitude of low-income households in Malaysia.

According to Yadav & Pathak (2017), low-income families' attitudes toward green consumption behaviour are positively impacted by perceived benefits. In other words, customers will become more enthusiastic and active in an activity when they perceive gaining an advantage from their involvement in new products, practises, or activities. According to Nguyen & Watanabe (2019), residents in Vietnam have a positive attitude toward waste separation since they believe they will profit from the practises. Additionally, perceived benefit was also found to have a strong correspondence to the attitude relating to green management adoption (Wu & Wu, 2014). This leads to the first two hypotheses development.

Behavioural intention and its determinants

An individual's willingness to try or the amount of effort they intend to put in to attain the behaviour is referred to as their behavioural intention (Ajzen, 2012). Despite the fact that attitude and intention are different psychological concepts, it is often believed that intentions include the factors that motivate people and affect their behaviour (Eagly & Chaiken, 1993). In most cases, it motivates someone to take a certain activity. It includes both a person's tendency to act and the amount of work necessary to carry it out.

One of the most widely cited behavioural theory has been adopted, namely the Theory of Planned Behaviour (TPB) to understand various behaviours relevant to the current issue like green purchase behaviour (Yadav & Pathak, 2017), water conservation (Trumbo & O'Keefe, 2001), and waste recycling (Echegaray & Hansstein, 2017). The TPB model has in general consistently proved its relevance, when put to the test of predicting different sustainable behaviours. The TPB model (Ajzen, 1991, 2012) has also been the prominent theoretical framework for analysing practices like waste separation and food waste reduction (e.g., Graham-Rowe et al., 2015; Liao et al., 2018; Stefan et al., 2013). The likelihood that a person will engage in an action increase with how strongly that person senses their

intention to do so. Attitude, subjective norm, and perceived behavioural control all have an impact on intentions. A person's attitude reveals how confident they are in the behaviour's outcome, while their impression of social pressure to engage in a particular conduct is described by their subjective norm and their perceived behavioural control, respectively (Ajzen, 1991).

Despite the widespread agreement that it has been successful in identifying the antecedents of behavioural intention, Ajzen (1991, p. 199) claimed that "the theory of planned behaviour, is, in principle, open to the inclusion of additional predictors", allowing researchers to extend the TPB model by considering the objectives and context of their studies. In fact, the model by itself is not enough to understand in depth the complexity of human behaviour (Armitage & Conner, 2001). Therefore, this paper adopts the TPB as a basic framework and introduces several other antecedent variables in understanding the adoption of sustainable food waste management practices at the household level.

In the specified study context, personal moral norm is defined as the moral obligation to conduct or not conduct sustainable food waste management which refers to the individual's personal beliefs about what is right or wrong to do (Ru et al., 2018; Wang et al., 2019; Visschers et al., 2016). Recently, Razali et al. (2020) focused on the aspect of moral norm among Malaysians, as being the most influential determinant in influencing waste separation behaviour among households. However, there was a contradiction with Corsini et al. (2018) whereby the authors noted that personal norm had no significant effect on Italian resident's waste prevention and sorting behaviour. Since Zorpas & Lasaridi (2013) stated how different research context and cultural background can produce inconsistent research result, it is worth testing the relationship between the personal moral norm and intention to practice sustainable food waste management within the Malaysian urban household setting.

Sustainable food waste management is based on the premise that people who are more concerned about the environment are more inclined to engage in pro-environmental activity as a result of their shared values (Chuah et al., 2020). Concern for the environment plays a significant role in consumer decision-making (Liao et al., 2020). Consumers who are unconcerned about the environment are hesitant to spend more for green products (Wei, Ang, and Jancenelle, 2018). Environmental concern is commonly used to justify pro-environmental behaviour, sustainable behaviour, and both, with some studies finding it to be the most important predictor of behavioural intention (Lee et al., 2014; Li et al., 2020; Polonsky et al., 2014). Ham & Han (2013) found that people who care a lot about the environment have a stronger effect on how they plan to act than people who care less about the environment.

Further, the literature discusses on several external situations whereby an individual's intention to participate in a specific practice may be affected, among others, by cost, time, and facilities available, which can affect their decision to perform the behaviour (Ru et al., 2018). Roustia et al. (2020) gives an adequate and thorough description when referring to the variable of situational factor. Situational factors are physical conditions that stimulate or discourage participation in activities such as food waste management. These may include convenience, the availability of time to practice waste separation, recycling and composting, adequate space for various types of household waste or availability of separate waste bins, and the cooperation of household members. Ma et al. (2018) found situational factors to be a significant predictor of respondents' behavioural intentions, although with very minor impacts. Previously, Zhang et al. (2015) supported situational factors and waste

separation behaviour to be significant and negatively correlated. Heidari et al. (2018) continues to infer situational factor to have a positive effect on recycling intention.

The intention-behaviour relationship

The TPB theorizes that the intermediate determinant of behaviour is via intention. Most of the research model in the literature however stops at the intention construct (e.g. Goh et al., 2019; Neubig et al., 2020; Rathore & Sarmah, 2021) which gives this current research an opportunity to fill the research gap. In fact, the findings of Russell et al. (2017) underscore the importance of not relying on intention as a proxy measure for behaviour. Their research shows a very different relationship to self-reported behaviour, serving as a note of caution for future research that conflates intention and behaviour.

