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Integrative model of behavioural intention: the influence of environmental concern and condition factors on food waste separation

Integrative
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Abstract

Purpose – This paper positions environmental concern as the antecedent of attitude, subjective norm and perceived behavioural control. It also sets to expand the theory of planned behaviour by including two condition factors: favourable situation and facility availability on the intention to separate food waste at source.

Design/methodology/approach – The study collects data by using self-administered questionnaires on 682 respondents in Malaysia. Structural equation modelling is employed to test the conceptual model and the proposed hypotheses.

Findings – The results show that environmental concern positively influences attitude and subjective norms, which, in turn, influences food waste separation intention. Favourable situation and facility availability are found to influence the separation intention.

Originality/value – This study is one of the earliest studies to investigate residents' intention to participate in food waste separation at a source that employs the expanded theory of planned behaviour with environmental concern and condition factors.

Keywords Food waste separation, Theory of planned behavior, Environmental concern, Favorable situation, Facility availability

Paper type Research paper

1. Introduction

Environmental issues have been brought into the spotlight, with the impact humanity has on it a growing global concern. Human consumption has greatly exceeded the sustaining capacity of Earth's global ecosystem. Dodds (2008) highlights that humanity's footprint has tremendous momentum, and the explosion of human impact creates a shockwave that threatens ecosystems worldwide. The amount of waste generated is growing exponentially around the world owing to population growth, infrastructure development, resource use and rising consumption. According to the Global Waste Management Outlook, the global annual rate of municipal solid waste is about 2 billion tons and increasing annually, while the composition of MSW is becoming more complex (UNEP, 2015). The current monstrous trend of municipal solid waste has triggered major public health, economic, and environmental problems. A high proportion of food waste is found in municipal solid waste. Food waste is discarded daily due to fundamental human



activities and behaviour of escalating their consumption (Dodds, 2008). Food production and waste are responsible for a significant portion of environmental footprints, namely greenhouse gas (GHG) emissions (carbon footprint), pressures on land (land footprint) and pressures on water resources (water footprint). Collectively, these can, in turn, affect biodiversity (FAO, 2019). The global carbon footprint of unconsumed food discarded contributes about 8% of total GHG emissions and a greater change in biodiversity (FAO 2013, 2019). Food waste that is currently disposed off in landfills can produce methane gas, resulting in 21 times greater environmental impacts. Instead, the organic residue generated is among the many types of food waste that could be separated and recycled.

Malaysia, with a total population of approximately 32 million, produces about 8,000 tons of food waste daily. By increasing at 3% annually, food waste contributes about 37% of total municipal solid waste. (Choon *et al.*, 2017). Sustained economic growth in this multi-ethnic nation over the past decades has provided the bedrock for much of the improvements in the state of households. Consequently, food waste generation from uneaten food and food preparation leftovers have escalated. Prior studies note that food waste separation at source program has limited implementation in Malaysia because of low awareness among residents and waste generators (Choon *et al.*, 2017). Food waste disposal is categorized under solid waste disposal, which is under the Malaysian Solid Waste and Public Cleaning Management Act 2007 (Act 672). There is low participation of both households and commercial premises in the primary action of food waste source-segregation (Moh and Manaf, 2014). The management and treatment of food waste are inefficient because of a restricted food waste management budget (Thi *et al.*, 2015). As a result, no specific method to dispose off food waste is being used in Malaysia (Moh and Manaf, 2014; Choon *et al.*, 2017). Source segregation of food waste is still at its infancy stage and remains one of the challenges in Malaysia and other parts of the world. To encourage efficient food waste separation at source, it is, therefore, important to understand the behavioural intention of residents to participate in food waste separation practices.

The theory of planned behaviour (TPB) is widely used to predict individuals' behavioural intentions. According to Ajzen (1991), people act sensibly and often reflect the consequences of their behaviours. As such, this theory hypothesizes that a person's intention will determine his/her behaviour. The original TPB constructs (attitude, perceived behavioural control, and subjective norm) proposed by Ajzen (1985) were found to affect food waste separation intention at varying magnitudes (Ramayah *et al.*, 2012; Karim *et al.*, 2013). Subsequently, some studies extended the model by incorporating condition variables to enhance the TPB model, including situational factor and facilities availability (Wang *et al.*, 2020; Rispo *et al.*, 2015). The impact of these variables varies under different contexts. Food waste separation at source aims to reduce negative environmental impacts. Prior studies found that environmental concern is one of the antecedents in determining pro-environmental behaviour (Yadav and Pathak, 2016; Oyekale, 2018). Its role in food waste separation has yet to receive much attention. The gaps found in previous literature motivated this study to re-examine the TPB model from an extended perspective. We aim to evaluate the influence of environmental concern on the three constructs of TPB (attitude, perceived behavioural control, and subjective norm), which, in turn, affect food waste separation intention. This study adds to the body of knowledge in TPB by highlighting the role of environmental concern in the context of food waste management.

