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ORIGINAL ARTICLE
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Keywords

Source separation | Waste | Cluster analysis | Extended TPB | SEM

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Youth and sustainable waste management: a SEM approach and extended theory of planned behavior

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Abstract
The present study aims to develop the Theory of Planned Behavior (TPB) to explain comprehensively the establishment of intention and behavior toward source separation of waste. The extended TPB involves the significant structures affecting the behavior along with the original variables of TPB model. Data were gathered from 420 students in Ferdowsi University, Iran, using questionnaires, and analyzed by cluster analysis, discriminant analysis and structural equation modelling techniques (SEM). The cluster analysis identified three distinct grouping according to TPB constructs, and it was validated by discriminant analysis. SEM results displays that motivation had the most important impact on intention, followed by moral obligation, perceived behavior control, subjective norm, situational factor and attitude. Fit statistic of the extended TPB model was good and had better explanatory power compared to the original TPB. It describes 81 and 57% of the variance for intention and behavior toward source separation waste, respectively.

Keywords Source separation · Waste · Cluster analysis · Extended TPB · SEM

Introduction

Solid waste generation is continuously increasing day by day. Its amount and composition become problematic in terms of environmental pollution due to rapid urbanization and development, exploding global population, and raising goods consumption [1–3]. Recycling has been considered as the most important strategy to decrease waste negative impacts on the environment, and reduce waste transport and disposal costs [4, 5]. Recycling requires source separation of waste, which is a critical component of integrated solid waste management system [6–8]. Governments should encourage high level of public participation for source separation of waste and identify its influencing factors [9].

Theory of Reasoned Action (TRA) and Theory of Planned Behavior (TPB) provide a theoretical framework to systematically investigate a broad range of intentions and behaviors in various fields, for example, environmental psychology (such as water conservation, energy consumption, sustainable food choice, and recycling) [10–13]. TRA was developed by Fishbein and Ajzen [14]. The theory aimed to determine the intention construct by the attitude towards the behavior and the subjective norm. TPB, proposed by Icek Ajzen [15], is a theory explaining human behavior. The theory assumes that a number of reasons or constructs including attitude, subjective norm, and perceived behavioral control is engaged in the formation of intentions to perform specific behavior. Recently, some studies found that TPB would help to predict waste separation behavior [13, 16, 17]. To improve potential of TPB model to predict behavioral intention, some additional constructs were suggested including environmental knowledge, situational factor, moral obligation, past behavior, social motivation. For instance, situational factors including separation time and convenience of storage facilities had a significant impact on recycling behavior [9]. Furthermore, it seems that environmental awareness was remarkably associated with the attitude towards recycling [18]. Additionally, moral obligation might indirectly anticipate behavior through waste separation behavior [9].

Based on the literature, to predict a waste separation behavior using SEM with the TPB theory, there are two

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main items, which should be considered. First, introducing additional constructs to TPB model other than the three mains (attitude, subjective norm, and perceived behavioral control) to interpret the behavior [9, 18]. Second, determine the most important factors that have influence on this behavior in community. In some studies, environmental awareness and knowledge have been considered as key factors of participation in recycling programs [19, 20]. The findings of Zhange et al. [8], Pakpour et al. [16], Nguyen et al. [4] and Chan and Bishop [21] indicated that the moral obligation is a determinant of recycling intention and behavior in a community. Attitudes towards the waste and environment were other predictors of waste separation behavior according to Rhodes et al. [3], Malik et al. [22], Ramayah et al. [18], and Tonglet et al. [23].

In the present study, with the aim of finding the most descriptors of recycling behavior among Iranian students, attitude, subjective norm, perceived behavior control, intention, moral obligation, environmental awareness, and situational factor were introduced. Recycling programs implemented in some cities of the world showed that the motivation would result in a higher rate of participation, but its contribution to explain waste separation behavior with SEM was not examined so far. Therefore, motivation was also considered as an additional construct. Based upon these factors, a comprehensive research on waste separation behavior among youth was conducted using SEM with the TPB theory.

Objectives and research hypotheses

Like other cities in Iran and many other developing countries, in Mashhad, the second large city in Iran, municipal solid waste is not separated before collecting. Although some voluntary recycling programs have been implemented by Mashhad Municipality Waste Management Organization but public participation is quite low, mostly due to lack of appropriate source separation facilities. Since Ferdowsi University of Mashhad (FUM), the third biggest and highest university in Iran, has a moral and ethical obligation towards environment, it would be expected to be a leader in implementing a movement of integrated waste management and 3R, through planning and managing waste separation facilities for campus. It is clear that broad participation of students in source separation of waste leads to social and environmental benefits.

With this background, the primary purpose of this research is to investigate whether the extended TPB model would predict and explain intention and behavior of the University students to segregate waste, and to find out about the influencing factors. The secondary purpose is to compare explanatory power of this model for recycling intention with original TPB. The tertiary purpose attempts to classify students based on the TPB constructs.

The rationale for hypothesis was the findings of the literature [24, 25] related to youth environmental behavior and standard TPB assumptions. The specific research hypotheses are as follow:

Hypothesis 1 Moral obligation and knowledge of environmental problems have positively related to attitude, subjective norm and perceived behavior control.

Hypothesis 2 Moral obligation and knowledge of environmental problems have positively associated with subjective norm.

Hypothesis 3 Motivation has positively linked with intention.

Hypothesis 4 Attitude, subjective norm and perceived behavior control explain the students' intention for source separation of waste.

Hypothesis 5 Situational factor and moral obligation have positively correlated to waste separation intention.

Hypothesis 6 Among all variables, student's attitude is the most descriptor of waste separation intention.

Hypothesis 7 Perceived behavior control has influence on waste separation behavior.

Hypothesis 8 Moral obligation positively associates with waste separation behavior.

Hypothesis 9 Situational factor has a positive effect on intention toward source separation of waste.

Materials and methods

Sampling

FUM has been chosen as the study area, which is located in the second most populous city of Iran. FUM has 12 faculties including Agriculture, Architecture and Urban Planning, Veterinary Medicine, Sciences, Psychology, Physical Education, Natural Resources and Environment, Mathematics, Economics, Engineering, Humanity Sciences, and Theology. According to statistics, there are around 27,000 students at FUM [26].

The sample size of participants was determined using Cochran formula [27] (Eq. 1).

$$n = \frac{\frac{pqz^2}{d^2}}{1 + \frac{1}{N}\left(\frac{pqz^2}{d^2} - 1\right)} \quad (1)$$

where n is the sample size of population, N is population size (27,000), z is the standard value for confidence level (1.96), d is the allowable error value (0.05), p is the estimated proportion of an attribute that is present in the population (0.5), and q is $1-p$.