There are several exceptions where a review across varying literature found the intention-behaviour relationships being hypothesized and tested. An investigation was conducted by Kanchanapibul et al. (2014) among young generations to assess the level of intention against the actual behaviour regarding green purchases. They explained that the intention dimension has significant effect on actual purchase. Besides that, intention appeared to be the most important predictor of the total amount of self-reported food waste (Vischers et al., 2016). On the contrary, it was insignificant in an earlier study by Stefan et al. (2013).

In the existing literature on food waste management, there is no *a priori* basis for mediation, hence this work is motivated by the need to address this void. Prior research has evaluated intention as a mediating variable in different contexts, such as in the study of Ifedayo (2020) that examines behavioural intention and use behaviour of podcasts for instructional activities. In a separate study, Sultan et al. (2020) investigated the mediating influence of intention in relation to organic food consumption behaviour. The influence on behaviour is mediated by intentions, according to previous research that combined theories such as NAM and the TPB (Onwezen et al., 2013). In light of this, this study will utilise a PLS-SEM approach to investigate the mediating function of attitude and intention in the sustainable food waste management behavioural intention of urban households.

Research methodology

Sample and procedure

The Klang Valley area's residents were the study's target audience. Respondents were sampled using multistage cluster sampling, which includes partitioning the population into clusters and then sampling from each cluster. For a pretest of the questionnaire, six experts were recruited. Based on their comments and discussions with pilot study participants, a few minor adjustments were made to the questionnaire for the main phase of data collection. Information was gathered via a web-based survey from September 2021 to January 2022. An online survey had definite advantages over surveys sent via mail or on paper. The response time was minimized since urban households are capable of using electronic devices to complete the surveys. Besides that, the response rate was maximized because respondents are comfortable using their own mobile devices rather than having to be in close contact during a traditional paper-based survey. In fact, the accuracy of data collected was maximized due to the option available via Google Form to validate responses and ensuring the submitted form has no missing data and is accurately filled. A complete dataset of 520 valid cases was obtained in total.

Questionnaire design and measurement

This study employed a survey questionnaire to assess the relationships between exogenous and endogenous variables. There are three parts to the survey questionnaire. Part 1 revolved around questions on household food and waste-related practices. Part 2 consisted of questions related to the study variables, and part 3 included background information asked about the respondents of the study. To design the questionnaire, instruments and measurement items were adapted from existing models and studies in order to ensure the reliability and validity. Operationalizations that had been shown effective in earlier studies were employed to facilitate the current research.

Overall, four items were adapted from Zand et al. (2020) and Limon & Villarino (2020) to measure knowledge, while three items were adapted from Ataei et al. (2021) and Dorce et al. (2021) to measure perceived benefit, and six items each to measure attitude, subjective norm, and perceived behavioural control, adapted from Yazdanpanah & Forouzani (2015), Ru et al. (2018), Karim Ghani et al. (2013), Russell et al. (2017), Aktas et al. (2018), and Graham-Rowe et al. (2015). Personal moral norm was operationalized using a three-item scale from Wang et al. (2019), and Ru et al. (2018), environmental concern using a five-item scale from Li et al. (2020) and Hamzah & Tanwir (2021), whereas situational factor using a seven-item scale from Heidari et al. (2018) and Zhang et al. (2015). Finally, intention and behaviour were operationalized by using the scales established by Karim Ghani et al. (2013), Liao et al. (2018), Razali et al. (2020) and Zhang et al. (2015). Measures were operationalized as multi-item constructs and assessed on a 7-point Likert scale from strongly disagree (1) to strongly agree (7).

Data analysis

Descriptive analysis was carried out to give an overview of the study sample's demographic background and to determine how food waste management practises are currently practised. PLS-SEM, or partial least squares structural equation modelling, was used to analyze the conceptual framework in this study. To estimate the partial regression relationships in the path model, PLS-SEM combines principal component analysis (PCA) with ordinary least squares (OLS) regression with the goal of maximizing explained variance and minimising endogenous construct error terms (Hair et al., 2017; Sarstedt et al., 2019). A two-step procedure is involved. First, an evaluation of the reflective and formative measurement models was separately assessed and then followed by the structural model in the path model.

In this study, there are several technical advantages supporting the use of PLS-SEM over CB-SEM (covariance-based SEM) which is a factor-based approach designed to explain covariance (Rigdon, 2012). Since PLS-SEM is a composite-based and causal-predictive approach to SEM, it is more suitable for exploratory research in which the goal is to predict statistical models (Rigdon, 2012) and to explain causal relations of the constructs of interest (Hair et al., 2017). This makes PLS-SEM a better choice for this prediction-oriented study than CB-SEM. Next, PLS-SEM is a preferred technique to address the research questions as they are related to the causal relationships between both reflective (i.e., personal moral norm, environmental concern, situational factor) and formative (i.e., behaviour) constructs, involving multiple direct and indirect effect paths from many indicators. Besides that, PLS-SEM does not rely on the assumption of normality, unlike a normal distribution required by CB-SEM. This makes it suitable for analysing data that exhibits a non-normal distribution (Hair et al., 2017; Sarstedt et al., 2014). Furthermore, CB-SEM is prone to identification

problems (Jarvis et al., 2003), while the PLS path modelling algorithm has favourable convergence properties (Henseler et al., 2015), that can handle both formative and reflective measurement models with ease (Hair et al., 2017).