Based on an environmentally motivated city in Malaysia, our findings suggest that the simultaneous effects of environmental concern and attitude, environmental concern and subjective norm, and favourable situation and facility availability affect behavioural intention to separate food waste at source. There is a paucity of prior studies focusing on key demographic groups that would support such intention. It is important to identify these

groups for initiative success. Thus, this study also identified the demographic groups that would take a proactive role in food waste management efforts.

The following section reviews the literature and develops the framework of each key variable along with hypotheses in the model. Next, in section three, we explain the research approach; section four presents the main findings, while section five is devoted to discussion and implications of the results. Finally, section six concludes the study.

2. Literature review and hypotheses development

Food waste separation is a behaviour that requires substantial effort from individuals to segregate waste according to certain categories. Social and environmental factors often influence such behaviour (Issock *et al.*, 2020). TPB allows individuals who have positive attitudes, with adequate support, to perceive they have control of engaging in the activity and have strong intentions to perform the behaviour. This study adopted TPB as the framework because it permits a distinct structure to investigate stakeholders' intentions to engage in food waste separation behaviour.

Attitude is the extent of a person's approval or disapproval of a specific behaviour. The attitude towards a particular behaviour stems out of his/her evaluation of the expected outcome(s) of the behaviour in question (Sumaedi *et al.*, 2016). If the person believes that performing a certain behaviour brings a beneficial outcome, he/she will have a favourable attitude towards that behaviour and willing to behave in such a way and vice versa. There is a considerable empirical evidence to show that attitude is a significant predictor of intention. In a study on pro-environmental behaviour, Koon *et al.* (2020) elucidated that attitude toward saving electricity has a significant positive relationship with the intention to save electricity. In this study, we assume that individuals would have positive attitudes towards food waste separation. This is due to the potential benefits of the practice, which include financial benefits, recycling of separated waste into compost and biofuels, reduction of waste burden on landfill sites, and a reduction in the emission of greenhouse gases (Zhang *et al.*, 2015; Woon and Lo, 2016). This positive attitude will, in turn, translate into higher intention to separate food waste at the source. Previous studies (Karim *et al.*, 2013; Chen and Lee, 2020) concluded that respondents' attitude positively influenced their intention to participate in waste separation. Hence, we postulate:

H1. Attitude has a positive influence on food waste separation intention

Subjective norm is a social factor that denotes the perceived social pressure to act upon a particular behaviour or not (Ajzen, 1991). The expectations or perceptions of the individual's salient reference groups, such as friends, family, neighbours, colleagues, government, and even mass media, could affect individuals' intention to perform or continuously perform a behaviour (Yadav and Pathak, 2016; Kang *et al.*, 2019). According to Xu *et al.* (2017), when individuals are uncertain about the right thing to do, they take cues and draw inferences from people they deem important. In the food waste literature, some studies have suggested that subjective norm has a positive relationship on behavioural intention. For instance, Wang *et al.* (2020) noted that subjective norm is positively associated with residents' waste sorting intention in China. In the same vein, Zhang (2019) also concluded that subjective norm is positively associated with residents' intention to participate in waste management activities. Ramayah *et al.* (2012) noted that individuals' waste separation intention is influenced and predicted by significant others in their lives. Zhang *et al.* (2015) also identified subjective norm as a significant predictor of household waste behaviours. We therefore hypothesize:

H2. Subjective norm has a positive influence on food waste separation intention

Perceived behavioural control describes an individual's belief in possessing the capability and resources to perform certain behaviour (Ajzen, 2002). An individual finds a behaviour easy to perform when he/she perceives to have control over aspects such as information, abilities, determination, time, and ease (Xu *et al.*, 2017). Nguyen *et al.* (2015) noted that residents who think waste separation is tough are more unwilling to participate in a waste separation program. Similarly, Bhatti *et al.* (2019) found that perceived behavioural control is an inconsequential predictor of intention for food waste among young consumers in a developing country. This suggests that perceived difficulty is a factor to consider in food waste separation. Individuals are willing to engage in pro-environmental behaviour based on their positive perception of their ability to do so (De Leeuw *et al.*, 2015). Thus, in the presence of opportunities and resources with minimal perceived obstacles, the individuals' willingness to perform a specific behaviour increased. Liao *et al.* (2018) revealed that perceived behavioural control was significantly and positively related to waste separation intention of takeaway waste in the workplace. The positive influence of perceived behavioural control in food waste behavioural intention is also revealed in other studies (Visschers *et al.*, 2016). We propose:

H3. Perceived behavioural control has a positive influence on food waste separation intention

In addition to the TPB variables, Davis *et al.* (2006) have suggested considering the situational factors in the study of behavioural intention. Situational factors refer to physical factors that can expedite or hinder the performance of certain behaviour. It is important to provide acceptable conditions to separate waste in residential areas to increase participation in waste separation programs or campaigns. Bernstad (2014) highlighted that situational factors might include space, effort, time, convenience, and access to recycling schemes, which, when present, can make individuals more willing to recycle. In the context of food waste studies, Wang *et al.* (2020) indicated that favourable situations such as incentive measures strengthened the effect of residents' intention to waste sorting. As reported, the incentive measures have a positive influence on residents' altruistic behaviour. Karim *et al.* (2013) also concluded that situational factors were significant predictors of food waste separation intention. Hence, we hypothesize:

H4. Favourable situation has a positive influence on food waste separation intention

Food waste separation is not only an individual effort but also requires provisions and support from the enforcement authorities. As such, local authorities need to provide ample facilities that will encourage such intention. Prior studies related to pro-environmental behaviour found that the insufficient facilities are one of the key hindrances (Woodard *et al.*, 2005; Tangwanichagapong *et al.*, 2017). Sufficient facilities such as food waste bins provided in the household, frequent collection of food waste by the municipality, and a food waste collection centre in the neighbourhood would encourage the intention to separate food waste at source. Similarly, Stoeva and Alriksson (2017) also explained that individuals with positive attitudes towards food waste separation could be discouraged from participating because of a lack of proper facilities. Bernstad (2014) also emphasized the significance of the presence of infrastructure (installation of sorting equipment in households) required for source segregation of waste. Rispo *et al.* (2015) further noted that the provision of quality service and connected infrastructure makes it easy for residents to participate effectively in waste management activities. Liao *et al.* (2018) conducted a study on staff's take away waste separation intention, whose findings concurred with the studies by Stoeva and Alriksson (2017) and Rispo *et al.* (2015). The authors concluded that facility availability, such as recycling bins in the office, satisfactory resources for separating takeaway waste collection was a useful predictor to waste separation intention. Hence, we postulate:

H5. Facility availability has a positive influence on food waste separation intention

Public concern about environmental issues is growing. It is believed that environmental concern is an important factor for environmentally friendly activities such as food waste separation at source. Ajzen (1985) commented that environmental concern affects individuals' behaviour indirectly. Dunlap and Jones (2002, p. 485) define environmental concern as "the degree to which people are aware of problems regarding the environment and support efforts to solve them and/or indicate the willingness to contribute personally to their solution." Jekria and Daud (2016) documented that environmental concern positively influenced individuals' attitudes, which, in turn, influenced their recycling intentions in Malaysia. Similar results were recorded by Khaola *et al.* (2014) in their study of green purchasing behaviour in Lesotho. Wang *et al.* (2016) found that the three main elements in the TPB model (attitude, perceived behavioural control, and subjective norm) are the mediators between environmental concern and intention to adopt hybrid electric vehicles. According to McCarthy and Liu (2017) and Bhatti *et al.* (2019), environmental concern awareness (i.e. greenhouse emissions, energy, and pollution) can cultivate positive behaviour towards food waste reduction. Thus far, only Liao *et al.* (2018) have provided evidence that environmental concern strongly influences attitude, subjective norm, and perceived behavioural control in takeaway waste in the workplace. Their study did not include the general household that generates most of the food waste. Therefore, we propose the following hypotheses:

H6a. Environmental concern has a positive influence on attitude

H6b. Environmental concern has a positive influence on subjective norm

H6c. Environmental concern has a positive influence on perceived behavioural control

The conceptual schema demonstrating the hypothesized relationships is illustrated in Figure 1.