The data was collected using a questionnaire based on a face-to-face method with 420 respondents during July and August of 2016. Accordingly, to achieve the desired sample size, a number of 35 samples were randomly taken from each of 12 faculties. A sample (n) of students from each faculty was chosen based on a systemic random sampling technique. No financial incentive was made to the student and their participation was voluntary. The time for answering questions was 20 min. After the questionnaire was completed by the percipients, it was checked to ensure that all questions were filled. Therefore, the response rate was 100%.

Measurement instruments

The survey instrument was a structured questionnaire. The questionnaire framework was founded on TPB model and adapted scales and indicators adjusted in previous studies (for instance [4, 5, 13, 15, 28, 29]). The questionnaire consists of three sections including dependent variables (intention to recycle and behavior), predictor latent variables (attitude, subjective norms, perceived behavioral control, responsibility, situational factor, environment knowledge, and feedback) and predictor manifest variables (gender, age, education level, type of faculty). Age was measured on a continuous scale, whereas the other demographics were defined as categorical variables. Furthermore, factors were measured using 5 points Likert scale which ranged from strongly disagree (1) to strongly agree (5). Before data collection, the questionnaire was pre-tested among the students to measure its validity and reliability.

Data analysis

Descriptive analysis, such as frequencies, percentages, means and standard deviations, is calculated. Cronbach alpha test was used to analyze reliability of each construct of measurement instrument. A commonly accepted rule of thumb is that a Cronbach's alpha value of 0.6 is considered as acceptable reliability and 0.8 or higher illustrates good reliability [30]. Furthermore, the correlations between predictor variables were analyzed by Pearson correlation test. The strength of these relationships was determined as small when r value was ± 0.1 to ± 0.29, medium when r value was ± 0.3 to ± 0.49, and large when r value was ± 0.5 to ± 1.0 [31].

Structural equation modeling (SEM) was applied with two stage procedures to test fitness of the proposed model with gathered data [32, 33]. In first step, reliability and validity of measurement instrument were determined by confirmatory factor analysis (CFA) including construct reliability (CR), and average variance extracted (AVE). In second step, fitness of the proposed model and afterwards the relationships between independent and dependent variables were evaluated by SEM test. The model fit was examined based on the following indices: Comparative Fit Index (CFI), Goodness of Fit Index (GFI), Tucker-Lewis Index (TLI), Incremental Fit Index (IFI), Adjusted Goodness of Fit Index (AGFI), Root Mean Square Error of Approximation (RMSEA), $\chi 2$ (Chi square), $\chi 2/df$ (Chi square to degree of freedom ratio). Model fit is satisfied if AGFI value goes beyond of 0.80, the values of other indices exceed from 0.90, RMSEA value was less than 0.05, and $\chi 2/df$ value was between 2 and 5 [32].

A two-step clustering method was applied to classify the student into relatively similar groups based on the constructs of extended TPB: (1) Hierarchical cluster analysis using the Ward method to recognize the proper number of clusters, and (2) a K-means cluster analysis, giving more elaborative information on the cluster membership. The Ward's cluster analysis, after merging individuals into different subgroups generated three clusters. The K-means cluster analysis was applied due to having more acceptability than the hierarchical approach [29]. The variables of obtained clusters were statistically different from each other by K-means clustering. To determine the practical significance of the relation among subgroup membership and individual features, the effect size was computed [34, 35]. Eta-squared ($\eta 2$) was used to calculate the effect size. Based on the criterion suggested by Cohen [34], eta-squared values can be interpreted as small (0.01), medium (0.06) and large (0.14) effect sized. One-way analysis of variance (ANOVA) and chi square (X^2) tests were used to compare cluster groups for continuous and categorical variables, respectively. Crosstab analyses were also applied to evaluate the between-group differences in the demographic characteristics. Finally, discriminant analysis was utilized to validity grouping determined by cluster analysis. The data were statistically analyzed using the AMOS 24.0 and SPSS 22.0 software packages.

Results

Respondents' demographic information

The socio-demographic characteristics of the participants are summarized in Table 1. A total of 420 students participated in this study, among which 63.3% of them were female and the remaining (36.7%) were male. A majority of the respondents (71%) was within the age group between 20 and 24 years, and only 1.7% of them were older than 34 years.

Table 1 Demographic characteristics of the participants

Factor	SD	Frequency, *n*	Percentage, %
Age			
> 19	2.84	53	12.6
20–24		298	71.0
25–29		51	12.1
30–34		11	2.6
34^{+}		7	1.7
Gender			
Male	0.482	154	36.7
Female		266	63.3
Level of education			
Associate	0.68	16	3.8
Bachelor		309	73.6
Master		56	13.3
Doctorate		39	9.3

Most of the survey respondents (73.6%) were undergraduate students.

The Pearson correlation was used, to analyze the relationship among the influencing factors on students' intention of waste source separation. The correlation is able to discover strength and direction of a linear relationship between dependent variables (intention and behavior) and independent or predictor variables. Table 2 presents the correlation and descriptive statistic results. It indicates that independent variables including attitude ($r = 0.524$), subjective norm ($r = 0.127$), perceived behavioral control ($r = 0.246$), environmental knowledge ($r = 0.467$), moral obligation ($r = 0.549$), situational factors ($r = 0.112$), and motivation ($r = 0.406$) have a significant positive relationship with intention. The attitude and the moral obligation were strongly correlated with waste source separation intention. However, the environmental knowledge and the motivation display moderate, and other variables show small correlations.

Measurement model: reliability and validity

CFA was conducted using maximum likelihood estimation (MLE) to evaluate the goodness of fit of measurement model and to construct validity. The calculated fit indices of the model for CFI, GFI, IFI, TLI, RMSEA, CMIN/*df*, and AGFI were 0.937, 0.907, 0.938, 0.926, 0.039, 1.641, and 0.883, respectively. Based on CFA findings, it was recognized that the values of fit indices are more than the recommended common acceptance levels [32]. Thus, it can be concluded that the measurement model showed good fit with the gathered data.