Results

Common method variance

Given that the data collected in this study is from a single source, common method variance (CMV) is a possible concern. CMV is defined as a systematic error variance shared among variables that are measured from the same sources or methods (Jakobsen & Jensen, 2015). Testing on the threats of CMV is crucial when the data is collected via a self-administered questionnaire and particularly when the predictor and criterion variables are obtained from the same person (Podsakoff et al., 2003). CMV may threaten the validity of the constructs and creates a systematic bias in a study (Tehseen et al., 2017).

In order to reduce the CMV, this study opts for the one-factor test to estimate the issue of CMV according to Podsakoff et al. (2003). The results of Harman's single-factor test confirmed that CMV was not severe in this study, as the uppermost factor accounted for 37.35% of the variance. This was lower than the suggested limit of 50% (Podsakoff et al., 2003). A full collinearity test was also conducted to determine whether any constructs reflect the variance inflation factor (VIF) values, equal to or greater than 5.0 (Hair et al., 2019). Results indicate that pathological VIFs for all constructs range from 1.082 and 3.595, confirming again that CMV was not a serious concern in this study.

Respondent profile

Although some responses were eliminated in the data screening stage, the sociodemographic composition of the sample remained stable. The sample included slightly more males (58.3%) than females (41.7%) (Table 1). In terms of age, the middle-aged group (i.e., 40-49) was the most dominant (32.6%), followed by the 50-59 years old group (26.4%) and those in their 30s (23.5%). Most respondents held a graduate university degree (58.3%), with an additional 8.6% holding a postgraduate degree. Three-fifths (60.0%) reported a monthly income of less than RM4,850, and slightly more than a quarter (27.7%) earned between RM4,850 and RM10,960. Around 55.4% of the Malaysian urban residents stay in landed house-type which refers to bungalows, terraces, semi-detached and village houses. Conversely, 44.6% live in high-rise buildings like flats, apartments and condominiums.

Table 1. Sample description

Variable	Categories	Frequency	Percent
Gender	Male	303	58.3
	Female	217	41.7
Age	Under 29	26	5.0
	30-39	122	23.5
	40-49	169	32.6
	50-59	137	26.4
	Over 60	65	12.5
Education level	Postgraduate	45	8.6
	Undergraduate	303	58.3
	Secondary	163	31.3
	Primary	4	0.8
	Non-formal	5	1.0

Variable	Categories	Frequency	Percent
Household income	Less than RM4,850	312	60.0
	RM4,850 - RM10,960	144	27.7
	More than RM10,960	64	12.3
House type	Bungalow	16	3.0
	Semi-detached	31	6.0
	Terrace	223	43.0
	Townhouse	18	3.4
	Flat	109	20.9
	Condominium	93	17.9
	Hostel/College	30	5.8

Note: 1 USD is approximately RM4.30 as of February 2023.

Source: Authors' own research results.

Current level of practices

Every day, most of the households prepare food at home (58.7%). The primary way of managing food surplus and food leftovers were to throw and discard them immediately, which has always been the norm and usual practice. The respondents do claim to practice waste sorting and keeping their leftovers for future use, but not as common as disposing them to be collected by waste management workers. Households identify six food waste categories (Figure 2).

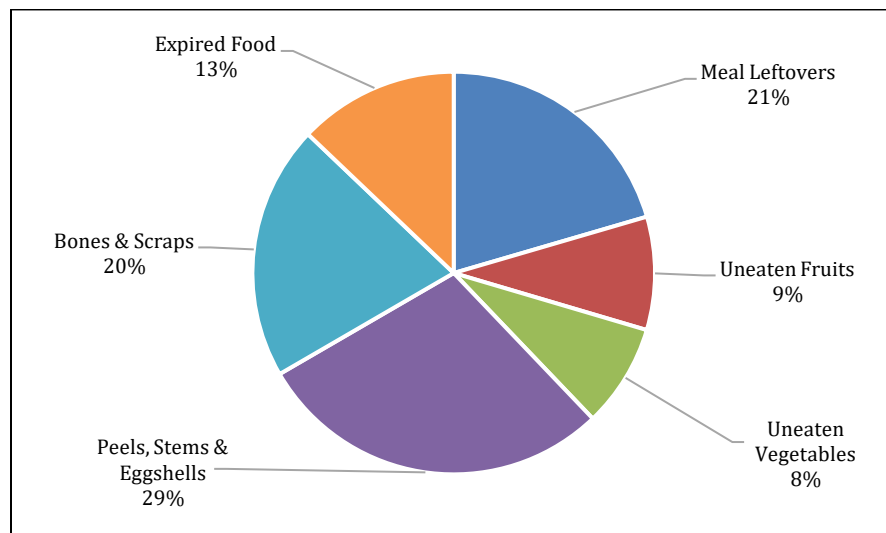


Figure 2. Types of food waste categories at the household level

Source: Authors' own research results.

