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Different Perceptions of Belief: Predicting Household Solid Waste Separation Behavior of Urban and Rural Residents in China

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Abstract: An unprecedented Household Solid Waste (HSW) separation program was launched in 46 cities and some pilot rural areas in China in 2019. This study examines the antecedents of waste separation behavior using the extended theory of planned behavior (TPB) to identify beliefs that are useful targets for interventions, and compares the urban-rural differences. Based on interviews with rural and urban residents, we identified residents' beliefs influencing waste separation behaviors, including four behavioral, seven normative, and eight control beliefs. Then, we tested the conceptual model with a two-stage questionnaire survey using a sample of 604 residents from urban and rural areas. Evidence from structural equation modeling supports the extended TPB in that it predicts waste separation intention and behavior on the whole. Moral norm and self-identity were found to independently predict intention and may prove a useful addition to the TPB; however, the path from attitude to intention is not supported in both urban and rural models. Moreover, the specific difference of belief between urban and rural residents was examined. The behavioral beliefs associated to money, including earning, free waste bin or bag, and fine, are significant only in the rural group. The normative beliefs of family, Chinese Communist Party (CCP) members, and government can affect residents' subjective norm in both urban and rural, while the beliefs of relatives, friends, and neighbors are significant only in the rural group. Implications for managers of operating waste separation programs were discussed. Further investigation into the potential of the model to intervene in waste separation behavior is required.

Keywords: waste separation; recycling; beliefs; urban-rural differences

1. Introduction

Municipal solid waste is one of the most serious problems confronting developing countries due to the conflicting development goals between rapid urbanization and the persistent craving for a cleaner environment. As one of the major sources of municipal solid waste, the increasing generation of household solid waste (HSW) has led to multitudes of environmental hazards such as waste siege, environmental degradation, water and soil pollution, and negative impacts on the quality of human life [1], to which most costs of municipal waste management are allocated [2]. Waste source separation is a critical component of a successful waste management system [3]. Besides this, it also is one of the most effective and economic ways to enhance the reuse and recycling rate of waste and to guarantee the quality of waste for the final disposal. The implementation of waste separation policy

depends on the change of residents' waste disposal habitual behavior. Some developed countries, such as Germany, UK, and Japan, have achieved success through 20–30 years' cultivation of public environmental awareness by social campaign and legislation. In contrast, the amount of garbage is rapidly increasing in many developing countries due to the rise of living standards and urbanization. On the other hand, because of the differences between urban and rural areas, lower income and lower educational level, and poor facilities of waste separation, the waste separation policies face great challenges. There is no doubt that the success of waste separation policy is strategically important for alleviating resources and sustainable development for them.

As the largest developing country, China has become the world's largest waste producer since 2004 [4] and the volume of waste removal has reached 228.02 million tons in China in 2018 [5]. Two-thirds of cities in China suffered "waste siege" [6]. Based on the experience of waste separation in eight cities since 2012, China launched a new mandatory waste separation campaign for 46 cities in 2018 by local-government-led campaign with a huge investment of resources along with legislation and management regulations [7]. The Ministry of Housing and Urban-Rural Development of China has set the goal of improving household waste management, with an implementation of mandatory separation of household solid waste in 46 cities, aiming at the recycling rate of household solid waste to exceed 35% by 2020. With an initial success after one year [8], this policy is expanding to 220 cities and rural districts in 2020.

However, in order to further facilitate and improve the waste separation program countrywide, several issues need to be addressed. Firstly, it is expensive to maintain the waste separation program because it requires a significant involvement from community officials, sanitation workers, and volunteers to participate and supervise. Secondly, the accuracy and participation rate of waste separation is still low in many cities in China. The project of waste separation in some communities did not yield a positive outcome after a period of processing time due to the lack of residents' engagement. It may be that some communities only focus on the publicity but ignore the importance of the residents' commitment or effective supervision [9]. Thirdly, it is still in question if the experience of waste separation policy in the pilot areas can be generalized. The vital factor that determines the sustainability of the waste separation problem is residents' participating behavior. As individual behaviors are mainly affected and dominated by psychological factors, it is necessary to identify the internal and external factors accountable for waste separation behavior. Little empirical studies have investigated resident perception and beliefs that are related to waste separation behaviors from a solid theoretical perspective.

The theory of planned behavior (TPB) is widely used to explain behaviors over which people may have limited volitional control [10]. The TPB argues that behaviors stem from individual perceived behavioral control and intention; then, the behavioral intention depends on three direct predictors, which include attitude, subjective norm, and perceived behavior control [11]. Attitude toward the behavior refers to the extent of an individual's positive or negative evaluation of behavior in question. Subjective norm is a person's perceived social pressures on whether to perform a particular behavior. In addition, a person's perception of how easy it is to perform can affect whether they are willing to perform it. Therefore, perceived behavioral control is the direct antecedent of behavior, and it predicts and explains intention. It explains human behavior and allows researchers to identify the determinants of environmental behavior and subsequently target these factors in interventions [12].