The results of internal reliability and convergent validity among items were summarized in Table 3. The results of Cronbach's alpha reliability analysis showed that coefficient values for attitude, subjective norm, perceived behavioral control, environmental knowledge, responsibility, situational factors, motivation, and for intention and behavior were 0.8, 0.74, 0.66, 0.74, 0.77, 0.63, 0.7, and 0.8, respectively. Furthermore, the survey indicates sufficient reliability in the range of 0.64–0.8 values. Additionally, composite reliability demonstrates a degree to which the observed variables display latent variables. The construct reliability of all items ranges from 0.7 to 0.795, exceeding the recommended threshold of 0.6 [36]. As a next step, convergent validity of the items was examined by AVE. Table 3 shows that all AVE values are above 0.5, which indicate that the latent variables have good validities [32].

Table 2 Descriptive statistics and correlations of extended TPB constructs

Predictor variables	(A)	(SN)	(PBC)	(EA)	(MO)	(SF)	(M)	(I)	(B)	Mean	SD
Attitude (A)	–									17.2	2.29
Subjective norm (SN)	**0.27	–								12.7	2.96
Perceived behavioral control (PBC)	**0.31	**0.21	–							15.1	2.54
Environmental awareness (EA)	**0.497	*0.112	**0.2	–						21.8	2.4
Moral obligation (MO)	**0.527	**0.31	**0.28	**0.51	-					19.7	2.71
Situational factors (SF)	0.053	0.066	**0.134	0.074	-0.034	-				19.8	3.45
Motivation (M)	**0.34	*0.1	**0.11	**0.38	**0.35	**0.129	-			8.34	1.35
Intention (I)	**0.524	**0.127	**0.246	**0.467	**0.549	*0.112	**0.406	-		16.5	2.35
Behavior (B)	**0.163	**0.33	**0.218	**0.12	**0.33	*0.09	0.06	**0.16	-	16.41	2.44

*Significant at $P < 0.05$

**Significant at $P < 0.01$

Table 3 TPB constructs and their validity and reliability

Constructs	Reliability coefficient	CR	AVE	Item	Number of item	Source
Attitude	0.8	0.795	0.69	4	I am interested in waste separation at university	[13]
					In my opinion, waste separation at university is an interesting activity	
					I think waste separation at university is essential	
					Waste separation at university needs to be further promoted in Iran	
Subjective norm	0.74	0.72	0.62	4	People who are important to me (friends, teachers and classmates) expect that I do waste separation	[13]
					The society in which we live expects that the students should separate their trash	
					My university criticizes me, if I do not do waste separation	
					My community criticizes me, if I do not do waste separation	
Perceived behavioral control	0.71	0.7	0.57	4	The decision to separate waste is dependent on me	[13]
					Waste separation at university is an easy task for me	
					I separate my waste, regardless of if the university has incentives for it or not	
					If I want, I can separate waste at the university	
					Lack of practical knowledge about methods of waste separation, makes it difficult for me	
Environmental awareness	0.74	0.71	0.62	5	Waste separation has economic benefits	[4]
					I believe that lack of appropriate waste management is a threat to my health and other students	
					I believe that overproduction of waste and improper disposal in landfills, causes serious environmental problems	
					I believe that the risks associated with the waste problems are real and serious	
					Waste separation reduces environmental pollution	
Moral obligation	0.77	0.79	0.66		I think I am responsible for the waste, which is produced at the university	[4]
					If I do not separate waste properly, I feel guilty	
					I would like to separate waste due to the sense of responsibility for environmental protection	
					I believe everyone (students, stuffs, and teachers) at university has a duty to perform and should do what they can do to reduce environmental pollution results from waste	
Situational factors	0.63	0.73	0.7	5	Lack of waste separation bins on campus has caused waste separation to be difficult	[13]
					Inadequate waste separation bins on campus has caused waste separation to be difficult	
					Inconveniency and unavailability of recycling bins affect my behavior	
					I do not have time to separate waste at university	
					All the people at university should collaborate to improve waste separation	
Motivation	0.73	0.71	0.59		The university should provide exciting incentives for waste separation	
					The university should spend the profit from waste separation for the reconstruction of green space	
					Giving awards and acknowledgments by authorities has caused me to separate waste	

Table 3 (continued)

Constructs	Reliability coefficient	CR	AVE	Item	Number of item	Source
Intention	0.8	0.76	0.66		I plan to separate waste on a regular basis at the university, if there is a recycling bin	[13]
					I plan to participate in waste separation at the university, if the authority provides convenient and available recycling containers	
					I would like to separate waste, if I am acquainted with the benefits and importance of waste separation	
					I plan to separate waste at university, if authorities provide the appropriate services for recycled materials collection	
Behavior	0.71	0.7	0.58		I regularly recycled paper or other parts of the waste and put it in the recycling bin at university	[13]
					I am always trying to generate much less waste at the university	
					I regularly recycle the recycling materials of waste and use them for other beneficial purposes	
					I have never recycle any parts of waste	
					I sometime recycle waste at university	

The structural model

Goodness of fit statistic and modeling comparisons

Because of good fit of measurement model, a structure model was used to determine goodness of fit statistics of the proposed theoretical structure. Seven models were independently tested to determine the contribution of each variable, which was introduced into TPB model. Besides, the simple models such as TRA and original TPB were analyzed and compared to others to assess their ability to explain recycling intention and behavior and fit statistics. As shown in Table 4, for all models, the results of SEM analysis yielded an acceptable model fit with data. In terms of model fit criteria, the TRA and original TPB model fit better than the full-extended TPB model due to lower AIC and BIC values. This result is in consistent with Shrestha and Burns [37], who reported that the extended TPB model has better explanatory power for hunting behavior when compared with the original TPB model. However, the goodness of fit indices of TRA were superior. In addition, the findings indicated that the full-extended model had superior explanatory power compared to others. The full-extended model indicates 81% of the variance in intention and 57% in source separation waste behavior, where it can be illustrated by independent variables. The results indicate a 28.6 and 1.3% increment in the explained variance of intention and behavior, respectively, compared to TPB model. For decades, researchers have attempted to expand TPB model by adding new constructs or modifying the paths to better recognize a wide range of human behavior in different aspect [37–43]. Consistent with these surveys, the results of current study indicated that the proposed extended TPB model has better explanatory ability for recycling intention (R^2 is 0.411) than the TPB model, (R^2 is 0.274). Therefore, the findings shows that the proposed extended model enhances the explaining of intention and it is consistent with previous studies [12, 39, 44–46].