Respondents were asked to rank the categories of food waste in their homes from most to least. Peels from fruits and vegetables, stems, and eggshells form the first category of food waste. Meal leftovers, bones and scraps, and expired food, follow closely behind. The final two categories of uneaten fruits and vegetables are almost evenly distributed. In general, the identified household food waste can be divided into 'avoidable' and 'unavoidable' food waste. The avoidable ones include uneaten food, whilst the unavoidable ones contain inedible items such as bones and peels. Eggshells, fruit, and vegetable peels are just a few examples of the unavoidable food waste that can be composted and later used as fertiliser.

The questionnaire included 16 questions designed to assess the extent of their sustainable practices regarding food waste management. The original scale follows the 7-point Likert scale. The analysis was carried out using a scalar-scoring approach. The score that was given was recorded as 1 to 7 following the original responses since all statements were positive. The household's practicing level was determined using the total score. The practices level was categorized into two levels, which are poor and good level of practices.

For the reusing leftovers component, the maximum score that could be achieved is up to 28 while the minimum score is 4. For a household who achieved a total score between 4 to 21, he or she is considered to practice poor leftover usage. Those who achieved a total score between 22 to 28 is considered to have good level of reusing leftover practices. For the waste separation component, the maximum score that could be achieved is up to 35 while the minimum score is 5. For a household who achieved a total score between 5 to 27, he or she is considered as having poor waste separation practices. Those who achieved a total score between 28 to 35 is regarded as practicing a good level of waste separation at home.

For the composting component, the maximum score that could be achieved is up to 49 while the minimum score is 7. For a household who achieved a total score between 7 to 38, he or she is considered to practice poor composting. Those achieving a total score between 39 and 49 is considered to have a good level of composting practices. Overall, the maximum score that could be achieved is up to 112 while the minimum score is 16. For a household who achieved a total score between 16 to 87, he or she is considered to have poor sustainable practices. Meanwhile, households achieving a total score between 88 and 112 is regarded as having a good level of sustainable practices toward food waste management.

Table 2. Level of practices in relation to sustainable food waste management (n=520)

Component	Poor practices	Good practices
Reusing food leftovers	166 (32%)	354 (68%)
Separating household waste	251 (48%)	269 (52%)
Composting	388 (75%)	132 (25%)
Overall	342 (66%)	178 (34%)

Note: The figure without parenthesis refers to score and the figure in parenthesis indicates the percentage of respondents.

Source: Authors' own research results.

Table 2 summarises the results of their responses to questions on their current food waste management. Urban Malaysian households portray the following pattern of behaviour. The results indicate that the level of practices differ in the three components of sustainable food waste management. The first component (reusing leftovers) portrays an encouraging level. For instance, around 68.0 percent of the urban households reuse their food leftovers in good ways, and their meal plans have been adjusted to include leftovers. The second component (separating waste) appears to have a mixed level of practice among the urban households. It can be seen that slightly more than half of the urban residents have good (52%) level of waste separation practices, whereby they do regularly separate their household waste and dispose all food waste at home separately from other types of household waste. Meanwhile, another 48% of them are still at the poor level of practicing waste separation at home.

Poor practices are more evident in the food composting component, where poor practices achieved the highest percentage (66%) among the study sample, compared to good practices of only 34% of the respondents. This shows that most of them do not engage in regular food composting, and waste separation may be performed but not for composting purposes, with no efforts made to ensure composting at home through the purchase of composting bins, or through the use of any available tools or technology. Given that quite a number of the respondents reside in high-rise structured buildings such as flats, apartments, and condominiums, it is not surprising that restricted space was the most often cited explanation (Figure 3). Another significant factor stated was a lack of knowledge (50%) about how to undertake home composting. Almost 41% said they never considered it, indicating limited knowledge of the practice, while 38% cited a lack of waste materials.