However, the applicability of TPB to predict pro-environmental behavior requires further examination. First, the completeness and efficiency of the TPB for predicting pro-environmental behavior not only depends on three direct predictors: attitude, subjective norm, and perceived behavioral control, but also is influenced by behavioral, normative, and control beliefs that commonly called indirect predictors [12,13]. When performing a behavior, the belief associated with the behavior in question is activated, which is called salient beliefs. Fishbein and Ajzen argue that such beliefs are important for behavioral intervention; by changing the salient beliefs, it should be possible to change global attitudes and intentions, and in turn, influence actual behavior [14]. These beliefs contain outcomes (behavioral beliefs), social pressures (normative beliefs), and facilitating/inhibiting factors

(control beliefs) associated with household separation behavior. The assessment of indirect predictors requires a qualitative exploration of factors that influence a given behavior because these beliefs vary from one context to another [15]. The previous research on waste separation behavior has largely overlooked underlying beliefs that eventually affect resident behavior.

Second, the TPB, as a rational-choice model, has been criticized for neglecting moral consideration, and the correlation between attitudes and intention in waste separation and recycling behavior has been questioned [16]. Residents do not participate in recycling behavior, even if they have high environmental attitudes and values [17,18]. White et al. also emphasized the “attitude-behavior gap” in the review of sustainable consumer behavior [19]. Although Ajzen and Fishbein abstain moral considerations [20], in the interest of the collective good, moral beliefs significantly contribute to the understanding of intention [21]. Waste separation behaviors require the individual to restrain egoistic tendencies for collective interests [22]. Stern et al. suggest that one such motive of environmental protection is provided by a judgment that pollution is, to put it bluntly, morally wrong [23]. The beliefs about how environmental hazards should be handled are based on moral judgments made by residents or organizations producing hazardous substances or regulating their use and disposal. Therefore, Kaiser and Scheutle found that TPB should be extended into the moral domain to improve the explanatory power for conservation behavior [24].

Third, previous studies also indicated that the subjective norm component of the TPB framework rarely contributes to the prediction over and above the effects of attitude and perceived behavioral control [25,26]. Poor measurement or overly narrow conceptualization of the subjective norm component may account for its lack of predictive validity. Armitage and Conner argue that the normative component includes both an internally reliable measure of subjective norm and a measure of self-identity [26]. Self-identity is defined as the salient part of the actor’s self that relates to a particular behavior. It may be regarded as the extent to which the actor sees him- or herself as fulfilling the criteria for a particular societal role. Self-identity reflects the internalization of external norms, which is another important psychological mechanism to explain the pro-environmental behavior [27].

Accordingly, this study integrates existing conceptualization and findings into an extended TPB framework, which incorporates the underlying beliefs, extended self-identity, and moral norm in predicting waste separation behavior (Figure 1).

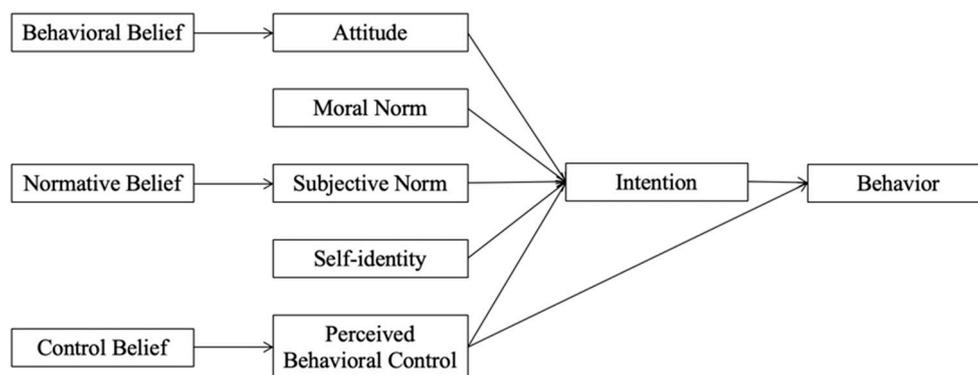


Figure 1. Extended Theory of Planned Behavior.