It is good to mention that a smaller value of comparison criteria such as AIC and BCC indicates a better parsimony and a better fit of the model. However, this rule is applicable

Table 4 Fit statistics for TRA, original and constructs integrated TPB models

Models	Variance explained		Model fit indexes										
	R^2 intention	R^2 behavior	χ^2/df	χ^2	CFI	IFI	AGFI	GFI	TLI	RMSEA	AIC	BCC	ECVI
TRA	0.202	0.520	2.091	169***	0.953	0.953	0.924	0.949	0.939	0.051	247	250	0.590
Original TPB	0.524	0.557	1.906	293***	0.938	0.939	0.910	0.934	0.924	047	405	411	0.968
MO integrated	0.701	0.562	1.837	382***	0.943	0.944	0.899	0.924	0.931	0.045	518	526	1.237
EA integrated	0.613	0.457	1.697	327***	0.951	0.951	0.913	0.933	0.941	0.041	447	454	1.068
SF integrated	0.590	0.464	1.899	332***	0.938	0.939	0.907	0.930	0.925	0.046	444	450	1.060
M integrated	0.692	0.467	2.262	352***	0.916	0.917	0.899	0.925	0.898	0.055	460	466	1.100
Total constructs	0.861	0.569	1.68	724***	0.931	0.932	0.910	0.935	0.921	0.04	982	1004	2.34

***Significant at α level of 0.001

when the key objective is to predict behavioral intention. On the other hand, if the key objective is to explain behavioral intention, the *R*-squared value (proportions of variance) would be preferable [47]. In the present study, according to comparative fit indexes, the TRA model fitted better than full-extended TPB. However, regarding the proportions of variance explained, the extended TPB more fully explains students' intention to source separation of waste than TRA and original TPB models. Such contradiction could be extensively found in literature [47–49].

According to a rough rule of thumb for interpreting practical importance in behavioral sciences is that R^2 values of 0.75, 0.50, or 0.25 for endogenous latent variables can be described as substantial, moderate, or weak, respectively [50]. The substantial result of R^2 for extended TPB model makes it clear that this model is explaining a larger part of the variance in behavioral intention. While TRA and original TPB were able to explain the recycling intention of students weakly and moderately.

Hypothesis testing

Path analysis is conducted to determine dependencies between a set of variables and to evaluate the survey's hypotheses (Figs. 1, 2; Table 5). A closer examination displays that all TPB variables including perceived behavior control, subjective norm, and attitude that explain the waste separation behavior, support the hypothesis entirely 4. There are comparable results with previous researches because of diverse culture and waste management infrastructure [13, 15,

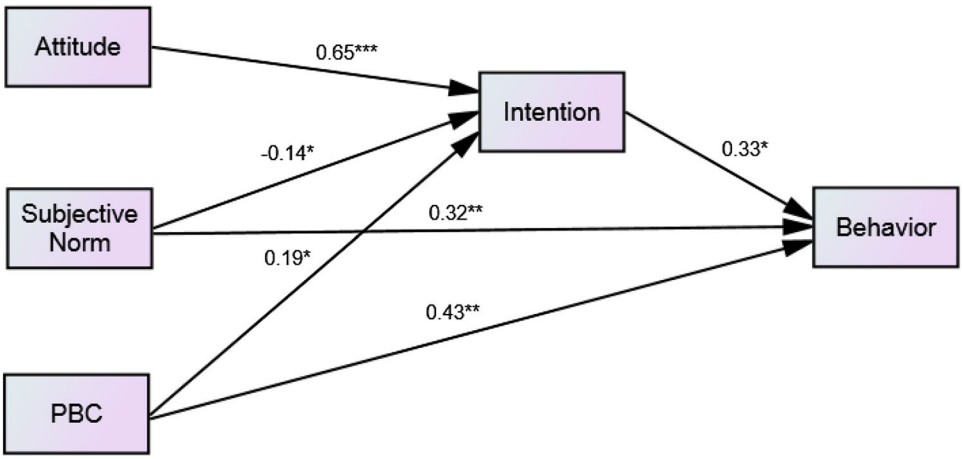

Fig. 1 The results of path analysis with standardized coefficients for TPB model

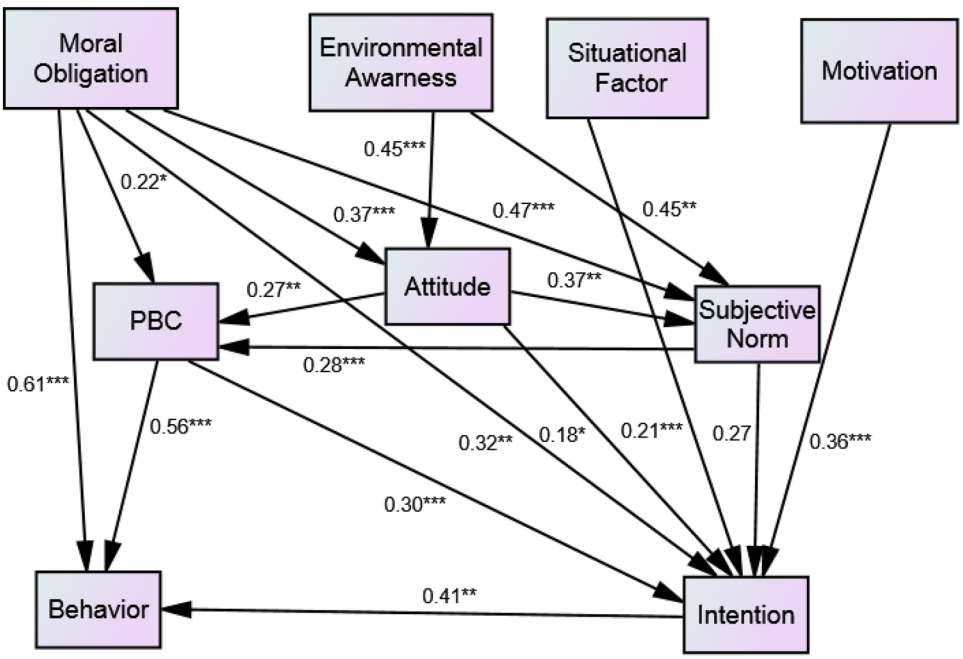

Fig. 2 The results of path analysis with standardized coefficients for extended TPB model