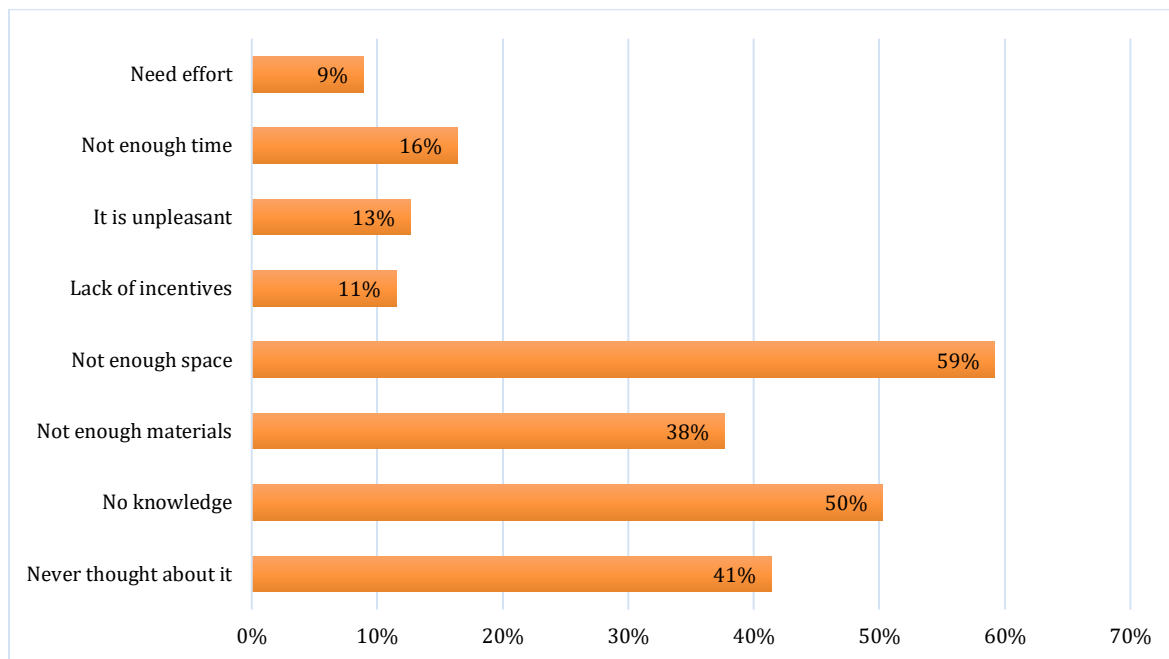


Figure 3. Reasons for not composting

Source: Authors' own research results.

PLS-SEM results

Reflective measurement model assessment

A measurement model that included all scale items was initially evaluated for the reflective constructs. All items reached acceptable outer loadings. The composite reliability (CR), Cronbach's α , and Rho_A all exceeded 0.7 (Hair et al., 2019), supporting the internal reliability. Factor loadings and the average variance extracted (AVE) were all above 0.7 and 0.5, respectively (Hair et al., 2019), approving the convergent validity. To determine discriminant validity, the heterotrait-monotrait ratio of correlations (HTMT) criterion (Henseler et al., 2015) were applied. As evident in Table 3, all HTMT values were below the 0.85 threshold, meaning that discriminant validity is established. Finally, the Stone-Geisser's Q value (Q^2) for the endogenous variables were all greater than zero, indicating the acceptability and cross-validated predictivity (Geisser, 1974; Stone, 1974). These results attested to the reliability and validity of the reflective measurement model.

Table 3. Reliability and validity statistics of the measurement model

Construct	HTMT Ratio (< 0.85)								
	ATT	EC	INT	KNW	PBC	BNF	PMN	SF	SN
Attitude (ATT)									
Environmental Concern (EC)	0.676								
Intention (INT)	0.683	0.760							
Knowledge (KNW)	0.783	0.636	0.655						
Perceived Behavioural Control	0.642	0.625	0.763	0.608					
Perceived Benefit (BNF)	0.701	0.541	0.521	0.732	0.576				
Personal Moral Norm (PMN)	0.644	0.794	0.811	0.573	0.734	0.507			
Situational Factor (SF)	0.191	0.181	0.114	0.249	0.080	0.231	0.115		
Subjective Norm (SN)	0.506	0.593	0.715	0.423	0.684	0.517	0.668	0.059	
CR (>.7)	0.963	0.941	0.973	0.846	0.932	0.869	0.929	0.925	0.962
Cronbach's α (>.7)	0.953	0.921	0.966	0.759	0.912	0.776	0.885	0.912	0.953
Rho_A (>.7)	0.954	0.928	0.966	0.779	0.920	0.779	0.889	0.937	0.956
AVE (>.5)	0.812	0.760	0.857	0.582	0.697	0.690	0.814	0.642	0.809
$Q^2 > 0$	0.425	-	0.623	-	-	-	-	-	-

Source: Authors' own research results.

Formative measurement model assessment

A two-stage approach was applied to estimate the reflective-formative higher-order construct (i.e., behaviour), whereby the latent variable scores for the lower-order constructs obtained from the repeated indicator approach in stage one, was used as formative indicators for the higher-order construct in stage two (Sarstedt et al., 2019). In order to validate the higher-order construct, an assessment of the collinearity between formative indicators were conducted. The variance inflation factors of the formative indicators were below the 3.3 threshold (Diamantopoulos & Siguaaw, 2006), thus precluding the possibility of multicollinearity issues.

Next, a bootstrapping procedure was done on the model with 5,000 subsamples to determine the significance and relevance of the indicator weights. As evident in Table 4, the indicator weights for each items reflect their contribution to the behaviour construct. The non-significant indicator weights should not be automatically regarded as poor measurement quality (Ramayah et al., 2018), since prior research or theory provides evidence for the relevance of this indicator for capturing the operationalized definition of sustainable food waste management (Ariyani & Ririh, 2020). This method is known as absolute contribution (Hair et al., 2017) to avoid poor content validity. As a result, the composting behaviour indicator is retained in the formative construct even though its outer weight was not significant, because conceptually it is an indispensable aspect of sustainable food waste management (Peng & Lai, 2012; Petter et al., 2007). The next move is to assess the structural model.

Table 4. Results of the formative higher-order construct

Construct	Items	Outer Weights	VIF	t-value weights	p-value
SFWM	Composting	0.013	1.347	0.220	0.804
	Reusing Leftovers	0.365	1.148	5.642*	0.000
	Waste Separation	0.803	1.475	14.246*	0.000

Note: Significant at t-value > 1.96*, SFWM = Sustainable Food Waste Management.

Source: Authors' own research results.

Structural model and hypothesis testing

The measurement model was turned into a structural model by adding the hypothesized paths between the constructs (Figure 4). The direct effects in the structural model are shown in Table 5. For the endogenous constructs, the model's in-sample predictive power was examined using R^2 . Based on the rule of thumb, the R^2 values were satisfactory for INT (0.733), ATT (0.527), and BHV (0.399) as per Hair et al. (2019). Note that the results of the direct-path relationships are presented first, followed by the results of the proposed mediating relationships.