3. Data and methodology

The research design of this study is built upon the theoretical framework and supported by empirical literature. For testing the proposed conceptual model (Figure 1), the study adopted a quantitative research approach based on a cross-sectional design. A self-administered survey using a paper-based questionnaire was developed to collect the data in Miri, Malaysia. Miri City Council was one of the four pioneer local authorities in Malaysia to implement the

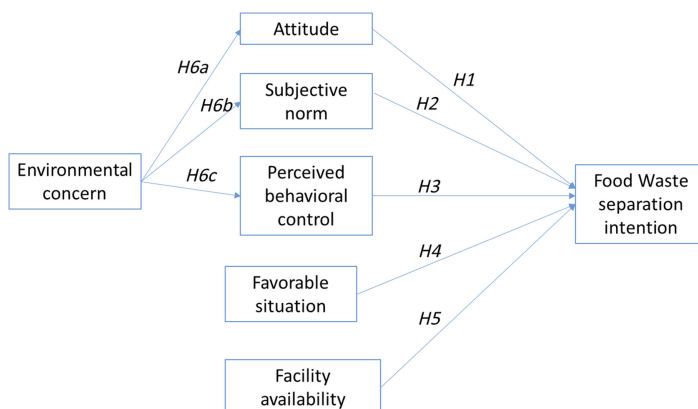


Figure 1.
Conceptual model

Local Agenda (LA) 21 Pilot Project in 1999. Under LA21, the local authority collaborates with various stakeholder groups to plan and manage environmental programs to promote sustainable development. Since it was accorded a city status in 2005, Miri has experienced rapid population growth and urban development, which resulted in a massive generation of solid waste, including food. Despite the existence of LA21, no food waste separation mechanism and policy has been established, although the city council is deliberating the implementation of this initiative. Miri was chosen to be the study site because of its involvement in LA21 and Miri City Council's plan to implement a food waste separation initiative to protect the environment. [Ling \(2018\)](#) noted that Miri residents had better awareness of environmental programs, issues, and practices.

The questionnaire was translated into three languages (English, Bahasa Malaysia, and Chinese). It was validated by conducting a pilot study with 30 participants in each language, which led to the final version after some amendments. Prior to the fieldwork, ethical approval on the questionnaire designed from governing institution and support from the Miri City Council was obtained. The paper questionnaires were randomly distributed to food-waste generators, which included eateries (restaurants, food courts, and cafeterias), cafeterias at schools, colleges/universities, factories, and supermarkets. The questionnaires were also randomly distributed to the public. Participants were informed about the survey objective and their consent was obtained before filling in the questionnaire. After eliminating incomplete questionnaires, 682 valid questionnaires were selected for analysis. Following the suggestion from [Armstrong and Overton \(1977\)](#), the respondents were divided into two groups to test for potential non-response bias: (1) respond vs. non-respond, and (2) early respond vs. late respond. We found no significant difference between the groups in the Chi-square test. Thus, non-response bias was not a concern in this study.

Measures for each of the constructs in the model, namely attitude, subjective norm, perceived behavioural control, situational factors, facility availability, environmental concern and waste separation intention, were adapted from prior relevant studies ([Karim et al., 2013](#); [Vischers et al., 2016](#)). All items in the survey instrument were measured using a 5-point Likert scale (1- Strongly disagree, 2- Disagree, 3- Neither agree nor disagree, 4- Agree, and 5- Strongly agree). Besides, the questionnaire also included questions related to the demographic profiles of respondents.

For testing the conceptual model presented in [Figure 1](#), IBM SPSS AMOS 25 statistical package was used to analyse the data with a two-step approach. First, Confirmatory Factor Analysis (CFA) was applied to estimate the measurement model. Subsequently, we employed Structural Equation Modelling (SEM) to discover the best-fitting model and examine causal relationships. This multivariate method is a combination of multiple regression and factor analysis to measure multiple dependent relationships at the same time ([Hair et al., 1998](#)). It is useful to explore relationships between the constructs and test the hypotheses.

4. Results

4.1 Measurement model

The measurement model was evaluated by conducting CFA with a maximum likelihood estimation method to ensure the reliability and validity of the measurement model. SEM permits a stepwise strategy to improve the goodness-of-fit indices of hypothesized model. The fit indices indicated that the measurement model has a good fit to the data ($\chi^2 = 1452.81$, $df = 532$, $p < 0.001$; RMSEA = 0.05, CFI = 0.930, NFI = 0.90). The goodness-of-fit model and overall statistics were attained in this study based on [Hair et al.'s \(1998\)](#) standard of model fitting. A minimum factor-loading criterion of 0.4 is required to be considered valid. To examine the convergent validity of the measurement scales, we used the Average Variance Extract (AVE) of a construct. A minimum of 0.5 in AVE is required to achieve this validity