In addition, previous studies also suggested that waste separation behavior is affected by social and demographic variables. In the context of China, where this study is conducted, rural-urban differences mean the differences in residential type, age structure, incomes, and educational level. With the development of China’s economy, rural young people have been converging to cities over the past decades. This has led to a large proportion of elderly people in rural areas [28]. Meanwhile, the difference in employment opportunities makes many people with a high educational level choose to stay in the cities. It has also led to higher incomes for urban residents [29]. On the other hand, due to differences in social policies and space constraints, rural residents are more likely to live in

bungalows, and urban residents are more likely to live in apartments. All of these factors contribute to differences between urban and rural residents in terms of waste separation behavior. Considering this program has also been tried in the rural district, our research investigated urban residents' and the rural dweller's household waste separation behavior simultaneously and discussed the differences in their waste separation behaviors. Therefore, the following research questions were developed for this study.

1. What is the relationship between beliefs and psychological factors (attitude, subjective norm, and perceived behavioral control)? Can the TPB predict the residents' waste separation behaviors?
2. Which factors have a significant effect on household solid waste separation behavior? To what extent do these factors predict waste separation behavior?
3. How do urban and rural waste classification behaviors differ?

In this study, in order to comprehensively understand the psychological mechanisms and external factors of household waste separation behavior, we integrated the direct predictors and indirect predictors of attitudes, subjective norms, perceived behavioral control, and extended moral norms and self-identity into TPB model, to examine the relationship between psychological factors and resident's waste separation behavior. Presented in the following sections, we first described the methodology and conducted the data analysis, and then, the results of this study provide theoretical support for the policy formulation of urban and rural household waste separation programs in China. Finally, we posted the conclusions and pointed out management implications, research limitations, and future research directions.

2. Methods

2.1. Elicitation of Beliefs

The purpose of elicitation of beliefs is to get the items of residents' waste separation beliefs, because the beliefs vary with the environment and groups. Beliefs were obtained through qualitative interviews. As a rule of thumb, the pilot study should include a sample of 25 to 30 participants of the general research population [30]. We recruited 24 participants for semi-structured qualitative interviews between August 10 and 20, 2019. They are from urban and rural in eastern China (13 in urban and 11 in rural district). Urban participants were randomly selected from a community in Hangzhou, and rural participants were selected from Jinhua, Zhejiang. All of these areas were already promoting waste separation practices. Each interview lasted about 20 min. After completing a short introduction, everyone was asked if their community has implemented waste separation. The questions related to positive or negative outcomes, social influences, and facilitating or inhibiting factors associated with waste separation behavior.

During the interview, the answers from each participant were recorded, and subsequently, two master students converted the recordings into text. After encoding, the two master students extracted the keywords respectively based on the three belief categories (behavioral belief, normative belief, and control belief). Content analysis of the interviews resulted in four behavioral beliefs, seven normative beliefs, and eight control beliefs being included in the TPB questionnaire (Table 1).

Table 1. Beliefs for waste separation behavior.

Category	Beliefs
Behavioral beliefs	Earnings, resources conservation, environmental protection, social progressing
Normative beliefs	Family, friends & relatives, neighbors, Chinese Communist Party members, cleaners, community, government
Control beliefs	Knowledge, time, storage space, publicity, convenience, feedback, free waste bin or bag, fine

2.2. Measurement

The beliefs of residents' waste separation behavior came from the pilot study. According to the TPB [11,31], each belief is constituted by two dimensions. Behavioral beliefs include behavioral belief strength and outcome evaluation. Descriptive normative beliefs include descriptive normative belief strength and identification with the referent. Injunctive normative belief includes injunctive normative belief strength and motivation to comply. Control belief is constituted by control belief strength and power of control factor. The multiplicative term of the two dimensions was used as the final data for the belief in each sample based on the TPB [11,32].

Otherwise, all of the items in TPB (attitude, subjective norm, perceived behavioral control, behavioral intention, and actual behavior) were based on maturity scales [26,31,33,34]. The extended variables (moral norm and self-identity) refer to White and Hyde [35] and Botetzagias et al. [36]. Seven-point bipolar adjective scales were used in all items of the two-stage questionnaire. The complete scales are available in Appendix A.

2.3. Sample and Data Collection

All the samples were selected in eastern China because, up until now, only the rural in eastern China implemented the HSW separation. All community samples were selected randomly from the community database and then we selected residents randomly in the community. The formal survey was conducted from 20 November 2019, to 5 January 2020. The urban survey was conducted in the community of Shanghai and Hangzhou, and the rural survey was conducted in the rural areas of Zhejiang and Shandong province.

Because behavioral intention can only be a future intention ("next week" in this study, detailed in Appendix A), the actual behavior can only be the past behavior that was expressed by respondents. The survey was conducted two times in this study [34]. First, the community questionnaire in the first survey includes all the items except two items for actual behavior, and the participants need to write down their phone numbers at the end of the questionnaire. To ensure the quality of the questionnaire, we used the home visit method in the first survey. Second, the investigators called the participants after a week and asked two questions about their actual waste separation behavior in the past week. If they completed both surveys, they could get 20 RMB (15 RMB cash in the first survey and 5 RMB by Alipay or WeChat in the second survey).