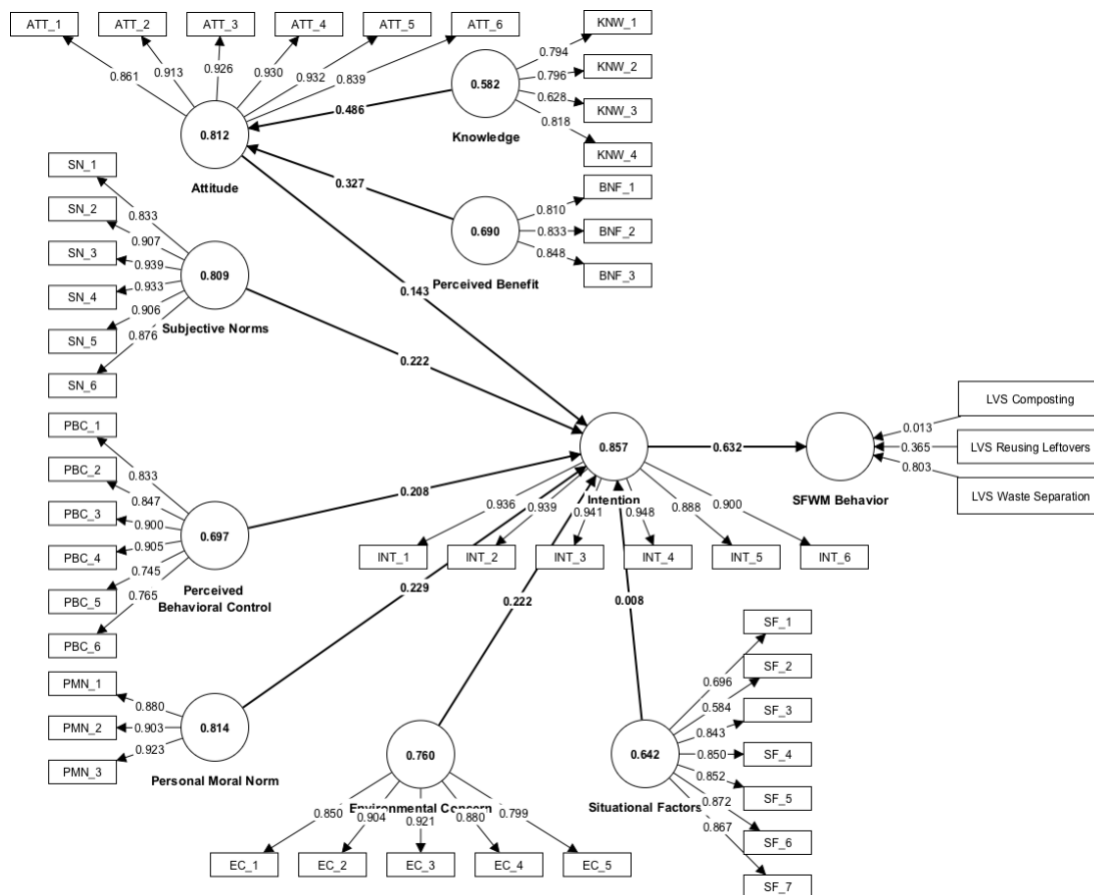


Figure 4. The structural model and PLS algorithm results

Source: Authors' own research results.

All the standardized direct-path coefficients were statistically significant at 1% significance level, except the non-significant coefficient between SF and INT. The direct-path coefficient between INT and BHV was the highest ($\beta = 0.632$); the second highest was between KNW and ATT ($\beta = 0.486$) and the third highest between BNF and ATT ($\beta = 0.327$). The direct relationship between PMN and INT was positive ($\beta = 0.229$), supporting H6. H4 and H7 were supported, because the direct relationships between SN and INT and between EC and INT were significant and positive ($\beta = 0.222$ for both). H5 was also supported, based on the significant and positive relationship between PBC and INT ($\beta = 0.208$), but the result

exhibited small effect sizes based on the f^2 values. Finally, there was a non-significant direct relationship between SF and INT ($\beta = 0.007$), thus H8 received no support.

Table 5. Direct paths between the constructs in the structural model (H1-H9)

Direct path	Std Beta	t-value	p-value	f^2 (effect size)	Decision
H ₁ : KNW → ATT	0.486	10.636	0.000	0.334 (medium)	Accepted
H ₂ : BNF → ATT	0.327	7.931	0.000	0.151 (medium)	Accepted
H ₃ : ATT → INT	0.144	3.501	0.000	0.038 (small)	Accepted
H ₄ : SN → INT	0.222	5.657	0.000	0.093 (small)	Accepted
H ₅ : PBC → INT	0.208	4.581	0.000	0.069 (small)	Accepted
H ₆ : PMN → INT	0.229	4.551	0.000	0.072 (small)	Accepted
H ₇ : EC → INT	0.222	4.759	0.000	0.072 (small)	Accepted
H ₈ : SF → INT	0.007	0.378	0.353	0.000 (no effect)	Rejected
H ₉ : INT → BHV	0.632	21.617	0.000	0.664 (large)	Accepted

Note: R^2 for Attitude = 0.527; Intention = 0.733; Behaviour = 0.399.