Table 5 SEM results of extended TPB model

Path	Coefficients (β)	Direct effect	Indirect effect	Total effect	t value	R
Moral obligation → attitude	0.366	0.366	–	0.366	4.020***	0.575
Environmental awareness → attitude	0.452	0.452	–	0.452	4.634***	
Moral obligation → subjective norm	0.471	0.471	0.135	0.606	3.620***	0.260
Attitude → subjective norm	0.369	0.369	–	0.369	2.959**	
Environmental awareness → subjective norm	−0.451	0.451	0.167	−0.284	−3.057**	
Subjective norm → perceived behavior control	0.280	0.280	–	0.280	3.306***	0.393
Attitude → perceived behavior control	0.271	0.271	0.103	0.374	2.606**	
Moral obligation → perceived behavior control	0.224	0.224	0.269	0.493	2.132*	
Motivation → intention	0.362	0.362	–	0.362	3.763***	0.861
Subjective norm → intention	−0.266	−0.266	0.085	−0.181	−3.868***	
Perceived behavior control → intention	0.304	0.304	–	0.304	3.525***	
Moral obligation → intention	0.315	0.315	0.056	0.372	3.260**	
Attitude → intention	0.184	0.184	0.016	0.200	2.272*	
Situational factors → intention	0.207	0.207	–	0.207	3.688***	
Intention → behavior	−0.406	0.406	–	0.406	2.949**	0.57
Perceived behavior control → behavior	0.559	0.559	0.123	0.435	3.930***	
Moral obligation → behavior	0.608	0.608	0.125	0.733	3.927***	

16, 18, 51, 52]. The extra constructs comprising situational factor ($\beta = 0.207$, $p < 0.001$), motivation ($\beta = 0.362$, $p < 0.001$) and moral obligation ($\beta = 0.315$, $p < 0.01$) also are related to the intention. Therefore, the hypothesis 3 and 5 are supported. This finding confirms Largo-Wight et al. [52] and Pakpour et al. [16] results. It is necessary to mentioned that among all variables, the motivation was the most descriptor of intention, thereby hypothesis 6 is rejected. Additionally, the environmental awareness ($\beta = 0.452$, $p < 0.001$) and the moral obligation ($\beta = 0.366$, $p < 0.001$) have a significant positive effect on the attitude towards waste sorting, which supports the hypothesis 1, respectively, same as Ramayah et al. [18]. Also, the moral obligation ($\beta = 0.471$, $p < 0.001$) and the environmental awareness ($\beta = 0.451$, $p < 0.01$) are positively linked to the subjective norm. Furthermore, the perceived behavior control ($\beta = 0.559$, $p < 0.001$) and the moral obligation ($\beta = 0.608$, $p < 0.001$) were correlated with recycling behavior. Thus, the hypothesis 7 and 8 are also supported, respectively, same as [15, 53, 54]. Finally, the situational factor related to the recycling intention, supports hypothesis 9, which is consistent with Latif et al. [55].

Cluster analysis

Cluster analysis was utilized as an exploratory statistical method to specify whether the constructs of the extended TPB could characterize and distinguish heterogeneous subgroups. Table 6 shows the characteristics of three-cluster solution. These clusters were labeled based on the calculated mean of behavior variable. This is because the statements of behavior construct directly indicated the times of doing waste source separation by respondents. So, the first cluster was considered as moderate recyclers, as it had a mean of 19. Cluster 2 presented the lowest mean (16) and

Table 6 Analysis of variance of extended TPB constructs for the three clusters

Construct	Mean value of cluster			df	F	Sig	$\eta 2$
	1 ($n = 117$)	2 ($n = 165$)	3 ($n = 138$)				
Attitude	19.00	7.00	20.00	2	108.350	0.00	0.35
Subjective norm	9.00	13.00	20.00	2	51.045	0.00	0.19
Perceived behavioral control	16.00	8.00	20.00	2	43.215	0.00	0.11
Environmental awareness	25.00	17.00	24.00	2	90.378	0.00	0.33
Moral obligation	19.00	18.00	22.00	2	136.111	0.00	0.43
Situational factors	6.00	21.00	30.00	2	185.210	0.00	0.006
Motivation	10.00	5.00	8.00	2	21.573	0.00	0.1
Intention	14.00	10.00	18.00	2	77.082	0.00	0.26
Behavior	19.00	16.00	25.00	2	27.701	0.00	0.1

was identified as low recyclers. Cluster 3 displays the maximum mean (25) and was identified as high recyclers. The number of participant in each cluster was as follow; low recyclers ($n = 117$, 27%), moderate recyclers ($n = 165$, 39%), and moderate recyclers ($n = 138$, 32%). As can be seen from Table 6, there were significant differences between the three clusters on the TPB constructs. Attitude (0.35), subjective norm (0.19), moral obligation (0.43), environmental awareness (0.33), and intention (0.26) represented a large effect size. Medium effect size was found for perceived behavior control (0.11), motivation (0.1), and behavior (0.1). Small effect was obtained for situational factor (0.006). ANOVA test confirmed that three clusters were notably different on all components of extended TPB model.

Differences among the three clusters from view of demographic characteristics were evaluated.

Their results were summarized in Table 7. From this table it can be seen that gender and faculty were statistically ($p < 0.01$) significant among the groups. No significant difference was found for other variables (education level and age). It is found that there is a significant division in the proportion of males and females within the cluster. Higher proportion of female was in the high recycler cluster, whereas more males were found in the low recycler cluster. According to the surveys of Owsus et al. [56], gender is an important factor in explaining recycling behavior. Although some of the studies were not consistent with this research. For example, Yau [57] found that gender of Hong Kong citizens do not have any role in waste source separation behavior.

A discriminant function analysis was performed to determine whether the constructs of extended TPB could perfectly explain recycling student group membership. It revealed two discriminant functions. Function 1 explained 60.7% of the variance, canonical correlation = 0.775 and function 2 explained 39.3% of the variance, canonical correlation = 0.702. The combination of these discriminant functions significantly differentiated the groups, Wilks Lambda = 0.202, $\chi^2 = 660$, $p < 0.001$. Eliminating the function 1 indicated that the second one also significantly differentiated the groups, Wilks Lambda = 0.507, $\chi^2 = 280$, $p < 0.001$. The structure matrix coefficients of the dependent variables and discriminant functions indicated that there is the largest absolute correlation between each variable

Table 7 Comparison of demographic characteristics of respondents between three clusters

Demographics	Cluster 1, *n*	Cluster 2, *n*	Cluster 3, *n*	X^2 (*df*)	*p* value
Gender					
Male	42	74	38	9.740 (2)	0.008
Female	75	91	100		
Education level					
Associate	5	8	3	8.055 (6)	0.234
Bachelor	90	125	94		
Master	13	21	22		
Doctorate	9	11	19		
Faculty					
Agriculture	7	9	19	46.545 (22)	0.002
Architecture	14	13	8		
Mathematical sciences	11	9	15		
Sport sciences	6	15	14		
Letters and humanities	10	17	8		
Education sciences and psychology	8	21	6		
Economics and administrative sciences	8	15	12		
Engineering	12	18	5		
Veterinary medicine	10	9	16		
Theology and Islamic studies	9	19	7		
Science	15	10	10		
Natural resources and environment	7	10	18		
Age					
> 19	16	18	19	4.621	0.797
20–24	80	119	99		
25–29	13	22	16		
30–34	4	4	3		
34+	4	2	1		

and function 1 as follows: moral obligation (0.659), attitude (0.584), environment awareness (0.525), followed by intention (0.494), subjective norm (389), perceived behavior control (0.344), to motivation (0.298) and behavior (0.296). Situational factor loaded strongly on function 2 ($r = 0.954$). The discriminant function plot displays that three clusters were sufficiently separated in discriminant function space (Fig. 3). Overall, 96.9% of original grouped cases are correctly classified.