3. Results

3.1. Descriptive Statistics

About 1300 questionnaires were distributed by home visit in the first survey, then the questionnaires were collected after 30 min. We received a total of 941 questionnaires fully completed. In the second step, we got in touch with the participants by telephone to finish the second part of the survey. Finally, only 604 respondents ($N_{\text{urban}} = 307$; $N_{\text{rural}} = 297$) were considered valid after completing both surveys (The original data is placed in Supplementary Materials (Table S1)).

Demographics (Table 2) consist of gender, age, education level, and monthly household income. The study uses family income as the indicator of income level because the income of most Chinese family members is shared with other family members [37]. The demographics show that rural residents are older than urban residents and that urban residents have higher education and household income than those of rural residents. This reflects the actual demographic characteristics of residents in urban and rural areas that were surveyed [38].

Table 2. Demographics Analysis.

Characteristics	Categories	Urban (N = 307)		Rural (N = 297)	
		Frequency	%	Frequency	%
Gender	Male	138	44.95	148	49.83
	Female	169	55.05	149	50.17
Age	Below 18	7	2.28	7	2.36
	18–35	78	25.41	47	15.82
	36–50	157	51.14	65	21.89
	51–65	46	14.98	121	40.74
	Above 65	19	6.19	57	19.19
Education	No education	0	0.00	18	6.06
	Primary school	5	1.63	79	26.60
	Junior high school	20	6.51	103	34.68
	Senior high school	36	11.73	56	18.86
	Junior college	53	17.26	15	5.05
	Undergraduate	119	38.76	15	5.05
	Postgraduate or above	74	24.10	11	3.70
Household Income monthly (RMB)	Below 5000	12	3.91	41	13.80
	5000–10,000	37	12.05	165	55.56
	10,001–15,000	83	27.04	74	24.92
	15,001–20,000	60	19.54	10	3.37
	20,001–30,000	68	22.15	4	1.35
	Above 30,000	47	15.31	3	1.01

3.2. Reliability and Validity

Reliability, also known as consistency, is the ability to give nearly identical results in repeated measurements under identical conditions. Cronbach's α and composite reliability (CR) as reliability indicators are shown in Table 3. All of the reliability indicators are higher than 0.8 in the urban and rural samples, which indicates that each variable exhibited strong internal consistency.

Table 3. Reliability and convergent validity.

Variables	Items	Urban				Rural			
		Loadings	AVE	CR	α^1	Loadings	AVE	CR	α
Attitude	AT1	0.843				0.911			
	AT2	0.952				0.909			
	AT3	0.819	0.690	0.898	0.864	0.874	0.719	0.910	0.894
	AT4	0.689				0.674			
Moral norm	MN1	0.866				0.771			
	MN2	0.931	0.705	0.876	0.853	0.835	0.650	0.848	0.846
	MN3	0.705				0.812			
Subjective norm	SN1	0.924				0.974			
	SN2	0.925	0.874	0.954	0.954	0.932	0.895	0.963	0.962
	SN3	0.955				0.932			
Self-identity	SI1	0.783				0.851			
	SI2	0.889	0.709	0.879	0.873	0.888	0.773	0.911	0.908
	SI3	0.850				0.897			
Perceived behavioral control	PBC1	0.839				0.944			
	PBC2	0.879	0.730	0.890	0.884	0.959	0.874	0.954	0.952
	PBC3	0.845				0.900			
Behavioral Intention	BI1	0.906				0.910			
	BI2	0.911	0.815	0.898	0.940	0.908	0.849	0.944	0.946
	BI3	0.932				0.945			
Behavior	BE1	0.946				0.958			
	BE2	0.914	0.865	0.928	0.925	0.932	0.893	0.944	0.943

¹ " α " Stands for Cronbach's α .

Standard factor loadings and average variance extracted (AVE) were used in the analysis of convergent validity. Standard factor loadings ranged from 0.689 to 0.955 in the urban samples (from 0.674 to 0.974 in the rural samples). The AVE ranged from 0.692 to 0.874 in the urban samples (from 0.650 to 0.893 in the rural samples). All the indicators met the criteria of factor loadings as they were above 0.7 [39], and the average variance extracted exceeded 0.5 [40–42].

Discriminant validity refers to the difference between a construct and the other construct [39]. Generally, the square root of the AVE should be greater than the inter-construct correlation [43]. The matrix of correlation and the square root of AVE confirm the better discriminant validity in the urban and rural samples (Tables 4 and 5).

Table 4. Square root of AVE and correlation matrix (Urban).