Source: Authors' own research results.

The bootstrapping with 5000 samples procedure was conducted to test the mediating effects. This is the most recommended approach for testing mediation in the PLS-SEM context (Hair et al., 2014; Zhao et al., 2010). The mediation model results can be seen in Table 6. Seven out of eight mediation hypotheses were supported. The two indirect impacts of KNW and INT via ATT ($\beta = 0.070$, $p < .001$) (H10), and BNF and INT via ATT ($\beta = .047$, $p < .001$) (H11), were significant and positive. The results of the statistical analysis did not find support for hypotheses H17. In contrast, findings indicated that INT mediates the relationship between ATT, SN, PBC, PMN, EC, and BHV, thus, providing support for hypothesis H12 to H16.

Table 6. Indirect paths to Intention and Behaviour

Indirect path	Std Beta	t-value	p-value	CI	Decision
H ₁₀ : KNW → ATT → INT	0.070	3.196	0.001	[0.031, 0.117]	Accepted
H ₁₁ : BNF → ATT → INT	0.047	3.317	0.001	[0.022, 0.079]	Accepted
H ₁₂ : ATT → INT → BHV	0.091	3.422	0.001	[0.042, 0.145]	Accepted
H ₁₃ : SN → INT → BHV	0.140	5.358	0.000	[0.091, 0.193]	Accepted
H ₁₄ : PBC → INT → BHV	0.131	4.506	0.000	[0.073, 0.187]	Accepted
H ₁₅ : PMN → INT → BHV	0.144	4.397	0.000	[0.079, 0.209]	Accepted
H ₁₆ : EC → INT → BHV	0.140	4.626	0.000	[0.078, 0.196]	Accepted
H ₁₇ : SF → INT → BHV	0.005	0.382	0.702	[-0.039, 0.026]	Rejected

Note: CI = 95% confidence interval.

Source: Authors' own research results.

Discussion and implications

The results provide support how sustainable food waste management helps in promoting the circular economy concept through the application of reusing food leftovers, separating food and non-food waste right from the source (at the household level), and by practicing home composting. Responsibility lies on the shoulders of each member of the household, to educate other household members on the benefits or implications involved in those practices. Increasing knowledge among the household and community level regarding sustainable management of food waste at the source is effective to generate a positive attitude towards controlling disposal to landfills, in line with the findings of Al-Mamun et al. (2018) and Barloa

et al. (2016) whereby satisfactory levels of knowledge, translated into satisfactory levels of attitude. Knowledge about the negative impact encourages consumers to re-evaluate their attitude towards sustainable food waste management and its possible impact on society, the environment, and the economy. Educational materials, media coverage and awareness campaigns should link the negative outcomes of depending on landfilling alone, or the consequences of wasteful behaviours to alarm consumers regarding the harmful impact from wrong disposal behaviour.

Meanwhile, the positive impact of perceived benefits on attitude is in agreement with Dorce et al. (2021) and Yadav & Pathak (2017). Recognizing that households also seek financial benefits from participating in food waste management, home composting can be incentivised. By creating industry- and state-sponsored food waste recycling and composting facilities, may improve cash rebates and economic return while reducing food waste in landfills. Policymakers should ensure that regulations assist rather than stifle composting. The compost can be sold to the agricultural sector for use in parks, green spaces, and public gardens.

The results also depict subjective norm to have a positive impact on intention, in accordance with findings of Aktas et al. (2018) and Russell et al. (2017). This is evidence that the sense of belonging to a community motivates households to actively examine the rules and norms of that society and respect the views of others. In Malaysia, the ZeComm or Zero Waste Community Initiative was introduced in 2018 to curb food waste from going into landfills. The program is designed to stimulate and encourage the community to make food waste one of their sources of income. This initiative may be enhanced to attract the interest of the local community to segregate waste and implement recycling activities and treat food waste i.e. composting.

The initiative included the element of benefit by rewarding local residents who treat food waste and send the segregated recycling waste to recycling centers established in residential areas. To date, there are 16 ZeComm locations across Malaysia. Participants can exchange their collection points with food products, which is part of the benefit gained from supporting the program. At one point of time during the program, a total of 9,246.63 kg of food waste and 4,186.96 kg of used cooking oil were successfully collected among the household community (SWCorp, 2021).

With regards to the findings where the opinion of important people is one of the important factors, opinion leaders may thus serve as strong influencers to encourage household consumers to engage in better food waste management. Social media platforms, such as YouTube, Instagram, and Facebook, can also be utilized to promote these opinion leaders and other social influencers in encouraging food waste management and reduction behaviours.

It seems important to ease the experience of managing food waste for the households to help increase their confidence level, perhaps by designing a simplified and affordable version of food composting machines that are within household capacity. The technology generators may collaborate with related standard agencies or business associations to design as per international standard, that is also recognized by authorities. Building specific facilities for food waste treatment may also ease the implementation of food waste separation and composting practices, especially for households living in high-rise buildings that lack space. This will increase the perceived behavioural control by offering households a feasible solution to ease and improve their waste management activities. These arguments are in line

with previous studies by Zhang et al. (2021) whereby their study sample felt confident they could separate the waste if they are confident and they wanted to do it.