Discussion

The purpose of the survey was to evaluate the ability TPB model has to describe FUM students' intention to separate waste at source and to examine influence of adding new constructs on explanatory power of TPB. The results of path analysis indicate that attitude, subjective norm, and perceived behavior control clarified 52.4% of the variance of recycling behavior, consistent with [18, 58–60]. Besides, surplus constructs including moral obligation, environmental awareness, situational factor, and motivation remarkably enhanced the explanatory power (based on the model fit and R) of the original model, same as results of [23]. Overall, the extended TPB is an impressive tool to explain intention and behavior for source separation of waste, describing 81 and 57% of variations, respectively.

Based on the results from SEM, motivation plays a fundamental role in FUM students' recycling intention where it was the most descriptor of intention, followed by moral obligation. The results recommended that the authorities should develop different types of reward strategies to increase the students' intention for source separation of waste. Moreover, moral obligation was found to be the strongest descriptor of recycling behavior, consistent with [10, 61]. Furthermore, the findings display that the participants' environmental awareness and moral obligation are correlated to attitude towards source separating of waste, same as [18]. It is needed to mention that elements such as public campaigns and educations increase people's knowledge about recycling and encourage intention for source separation of waste [20, 62, 63].

In summary, this study presents a theoretical framework based on TPB examining recycling intention and behavior among an academic community. Its results confirmed many previous findings [8, 13, 16, 18] and exhibited that three constructs of TPB (attitude, subjective norm, and perceived behavior control) could explain recycling intention. Furthermore, new descriptive variables, for instance, moral obligation, environmental awareness, situational factor, and motivation, were identified to improve the expletory ability of TPB.

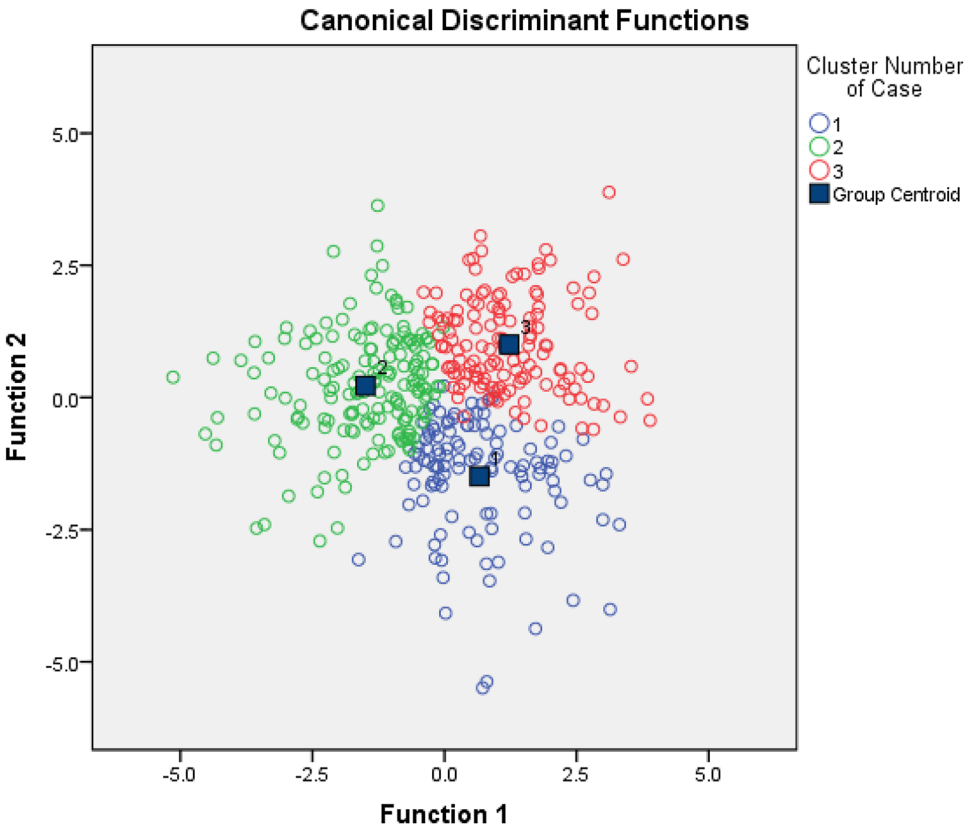

Fig. 3 Scatter plot of three clusters in discriminant function space

These constructs have direct and indirect influences on recycling behavior. It is that if the respondents have a high level of environmental awareness and moral obligation, they will have attitudes that are more desirable and have intentions towards separating waste at source.

Implication and limitation

Currently, many efforts have been made in policy making and implementation to achieve sustainable waste management through 3R. Individual's participation is the main element in successful source separation of waste. The survey's findings have critical implications for decision-making to develop appropriate strategies and implement recycling programs. Data analysis revealed that people who have positive recycling attitudes, have more environmental awareness and the sense of responsibility. Thus, the officials should enhance public knowledge and morality in various ways, for example, campaigns, media, and education. Furthermore, the factor of motivation was recognized as the best descriptor of recycling intention. In this regard, giving reward (such as economic incentives, and lottery ticket) could encourage individuals to participate in source separation of waste [56, 64, 65]. Therefore, the government should consider reward strategies and schemes for promoting waste separation. The results also recommend that situational factor has a positive effect on recycling intention. Accordingly, availability and sufficiency of recycling bins are main factors in engaging public in source separation of waste, and consequently, lack of necessary infrastructures is a major obstacle to recycling [55, 66, 67]. Therefore, the government, and here FUM, must provide and improve facilities for recycling. Finally, demographic characteristic such as gender and academic discipline of youth are the relevant parameters that authorities should consider in the promotion of waste separation plans.