(Fornell and Larcker, 1981). Table 1 shows that all items in each of the constructs achieved a minimum factor loading of 0.4, thus ensuring the validity of the model. All constructs have an

Constructs	Indicators	Factor Loadings	CR	AVE
Environmental Concern (EC)	EC1 The state of the world's environment and what it will mean for my future is worrying	0.53	0.88	0.54
	EC2 Mankind is severely abusing the environment	0.57		
	EC3 Humans must live in harmony with nature in order to survive	0.65		
	EC4 Environmental problems are very important	0.88		
	EC5 Environmental problems cannot be ignored	0.86		
	EC6 We should care about environmental problems	0.74		
Attitude (ATT)	ATT1 FWSS is a good activity	0.63	0.87	0.54
	ATT2 FWSS should be promoted in Miri	0.79		
	ATT3 FWSS at home is useful	0.97		
	ATT4 FWSS is needed	0.91		
	ATT5 FWSS is an act of environmentally responsible	0.65		
	ATT6 Solid waste management initiative is a good way to contribute to a better environment	0.55		
Subjective Norm (SbN)	SN1 My family would think I should adopt FWSS	0.44	0.89	0.67
	SN2 My neighbours would think I should participate in FWSS	0.91		
	SN3 My neighbours would think I should be involved in FWSS	0.85		
	SN4 The community in the area I live think I should adopt FWSS	0.7		
Perceived Behavioural Control (PBC)	PBC1 The decision to separate my food waste is completely up to me	0.81	0.76	0.61
	PBC3 I have complete control in deciding whether or not to adopt FWSS	0.85		
Situational Factor (SF)	SF1 I have enough space in my house/shops/stalls to practise FWSS	0.75	0.82	0.60
	SF2 I have enough time to properly practise FWSS	0.73		
	SF3 I have proper knowledge on how to practise FWSS	0.78		
Facility Availability (FA)	FA1 Provision of food waste bins will encourage my participation in FWSS	0.67	0.85	0.58
	FA2 Separate and regular collection of food waste will encourage my participation in FWSS	0.88		
	FA3 Food waste collection centres being set up in neighbourhood will encourage my participation in FWSS	0.72		
	FA4 Provision of a composter unit to compost our own food waste will encourage my participation in FWSS	0.79		
Behavioural Intention (INT)	INT1 I intend to separate my food waste at home/shop/staff on a regular basis if there are food waste collection measures	0.81	0.89	0.62
	INT2 if I am satisfied with the food waste collection measures by the local authority	0.89		
	INT3 if am convinced with the benefits of FWSS	0.74		
	INT4 if the local authority enforces public participation in FWSS	0.77		
	INT5 if the local authority provides satisfactory services for the separated food waste collection	0.70		

Note(s): FWSS=Food waste separation at source

Table 1.
Measurement model
evaluation

AVE of more than 0.5, which provided further assurance of the validity of the model for additional statistical analysis (Fornell and Larcker, 1981). A composite reliability test was run to assess the internal consistency of the multi-item measures. The composite reliability, ranging from 0.76 to 0.89, were higher than the recommended threshold of 0.6 (Bagozzi and Yi, 1988).

We used discriminant validity to examine whether each construct is distinctive from other constructs. As indicated in Table 2, all constructs had a lower than 0.8 value in correlation. The square root of AVE (indicated in italic in Table 3) was also found to be greater than its correlation value. Hence, the discriminant validity was also evident, and the model was suitable for structural path analysis.

4.2 Structural model

Path analysis was conducted to check the goodness-of-fit of the structural model. Figure 2 shows the path analysis of the food waste separation intention model. The overall goodness-of-fit of the structural model are as follow: $\chi^2(685) = 2467.26$, chi-square/degree of freedom = $2,647/685 = 3.60$. GFI = 0.86, AGFI = 0.83, CFI = 0.90, NFI = 0.86, and RMSEA = 0.065. Results showed that the fit of the model was adequate. The model also showed an R^2 value of 0.48. In this case, the strength of the relationship between this model and the dependent variable was 48%. To compare this extended TPB model with the original model, we also tested the three main variables (attitude, perceived behavioural control, and subjective norm) with behavioural intention. We also found a good fit with data using the original model with an R^2 value of 0.37. Hence, the extended TPB model used in this study has a greater predictive ability for intention to separate food waste at source.