This study adds the psychological and individual push factor of moral obligations into the sustainability discussion. Although the current finding conflicts with Corsini et al. (2018), it is in agreement with Wang et al. (2019) who highlighted the relevance of personal moral norms and stated that when residents have high moral obligations to exercise sustainable food waste management, their intentions to conduct the behaviour will be stronger. This provides insights into morality enhancement among the public. It is noted that morality could not be built overnight and should be nurtured from the early years of age. Hence, the inclusion of moral norms related to sustainable behaviour in the school curriculum can make a difference to the future generation. In practice, waste management managers, community-based leaders, and non-governmental organizations (NGOs) can focus on heightening residents' sense of social obligation, in their upcoming programs.

Furthermore, the results recommend environmental concern to be instilled where possible. The current study findings regarding the positive relationship between environmental concern and intention echoes that of Li et al. (2020). Residents should be permitted to volunteer by providing financing for activities that are environmentally friendly (e.g., providing composting bins to the community or becoming green ambassadors). The most efficient method of communication for this group of people is to organize the messages in such a way that they concentrate on the significance of environmental protection in addition to the ideals held by the society. This is in line with the emphasis that consumers' intention to adopt direct and indirect pro-environmental behaviours are affected by environmental concern (Alzubaidi et al., 2021). Communication methods need to be more narrowly targeted in order to attract the attention of environmentally conscientious urbanites. One approach would be to highlight the benefits offered by the decrease of methane when food waste is considerably reduced from entering landfills. This in turn gives indirect benefits to other relevant environmental reasons, such as pollution management and climate change issues.

It is also important to note that the insignificant result of situational factor in this study requires further investigation in order to add to the discussion and provide new insights in the research area. It appears not to be as important as expected, which contradicts with the findings from Heidari et al. (2018) and Zhang et al. (2015). However, this contradiction opens up opportunities for future research to explore further. Finally, this study was conducted as a response to the suggestions by Nik et al. (2022) to expand the list of factors that may determine the households' adoption of sustainable food waste management, as well as the demand by Attiq et al. (2021) for additional research on the link where intention influences behavioural outcomes. This study managed to highlight the less-researched mediating role of intention, bridging between psychological determinants and the behavioural adoption, signalling a significant mediation of the urban households' intention between all exogenous variables and the actual behaviour.

Limitations and future research avenues

This study, while making significant contributions to the literature, is not without limitations. First, this study is limited by its cross-sectional design. For instance, the empirical data in this study were collected at one point in time from households within the Klang Valley. Although it allows controlling for various exogenous factors which increases the internal validity,

future research may test the model on different segments of people or different industries or in other countries or cultures to enhance the generalizability of the findings. Second, this study has focused more on the intrinsic determining factors. Including extrinsic factors in sustainable food waste management research may reveal the associated type of external aspects that best explain the behavioural intention of households. Consequently, focusing on that and several other options offer the potential for new knowledge and insights, both theoretical and practical. Future research shall also conduct a comparative study to identify differences in the factors influencing practitioners versus non-practitioners of sustainable food waste management, or comparing the outcome for different variables for different categories of respondents. Methodologically, it would be interesting to combine quantitative data analysis using PLS-SEM with other analytical methods, such as Bayesian modelling, or based on a specific case study, or from a grounded theory perspective. Last but not least, as demonstrated in the current study, sustainable food waste management is a multidimensional construct that encompasses a variety of elements. Future research may replicate this study by exploring the construct further and developing a different multidimensional measure that will be extended with a more in-depth analysis of its impacts.

Conclusion

In order to fulfil the constantly increasing worldwide demand for food, it is the social responsibility of all stakeholders in the food supply chain to not only ensure that food production is adequate and safe for consumption, but also to ensure that food waste is reduced and managed sustainably. Tackling the food waste issue is important to improve livelihood and human well-being, and for achieving sustainable waste management. Factors affecting people's behavioural intention should be tackled for them to become enablers of the diversion of food waste from the solid waste stream. The transformation from a linear economy to a circular economy based on the principles of reduce, reuse and recycle must include both the household and community level to minimising solid waste generation at source and maximising the use of resources, by promoting sustainable food waste management practices. The empirical findings from the current study support that both knowledge and perceived benefit influence attitude positively. The analysis also support that attitude, subjective norm, perceived behavioural control, personal moral norm, and environmental concern of individual members of the household positively influence their intention to implement best practices of reusing leftovers, separating household waste, and doing composting. Furthermore, intention was proved to mediate the relationship, whereas the factor of situational factor was insignificant. This model can guide best practices and become the pushing factors that could be used as a basis to achieve sustainable food waste management at the household level. Furthermore, the authorities already involved in food waste management framework can intervene in reducing food waste at various sub-levels, whereas households with assistance from NGOs can take part in reusing leftover food through donations and redistribution. This is to overcome the challenges associated with donating edible leftovers to charity (Dhir et al., 2020; Hamerman et al., 2018). The role of awareness campaigns run by the government can be evaluated and may be successful in influencing long-term consumer behaviour. Continuous commitment of all parties in the food supply chain is crucial, since enabling sustainability in food waste management cannot be achieved just via the efforts of the government alone.

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