Construct	AT	MN	SN	SI	PBC	BI	BE
AT	0.831						
SN	0.592	0.840					
PBC	0.326	0.405	0.935				
SI	0.474	0.803	0.448	0.842			
MN	0.601	0.709	0.389	0.686	0.854		
BI	0.474	0.686	0.441	0.712	0.627	0.903	
BE	0.375	0.547	0.353	0.569	0.490	0.809	0.930

Table 5. Square root of AVE and correlation matrix (Rural).

Construct	AT	MN	SN	SI	PBC	BI	BE
AT	0.848						
SN	0.667	0.806					
PBC	0.580	0.541	0.946				
SI	0.635	0.791	0.669	0.879			
MN	0.654	0.590	0.837	0.665	0.935		
BI	0.562	0.550	0.842	0.696	0.810	0.921	
BE	0.518	0.491	0.729	0.594	0.765	0.807	0.945

3.3. Analysis of Behavioral, Normative, and Control Beliefs

The relationship between indirect variables (beliefs) and direct variables (psychological variables) elicited in the pilot study was estimated using linear regression (SPSS 26.0). The results are shown in Table 6.

In both cases, the four behavioral beliefs account for the variance in attitudes (39.0% and 33.2% for urban and rural residents, respectively). In all the beliefs, environmental protection was the dominant determinant of attitude. Otherwise, the beliefs of social progressing are only significant in predicting attitudes in urban residents, and the beliefs of earnings to attitudes are supported only in rural residents.

The seven normative beliefs accounted for 30.5% of the variance in subjective norms in urban residents and 82.2% in rural residents. The belief components account for considerably more of the variance in rural residents' subjective norm than urban. Analysis of normative belief components revealed that subjective norm of rural residents is principally determined by the normative beliefs from families, friends, relatives, neighbors, Chinese Communist Party (CCP) members, and government. In contrast, the urban residents' subjective norms can only be influenced by the references of families, CCP members, and government. CCP members and family were shown to exert the greatest influence on both cases. The cleaners and community managers are ineffective in promoting household waste separation to residents in both urban and rural residents.

The control beliefs account for 40.4% (81.2%) of the variance in perceived behavioral control in urban (rural) residents, which means that control beliefs play an important role in residents' behavioral control, especially for rural residents. The estimated results about control beliefs indicated that the

control factors of knowledge and convenience have positive effects for predicting perceived behavioral control in both rural and urban residents. The effects of time and publicity are only significant for urban residents, and the control factors related to money, including providing waste bin or bag and fine, only affect rural residents' perceived behavioral control.

Table 6. Regression of beliefs on attitude, subjective norm, and perceived behavioral control (PBC).

Beliefs	Urban			Rural		
	SEB ¹	SE ²	Sig. ³	SEB	SE	Sig.
Behavioral beliefs: ($R^2_{\text{urban}} = 0.390$; $R^2_{\text{rural}} = 0.322$)						
Earnings	0.007	0.003	0.883	0.270	0.005	0.001 ***
Resource Conservation	0.046	0.005	0.510	0.049	0.008	0.613
Environmental protection	0.341	0.007	0.001 ***	0.325	0.009	0.004 **
Social progressing	0.284	0.005	0.001 ***	0.115	0.009	0.287
Normative beliefs: ($R^2_{\text{urban}} = 0.305$; $R^2_{\text{rural}} = 0.822$)						
Family	0.288	0.009	0.001 ***	0.242	0.007	0.001 ***
Relatives & friends	0.082	0.009	0.285	0.146	0.008	0.034 *
Neighbors	-0.129	0.009	0.109	0.183	0.008	0.007 **
CCP members	0.331	0.007	0.001 ***	0.235	0.007	0.001 ***
Cleaners	-0.060	0.008	0.391	0.015	0.007	0.586
Community	-0.067	0.011	0.401	0.112	0.008	0.104
Government	0.172	0.011	0.021 *	0.073	0.006	0.009 **
Control beliefs: ($R^2_{\text{urban}} = 0.404$; $R^2_{\text{rural}} = 0.812$)						
Knowledge	0.443	0.005	0.001 ***	0.136	0.007	0.005 **
Time	0.112	0.004	0.036 *	0.058	0.009	0.076
Storage Space	-0.033	0.004	0.510	0.017	0.009	0.633
Publicity	0.167	0.004	0.005 **	0.054	0.006	0.094
Convenience	0.130	0.004	0.014 *	0.146	0.007	0.010 **
Feedback	0.043	0.004	0.471	0.014	0.006	0.640
Free waste bin or bag	-0.064	0.004	0.214	0.515	0.007	0.001 ***
Fine	-0.053	0.003	0.289	0.140	0.007	0.014 *

¹ "SEB" stands for the standard estimated beta. ² "SE" stands for standard error. ³ "Sig." stands for significance. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

3.4. Extended TPB Analysis

The extended TPB model was estimated using Structural Equation Modeling (SEM, Amos 24.0) in this study. Goodness-of-fit indices evaluate whether the hypothetical path analysis model and the collected data are compatible with each other. The model fit of the overall structural equation modeling is a great indicator to predict model quality. Path coefficients, standard errors, and their significance for the integrated model are presented in Figure 2. The results suggest a good fit for the SEM model.