Table 2.
Correlation between
the constructs and
descriptive statistics

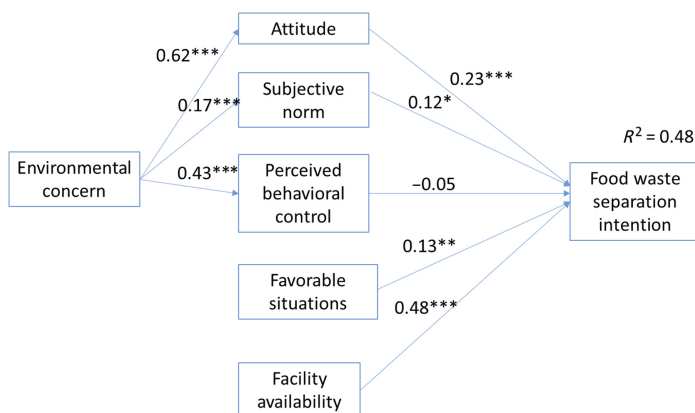
Construct	EC	ATT	SN	PBC	SF	FA	INT
EC	<i>0.73</i>						
ATT	0.56**	<i>0.73</i>					
SN	0.11	0.38**	<i>0.82</i>				
PBC	0.37**	0.37**	0.23**	<i>0.78</i>			
SF	0.18**	0.39**	0.56**	0.48**	<i>0.77</i>		
FA	0.65**	0.66**	0.30**	0.30**	0.32**	<i>0.76</i>	
INT	0.44**	0.60**	0.34**	0.30**	0.38**	0.68**	<i>0.79</i>
Means	4.16	3.86	3.15	3.87	3.30	3.73	3.75
SD	0.64	0.65	0.86	0.74	0.86	0.73	0.73

Note(s): (1) The diagonal elements italic are the square roots of AVEs; (2) **. Correlation is significant at the 0.01 level (2-tailed)

Table 3.
Hypotheses results

Hypothesis	Result
H1: Attitude has a positive influence on waste separation intention	Supported
H2: Subjective norm has a positive influence on waste separation intention	Supported
H3: Perceived behavioural control has a positive influence on waste separation intention	Not supported
H4: Favourable situation has a positive influence on waste separation intention	Supported
H5: Facility availability has a positive influence on waste separation intention	Supported
H6a: Environmental concern has a positive influence on attitude	All supported
H6b: Environmental concern has a positive influence on subjective norm	
H6c: Environmental concern has a positive influence on perceived behavioural control	

Integrative model of behavioural intention



Note(s): * $p < 0.01$, ** $p < 0.05$, *** $p < 0.001$

Figure 2.
Path analysis of food waste separation intention

Table 3 displays the statistical results of the factors of food waste separation intention. Attitude has a positive and statistically significant impact on food waste separation intention ($\beta = 0.23, p < 0.001$), which supported H1. Subjective norm ($\beta = 0.12, p < 0.01$) has a positive and significant relationship with the intention to separate food waste, providing support to H2. The results are consistent with prior studies (Karim *et al.*, 2013; Zhang *et al.*, 2015). On the other hand, perceived behavioural control ($\beta = -0.05, p = 0.20$) shows a negative but not significant relationship with food waste separation intention. Thus, H3 is not supported, contradicting the earlier work of Visschers *et al.* (2016).

This study included three additional constructs in the extended TPB model. Both favorable situation factors ($\beta = 0.11, p < 0.05$) and facility availability ($\beta = 0.48, p < 0.001$) have positive and significant relationships with food waste separation intention, thus providing support to H4 and H5, respectively. The results offer support to Wang *et al.* (2020) and Liao *et al.* (2018) in the current context. Environmental concerns are statistically and positively related to attitude ($\beta = 0.62, p < 0.001$), subjective norm ($\beta = 0.17, p < 0.001$), and perceived behavioural control ($\beta = 0.43, p < 0.001$), supporting H6a, H6b and H6c respectively. We extended the findings of Liao *et al.* (2018) by showing a similar influence of environmental concern of food waste separation in the context of a society. The findings suggest that attitude, subjective norm, favourable situation, and facility availability have significant direct effects on food waste separation intention. In addition, we also reveal the indirect influence of environmental concern influences intention via attitude, subjective norm, and perceived behavioural control, which was not examined before. The results provide evidence that residents with environmental concerns will translate to good environmental attitude, subjective norm, and perceived behavioural control, which will create a strong behavioural intention in food waste separation.