There are some limitations, which should be acknowledged when the findings are interpreted. First, the theoretical models were tested in the university context in Iran, with the aim to assess the intention to separate waste at source and its influencing factors in the society. Therefore, it seems that one cannot extend the results to other communities. Second, based on the results, the extended TPB provided to be a useful framework for examining intentions toward source separation of waste. In contrast, it has lower predictive power than TRA and original TPB. Finally, a wider variety of variables (e.g., personal characteristics, financial incentive) can be included in the extended TPB model. These efforts would help to increase the power of prediction and understanding the intention towards source separation of waste.

Conclusion

Engagement in source separation of waste is the most important factor in recycling programs. This survey aimed to explore roles of influencing variables such as relationship among attitude, subjective norm, perceived behavior control, moral obligation, situational factor, motivation, environmental awareness, and intention in explaining the recycling behavior of FUM students. Based on the results of comparative fit indexes, the TRA and original TPB models fitted better than extended TPB. However, regarding the proportions of variance explained, the extended TPB more fully explained students' intention towards source separation of waste than original TPB model. The motivation was also the strongest descriptor of waste source separation intention, followed by moral obligation. It suggests that the authorities should encourage people, using economic incentives, to separate waste at source. Finally, the respondents stated that feedback after waste separation (such as reconstruction of green space by benefits of segregated waste) could motivate them to do it.

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References

1. Aja OC, Al-Kayiem HH (2014) Review of municipal solid waste management options in Malaysia, with an emphasis on sustainable waste-to-energy options. J Mater Cycles Waste Manag 16:693–710
2. Weng Y-C, Fujiwara T, Matsuoka Y (2009) Municipal solid waste management and short-term projection of the waste discard levels in Taiwan. J Mater Cycles Waste Manag 11:110–122
3. Ryan ER, Mark RB, Mark C, Gert-Jan de B, Navin K, Amy L-C (2014) Prediction of depot-based specialty recycling behavior using an extended theory of planned behavior. Environ Behav 47:1001–1023
4. Nguyen TTP, Zhu D, Le NP (2015) Factors influencing waste separation intention of residential households in a developing country: evidence from Hanoi, Vietnam. Habitat Int 48:169–176
5. Mahmud SND, Osman K (2010) The determinants of recycling intention behavior among the Malaysian school students: an application of theory of planned behaviour. Procedia Soc Behav Sci 9:119–124
6. Alavi Moghadam MR, Mokhtarani N, Mokhtarani B (2009) Municipal solid waste management in Rasht City, Iran. Waste Manag 29:485–489
7. McDougall FR, White PR, Franke M, Hindle P (2001) Integrated solid waste management: a life cycle inventory. Blackwell Science, London
8. Zhuang Y, Wu S-W, Wang Y-L, Wu W-X, Chen Y-X (2008) Source separation of household waste: a case study in China. Waste Manag 28:2022–2030
9. Zhang D, Huang G, Yin X, Gong Q (2015) Residents' waste separation behaviors at the source: using SEM with the theory of