In the urban sample, $\chi^2_{\text{urban}} = 582.870$, $\chi^2/DF_{\text{urban}} = 3.389$, $CFI_{\text{urban}} = 0.931$, $GFI_{\text{urban}} = 0.852$, $IFI_{\text{urban}} = 0.932$, $RMSEA_{\text{urban}} = 0.088$. In the rural sample, $\chi^2_{\text{rural}} = 407.184$, $\chi^2/DF_{\text{rural}} = 2.367$, $CFI_{\text{rural}} = 0.966$, $GFI_{\text{rural}} = 0.878$, $IFI_{\text{rural}} = 0.966$, $RMSEA_{\text{rural}} = 0.068$. All of the model fit indicators are higher or closer to the relevant evaluation criteria [44], which suggests that the two models achieved a good fit to the data. The two models and their results were shown in Figure 2a (urban) and Figure 2b (rural).

Based on the results, the percentage of explained variance (R^2) of intention and behavior is 57.3% and 65.5% in urban residents, while it is 76.6% and 68.7% in rural residents. It shows that extended TPB can effectively predict household solid waste separation behavior in both urban and rural residents. In the prediction of waste separation behavior, the intention plays most crucial role in both urban and rural groups ($r_{\text{urban}} = 0.826$, $p < 0.001$; $r_{\text{rural}} = 0.544$, $p < 0.001$); however, the another predictor of behavior, perceived behavioral control, is significant only in the rural group ($r_{\text{urban}} = -0.041$, $p = 0.619$; $r_{\text{rural}} = 0.324$, $p < 0.001$). In addition, in the three original variables in TPB, the subjective norm

($r_{\text{urban}} = 0.118, p = 0.014$; $r_{\text{rural}} = 0.468, p < 0.001$) and perceived behavioral control ($r_{\text{urban}} = 0.158, p = 0.036$; $r_{\text{rural}} = 0.311, p < 0.001$) have effective impacts on waste separation intention, but the path from attitude to intention was not supported in both urban and rural models. Besides this, the moral norm and self-identity as the extended factors was tested in the integrated model, which shows that the self-identity are positive to intention of waste separation in both models ($r_{\text{urban}} = 0.361, p < 0.001$; $r_{\text{rural}} = 0.235, p = 0.002$), while the moral norm are only supported in the urban model ($r_{\text{urban}} = 0.209, p = 0.028$; $r_{\text{rural}} = -0.058, p = 0.430$) based on the SEM results. Overall, it is shows that the normative psychological variables, including subjective norm ($r_{\text{rural}} = 0.468, p < 0.001$) in the rural model and its internalized factor, self-identity ($r_{\text{urban}} = 0.361, p < 0.001$), as well in the urban model, play a key role in residents' HSW separation behavior.