Further investigation was conducted to examine the mediating effect of attitude and subjective norm. Previous studies found that these two constructs were mediators in the TPB model but showed mixed results in the mediating effect (see Liao *et al.*, 2018; Yeoh and Paladino, 2007). Therefore, a mediating effect test was conducted in this study by examining the path regression coefficients between the variables. Table 4 shows that both attitude and subjective norm are partial mediators in the relationship between environmental concern and behavioural intention. This is because the direct effect between EC → INT was still significant after the mediators were included in the model. In the case of attitude, the path

MEQ	Path	Beta estimate	SE	CR	Result
	<i>Direct model</i>				
	EC-> INT	0.44	0.05	9.73	Significant
	<i>Attitude as mediator</i>				
	EC-> ATT	0.55	0.04	9.82	Significant
	ATT-> INT	0.51	0.08	8.46	Significant
	EC-> INT	0.15	0.05	3.34	Significant
	<i>Subjective Norm as mediator</i>				
	EC-> SN	0.10	0.06	2.36	Significant
	SN-> INT	0.30	0.03	7.43	Significant
	EC-> INT	0.41	0.04	9.48	Significant

Table 4.
Path regression
coefficient and its
significance

coefficient in EC→ INT reduced from 0.44 to 0.15, though it remained significant. Similarly, the path coefficient in EC→ INT reduced from 0.44 to 0.41 when the subjective norm was the mediator. As such, the results indicate that the combined effects of environmental concern, attitude, and the subjective norm will increase food waste separation intention.

4.3 Food waste separation intention and demographic attributes

Apart from examining the hypothesized model, this study also identified the most effective target groups to implement food waste separation in Miri City. Statistically significant tests were conducted on demographic attributes to identify such groups. An independent sample *t*-test was used on gender, while one-way ANOVA was employed for the other demographic attributes to depict the statistical significance of each of the attributes.

Table 5 shows that age, gender, and income level demonstrated statistically significant relationships with food waste separation intention. Compare mean analysis within these demographic attributes further shed light on the group of people who are most likely to practice food waste separation. Respondents aged 50 and over show the highest propensity to participate in food waste separation, followed by those aged 40–44. Respondents who are younger than 39 years old are less inclined to adopt food waste separation. In terms of income, respondents earning between RM6,000 and RM7,000 show a higher intention to separate food waste than those earning between RM8,000 and RM9,000, although respondents in that income bracket have a higher intention to separate food waste than those who earn more than RM10,000. Respondents in the income range of RM1,000–RM5,000 show the least intention to separate food waste. Female respondents had a higher intention to separate food waste than male respondents, who reported very low intentions to practice food waste separation.

Table 5.
Food waste separation
intention and
demographic
attributes

Demographic attributes	Intention
Age	0.016*
Gender	0.037*
Marital status	0.125
Size of household	0.954
Academic Qualification	0.139
Income level	0.005*

Note(s): *Mean difference is significance at 95% confidence level

5. Discussion and implications

5.1 Discussion of results

The empirical results are consistent with prior studies, to some extent. We confirm that attitude is predominantly imperative in predicting intention in separating food waste ($\beta = 0.23, p < 0.001$) in this current context, providing support to previous studies (Karim *et al.*, 2013; Wang *et al.*, 2020). If individuals feel that food waste separation at source is useful and a good contribution to the environment, they would be more inclined to such action. Consistent with an earlier study by Zhang *et al.* (2015), subjective norm ($\beta = 0.12, p < 0.01$) is also an important determinant in food waste separation intention though the strength is slightly weaker compared to attitude. This demonstrates that individuals' intention to separate food waste is influenced by the expectations of reference groups such as family, neighbours, and community. Wunder *et al.* (2019) note that social norm campaigns are effective in influencing people to reduce food waste when people are aware of the behaviour of others.

Apart from the original construct in the TPB model, situational factors, including adequate household space, available time, and knowledge on how to separate food waste, were found to be significant indicators of intention ($\beta = 0.11, p < 0.05$). Facility availability is found to be significant in this study ($\beta = 0.48, p < 0.001$). Previous studies by Stoeva and Alriksson (2017) and Tangwanichagapong *et al.* (2017) indicated that promoting food waste separation is more effective when facilities are easily accessible.

This study also confirmed the role of environmental concern in influencing pro-environmental behavioural intention through attitudes ($\beta = 0.62, p < 0.001$), norms ($\beta = 0.17, p < 0.001$), and perceived behavioural control ($\beta = 0.43, p < 0.001$) in the context of food waste separation but with different results. The findings corroborate the prior results of Liao *et al.* (2018) in the household food waste separation context. This indicates that environmental concern has an indirect effect on behavioural intention via behaviour-specific constructs. This could be attributed to the environmental awareness programs that LA21 conducted in the past two decades.