planned behavior in Guangzhou, China. Int J Environ Res Public Health 12:9475–9491
10. Lam S-P (1999) Predicting intentions to conserve water from the theory of planned behavior, perceived moral obligation, and perceived water right 1. J Appl Soc Psychol 29:1058–1071
11. Chen M-F (2016) Extending the theory of planned behavior model to explain people's energy savings and carbon reduction behavioral intentions to mitigate climate change in Taiwan–moral obligation matters. J Clean Prod 112(Part 2):1746–1753
12. Yadav R, Pathak GS (2016) Young consumers' intention towards buying green products in a developing nation: extending the theory of planned behavior. J Clean Prod 135:732–739
13. Karim Ghani WAWA., Rusli IF, Biak DRA, Idris A (2013) An application of the theory of planned behaviour to study the influencing factors of participation in source separation of food waste. Waste Manag 33:1276–1281
14. Fishbein M, Ajzen I (1975) Belief, attitude, intention and behavior: an introduction to theory and research. Addison-Wesley, Reading
15. Ajzen I (1991) The theory of planned behavior. Organ Behav Hum Decis Process 50:179–211
16. Pakpour AH, Zeidi IM, Emamjomeh MM, Asefzadeh S, Pearson H (2014) Household waste behaviours among a community sample in Iran: an application of the theory of planned behaviour. Waste Manag 34:980–986
17. Loan LTT, Nomura H, Takahashi Y, Yabe M (2017) Psychological driving forces behind households' behaviors toward municipal organic waste separation at source in Vietnam: a structural equation modeling approach. J Mater Cycles Waste Manag 19:1052–1060
18. Ramayah T, Lee JWC, Lim S (2012) Sustaining the environment through recycling: an empirical study. J Environ Manag 102:141–147
19. Grodzińska-Jurczak M, Tomal P, Tarabuła-Fiertak M, Nieszporek K, Read AD (2006) Effects of an educational campaign on public environmental attitudes and behaviour in Poland. Resour Conserv Recycl 46:182–197
20. Sidique SF, Joshi SV, Lupi F (2010) Factors influencing the rate of recycling: an analysis of Minnesota counties. Resour Conserv Recycl 54:242–249
21. Chan L, Bishop B (2013) A moral basis for recycling: extending the theory of planned behaviour. J Environ Psychol 36:96–102
22. Malik NKA, Abdullah SH, Manaf LA (2015) Community participation on solid waste segregation through recycling programmes in Putrajaya. Procedia Environ Sci 30:10–14
23. Tonglet M, Phillips PS, Read AD (2004) Using the Theory of Planned Behaviour to investigate the determinants of recycling behaviour: a case study from Brixworth, UK. Resour Conserv Recycl 41:191–214
24. de Leeuw A, Valois P, Ajzen I, Schmidt P (2015) Using the theory of planned behavior to identify key beliefs underlying pro-environmental behavior in high-school students: implications for educational interventions. J Environ Psychol 42:128–138
25. Yadav R, Pathak GS (2016) Intention to purchase organic food among young consumers: evidences from a developing nation. Appetite 96:122–128
26. OEA (2016) Student population and demographics in office of education administration. Ferdowsi University of Mashhad, Mashhad
27. Cochran WG (1977) Sampling techniques. John Wiley, New York
28. A. I. (2002)Constructing a TpB Questionnaire: conceptual and methodological consider-ations, vol 17
29. Hasan SNMS., Harun R, Hock LK (2015) Application of theory of planned behavior in measuring the behavior to reduce plastic consumption among students at Universiti Putra Malaysia, Malaysia. Procedia Environ Sci 30:195–200
30. Francis J, Eccles MP, Johnston M, Walker AE, Grimshaw JM, Foy R, Kaner EF, Smith L, Bonetti D (2004) Constructing questionnaires based on the theory of planned behaviour. Man Health Serv Res 2010:2–12
31. Cohen J (1977) Statistical power analysis for the behavioral sciences. Elsevier, New York City
32. Hair JF, Anderson RE, Tatham RL, Black BC (2006) Multivariate data analysis. Pearson Education Inc, New York City
33. Anderson JC, Gerbing DW (1988) Structural equation modeling in practice: a review and recommended two-step approach. Psychol Bull 103:411–423
34. Cohen J (1988) Statistical power analysis for the behavioral sciences. Lawrence Erlbaum, NJ
35. Warner LA, Lamm AJ, Rumble JN, Martin ET, Cantrell R (2016) Classifying residents who use landscape irrigation: implications for encouraging water conservation behavior. Environ Manag 58:238–253
36. Bagozzi RP, Yi Y (1988) On the evaluation of structural equation models. J Acad Mark Sci 16:74–94
37. Shrestha SK, Burns RC (2016) Integrating constraints to the theory of planned behavior in predicting deer hunting participation. Hum Dimens Wildl 21:445–459
38. Bansal HS, Taylor SF (1999) The service provider switching model (SPSM): a model of consumer switching behavior in the services industry. J Serv Res 2:200–218
39. Han H, Kim Y (2010) An investigation of green hotel customers' decision formation: developing an extended model of the theory of planned behavior. Int J Hosp Manag 29:659–668
40. Kim YJ, Njite D, Hancer M (2013) Anticipated emotion in consumers' intentions to select eco-friendly restaurants: augmenting the theory of planned behavior. Int J Hosp Manag 34:255–262
41. Gao L, Wang S, Li J, Li H (2017) Application of the extended theory of planned behavior to understand individual's energy saving behavior in workplaces. Resour Conserv Recycl 127:107–113
42. Dunn KI, Mohr P, Wilson CJ, Wittert GA (2011) Determinants of fast-food consumption. App Theor Plan Behav Appet 57:349–357
43. Chen M-F (2017) Modeling an extended theory of planned behavior model to predict intention to take precautions to avoid consuming food with additives. Food Qual Prefer 58:24–33
44. Bansal HS, Taylor SF (1999) The service provider switching model (SPSM): a model of consumer switching behavior in the service industry. J Serv Res 2:200–218
45. Han H, Hsu L, Sheu C (2010) Application of the theory of planned behavior togreen hotel choice: testing the effect of environmental friendly activities. Tour Manag 31:325–334
46. Ryu K, Jang S (2006) Intention to experience local cuisine in a travel destination: the modified theory of reasoned action. J Hosp Tour Res 30:507–516
47. Huh HJ, Kim T, Law R (2009) A comparison of competing theoretical models for understanding acceptance behavior of information systems in upscale hotels. Int J Hosp Manag 28:121–134
48. Bai L, Tang J, Yang Y, Gong S (2014) Hygienic food handling intention. An application of the theory of planned behavior in the Chinese cultural context. Food Control 42:172–180
49. Lin M-L, Yu T-K (2018) Patent applying or not applying: what factors motivating students' intention to engage in patent activities. Eurasia J Math Sci Technol Educ 14:1843–1858
50. Hair J, Hult G, Ringle C, Sarstedt M (2013) A Primer on partial least squares structural equation modeling (PLS-SEM). Sage, Thousand Oaks
51. Georgina AM, Davis (2008) Using the theory of planned behaviour to determine recycling and waste minimisation behaviours: a case study of Bristol City, UK. Aust Community Psychol 20:105–117

52. Erin Largo-Wighta HBLL. (2012) An empirical test of an expanded version of the theory of planned behavior in predicting recycling behavior on campus. Am J Health Ed 43:66–73
53. Lee H-S (2016) Examining neighborhood influences on leisure-time walking in older Korean adults using an extended theory of planned behavior. Landsc Urban Plan 148:51–60
54. Jiang C, Zhao W, Sun X, Zhang K, Zheng R, Qu W (2016) The effects of the self and social identity on the intention to microblog: an extension of the theory of planned behavior. Comput Hum Behav 64:754–759
55. Latif SA, Omar MS, Bidin YH, Awang Z (2012) Environmental problems and quality of life: situational factor as a predictor of recycling behaviour. Procedia Soc Behav Sci 35:682–688
56. Owusu V, Adjei-Addo E, Sundberg C (2013) Do economic incentives affect attitudes to solid waste source separation? Evidence from Ghana. Resour Conserv Recycl 78: 115–123
57. Yau Y (2010) Domestic waste recycling, collective action and economic incentive: the case in Hong Kong. Waste Manag 30:2440–2447
58. Chan K (1998) Mass communication and pro-environmental behaviour: waste recycling in Hong Kong. J Environ Manag 52:317–325
59. Kelly TC, Mason IG, Leiss MW, Ganesh S (2006) University community responses to on-campus resource recycling. Resour Conserv Recycl 47:42–55
60. Andersson M, von Borgstede C (2010) Differentiation of determinants of low-cost and high-cost recycling. J Environ Psychol 30:402–408
61. Chen M-F, Tung P-J (2014) Developing an extended theory of planned behavior model to predict consumers' intention to visit green hotels. Int J Hosp Manag 36:221–230
62. Bratt C (1999) The impact of norms and assumed consequences on recycling behaviour. Environ Behav 31:630–656
63. Saphores JM, Nixon H, Ogunseitan OA, Shapiro AA (2006) Household willingness to recycle electronic waste: an application to California. Environ Behav 38:183–208
64. Timlett RE, Williams ID (2008) Public participation and recycling performance in England: a comparison of tools for behaviour change. Resour Conserv Recycl 52:622–634
65. Hong Kong Environmental Protection Department, Hong Kong Waste Reduction (2017) https://www.wastereduction.gov.hk/en/workplace/index_lookforland.htm
66. Bernstad A (2014) Household food waste separation behavior and the importance of convenience. Waste Manag 34:1317–1323
67. Dhokhikah Y, Trihadiningrum Y, Sunaryo S (2015) Community participation in household solid waste reduction in Surabaya, Indonesia. Resour Conserv Recycl 102:153–162