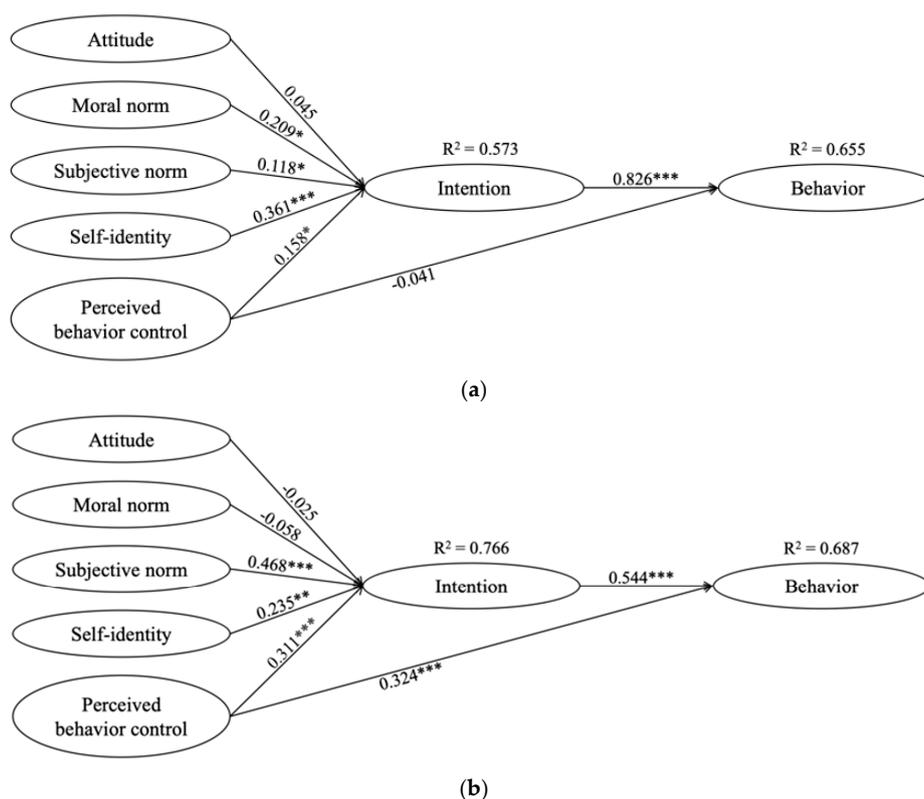


Figure 2. SEM result. (a) Urban model; (b) rural model. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

4. Discussion

This study provides evidence to support the utility of the extended TPB as a predictor of HSW separation behaviors. In particular, the beliefs identified might provide targets for future policy interventions. These inconsistently predicted attitudes, subjective norms, and perceived behavior control from underlying beliefs, suggesting that the antecedents of these variables require further investigation.

4.1. Determinants of HSW Separation Behavior

Overall, our findings showed that the extended TPB can explain a large amount of HSW separation behavior. First of all, there proved strong correlations between waste separation intention and behavior, which indicated that improving waste separation intention appears an effective means to make residents enact waste separation behavior. The waste separation intention was determined by five psychological variables, including three original factors in TPB and the two extended variables—moral norm and self-identity—in our conceptual model. Based on the results of SEM, the two normative components, subjective norm and self-identity, seem crucial in residents' HSW separation intention.

In particular, subjective norms ($r_{\text{rural}} = 0.468, p < 0.001$) are the most important factor for rural residents, and besides this, as the supplement of subjective norm and reflecting the internalization of external norms [27], self-identity ($r_{\text{urban}} = 0.361, p < 0.001$) appears the most critical factor in predicting urban residents' HSW separation intention. The results show the crucial role of normative components in residents' waste separation behavior and the differences between urban and rural: the urban residents' waste separation behavior is more likely to be affected by the internal normative component, i.e., self-identity, than that of rural residents. It also demonstrates that the citizens in Chinese cities have higher environmental concerns than the rural residents, same as Yu's study [45].

However, the above finding is not consistent with Taylor and Todd's result [46], in which intention is most strongly determined by attitudes, whereas the influence of subjective norms and perceived behavioral control (PBC) are relatively weaker. By contrast, the relationship between attitudes and waste separation intention ($r_{\text{urban}} = 0.045, p = 0.439$; $r_{\text{rural}} = -0.025, p = 0.636$) is not supported by both urban and rural residents. Xu et al. also found that attitudes did not predict the residents' waste separation behavior in China [37]. This result confirms the existence of the "attitude-behavior gap," the same as previous studies [17,18]. Meanwhile, same as many previous studies [36,47], the moral norm can influence the residents' HSW separation intention in urban residents, but it is inefficient in rural residents ($r_{\text{urban}} = 0.209, p = 0.028$; $r_{\text{rural}} = -0.058, p = 0.430$). A possible interpretation of this might be that the waste separation program is mainly promoted by the force of the government in Chinese rural areas. The rural residents' environmental awareness and moral responsibility have not been fully established. So, they are more influenced by subjective norms, PBC, and self-identity than by their attitudes and moral norm.

In addition, perceived behavioral control, the third factor in the original TPB model, has a positive effect in predicting waste separation intention in both urban and rural groups, which is consistent with many previous findings [48–50]. It means that the PBC can be affected by some external measures, thereby changing the waste separation intention and behavior. However, the direct effect of PBC on waste separation behavior is only supported in the rural model ($r_{\text{rural}} = 0.324, p < 0.001$), which is partly consistent with Armitage and Conner's [26] and Soorani and Ahmadvand's [51] findings that behavioral control is the second determinant of behavior to the extent that perceptions of control reflect actual control, and when one acts, the PBC should directly influence behavior. This relationship is not significant in the urban sample ($r_{\text{urban}} = -0.041, p = 0.619$), which means that the inhibiting/facilitating factors associated with the waste separation behavior has minor direct influence. Urban residents are more likely to consider waste separation under the volitional control on the whole, and the separation behavior depends more on how willingly they are motivated to classify.