Notwithstanding environmental concern's positive influence on the three constructs of the TPB model, perceived behavioural control had no effect on the respondents' intention of separating food waste at source ($\beta = -0.05, p = 0.20$). This could be because the practice of food waste separation at source has not been implemented, and therefore, the respondents cannot perceive the opportunity and difficulty in taking action. Waste separation is not a common practice in Malaysia, with food waste constituting. The findings suggest that the residents may need to advocate for government interventions such as a campaign of mandatory food waste separation at the source.

5.2 Theoretical implications

Recent studies have started to adopt TPB in examining food waste behaviour (Viscchers *et al.*, 2016; Principato *et al.*, 2020). Consequently, our findings contribute to waste management studies by investigating the intention to separate food waste at source based on an extended TPB model. First, we add to the literature by confirming the antecedent (environmental concern) of three core components in TPB (attitude, subjective norm, and perceived behavioural control). A strong environmental concern is important to initiate attitude and subjective norm, which, in turn, motivate the intention to separate food waste at source. This backward extension to the research model enriches the current understanding of TPB and its applicability in food waste studies. Second, we also included two variables, which have been used to understand behavioural intention: favourable situation and facility availability for the TPB model. Our findings show that both variables are strong predictors in determining food waste separation. This extended model has a greater predictive ability for intention to separate food waste at source ($R^2 = 0.48$) than the original TPB ($R^2 = 0.37$). Further, our study

asserts that developing an extended framework of TPB as a coherent set of logical elements or principles provides an opportunity for a greater understanding of the nature of separating food waste at the source.

5.3 Practical implications

Based on the findings, there are several implications for local municipal councils and stakeholders. The influence of environmental concern on attitude and subjective norms highlights the need to increase environmental awareness. The local municipal council could convince residents of their capability to separate food waste through education campaigns, which should be conducted at regular intervals for all levels of stakeholders, including schoolchildren. All stakeholders would be made more aware of the adverse impact that food waste can bring to the environment. It is important to increase environmental awareness and impart knowledge to inculcate a culture of environmental responsibility at all levels of society. A greater environmental concern will give rise to positive attitudes, which will lead to an increased intention of stakeholders to separate food waste at source. Stakeholders could also take ownership of the various campaign exercises and educational activities to share in the responsibility of environmental action. The critical sources of waste generation need to be identified so that custom programs can be created and communicated. One such campaign to model is Japan's "No Food Lost Campaign," which was aimed at reducing food waste at all stages of the food supply chain (Parry *et al.*, 2015). Another initiative to implement is the "Total Recycling for Kitchen Garbage" program, which was executed in Taiwan (Thi *et al.*, 2015). The purpose of this program was to segregate and collect food waste from residential areas, restaurants, and hotels and used it to feed animals and produce fertilizer. These types of programs could change the attitudes of residents by shifting the paradigm from "it is not my business" to "it is my responsibility."

Various local stakeholders such as colleges, universities, government agents, corporate and community leaders, resident associations, and non-profit organisations could work together to promote food waste separation practice. This would create strong norms among residents, which result in a higher intention to separate food waste. Food operators and households could allocate specific working hours to food waste separation, which could mitigate the time pressure factor. For increasing knowledge regarding food waste separation, a series of workshops on how to reduce food waste at the source could be organized for local food operators. This type of education is imperative because food handlers generate the most waste, and increasing their knowledge could lead to a higher intention of separating food waste at source. Provision of food waste bins and the frequency of food waste collection would entice residents to practice food waste separation. Local councils could avoid leachate percolation and foul odours in buildings and residential areas by transporting waste to the refuse collection in a timely manner (Liao *et al.*, 2018). At the same time, local councils could put recycle bins in several points in the city. The irregularity of waste collection service could be avoided through heightened enforcement and close monitoring of the performance of waste collection contractors. Apart from that, an effective enforcement mechanism and facilities should be put in place to ensure that the separation of food waste is carried out to curb the greenhouse gas emissions from discarded food.

6. Conclusion

This paper cannot be concluded without acknowledging the limitations of the study. First, this study, focusing on the extended TPB model, may not provide a holistic lens to evaluate environmental protection practice. Although there are other theories that could be used as frameworks for environmental behaviour, such as moral agency, social cognitive, and norm activation theories, each one of them has its own strengths and weaknesses. Future research could consider integrating theories to provide a more comprehensive lens for pro-environmental

behaviour. Second, focusing on one city limits the generalisability of this study. Future research could be duplicated to major cities in Malaysia, covering diverse groups of stakeholders to better gauge the extent of their pro-environmental behaviour.

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