4.2. Predictors for Attitudes

Table 6 presents the correlations between behavioral beliefs and attitudes, which indicate that the four behavioral belief items account for 39.0% (32.2%) of the variance in attitudes in urban (rural) residents. Environmental protection influenced attitudes the most, which suggests that the benefits to society have a greater influence on attitudes toward waste separation behavior than the benefits to individuals. Furthermore, the belief of social progressing is significant in urban areas but not in rural areas, while the relationship between earnings and attitudes toward waste separation is supported only in rural areas. Perhaps the reason rural residents are more sensitive about money compared to urban residents is because of their lower income levels. This result is not consistent with De Young's [52] and Chu and Chiu's [33] findings that recyclers ranked conservation of resources far ahead of monetary rewards. Yu also found that urban residents show higher social behavioral beliefs (i.e., environmental concern) than rural residents [45]. Thus, in terms of changing attitudes, the policymakers should emphasize the societal benefits for urban residents when promoting waste separation. Government and communities can increase rural residents' attitudes toward waste separation by improving the sales channels for recyclables. However, this policy will only help change rural residents' attitudes toward waste separation.

Surprisingly, resource conservation was not significant for both rural and urban residents. A possible reason for this may be that the publicity from government and communities pay more attention to environmental protection rather than they do for resource conservation. Furthermore, residents are more aware of the improvement of the community environment, and they rarely use the products made from recyclables that they disposed of.

4.3. Predictors for Subjective Norms

The study explores the normative beliefs from two aspects of descriptive (modeled as beliefs affected by families, friends, relatives, and neighbors) and injunctive (modeled as beliefs affected by CCP members, cleaners, community, and government). As a whole, the most influencing factors of the seven beliefs are CCP members and family in both urban and rural areas. The influence of government is a little weaker than CCP members and for family, but it is still the third most important belief. In China, CCP members are usually prestigious people in a community and are more likely to spread the policies formulated by the government and communities.

Subjective norms are believed to be motivated by the need for approval from significant others [11], and urban and rural residents comply with the expectations and pressure of CCP members and government. This suggests that programs stressing the responsibility of government and CCP as promoters of public policy efforts to promote HSW separation behavior is effective. However, the cleaners and communities cannot produce effective norms for both rural and urban residents. This could be because cleaners and communities do not have the factual power to reward or punish residents' waste separation behaviors.

In descriptive norms, as can be seen from the results, both urban and rural residents are most influenced by family. This result is consistent with Chu and Chiu's findings [33] that family influence is greater than other descriptive normative factors such as friends and neighbors. However, the normative beliefs from friends, relatives, and neighbors are supported only in rural areas. One possible explanation is the difference in the living environment between the city and the countryside. The neighbors of rural residents are often the same as their relatives and friends due to living in the same village. In contrast, urban residents live in apartments and often dispose of their waste without their neighbors seeing. Because of the mutual influence of family members, they are very important for their waste separation behavior, and this also provides many effective suggestions for policymakers. For example, teachers teach students how to classify household waste in school and ask students to guide their parents' separation behaviors. In rural areas, policymakers can promote programs stressing normative influences via villager groups and personal networks. In the countryside of China, the government asks several villagers' families to form a group for mutual supervision and making progress together.

4.4. Predictors for Perceived Behavioral Control

Multiplication of the perceived likelihood of inhibiting/facilitating factors and the factor's power provides control beliefs [53]. In Figure 2a, the knowledge of waste separation is most difficult for residents to perceive in terms of internal factors. This means the method of garbage separation is very important for separation behavior. Now, in the urban areas of China, the household waste is separated into four categories, while it is only sorted into two categories about household food waste and recycled waste in rural areas. Besides this, distributing brochures and placing informative billboards next to garbage stations about garbage separation also play a role. Time was only a significant factor in the PBC in urban areas because the fast-paced lifestyle limits them to spend time to classify household waste. Although we speculate that urban residents are very concerned about the storage space for recyclables because their apartments are smaller than in rural areas, the factor of storage space for recyclables is not supported in both rural and urban areas. This also contradicts some studies [33]. The possible reason for this may be the convenience of waste separation facility that reduces the amount of waste that is kept at home, which means less space is needed to store waste, especially larger recyclables.

As for external control factors, the convenient separation facilities are the most important facilitating factors, especially in rural areas; the free separation garbage bins and bags are the most important determinants of PBC. This is consistent with many previous studies [54]. This suggests that providing free trash separation bins and bags is the key to cultivating and establishing the habits of HSW separation behavior. However, there are also some differences between urban and rural areas. Publicity is significant in urban areas, and this means that a large public awareness campaign can effectively improve the level of intrinsic motivation among residents. Lastly, contrary to our expectation, the fine policy is only significant for the rural residents; this might indicate that they care about the money more than urban residents. Another reason could be that the penalty is not high enough or is not implemented by the government. Concerning the feedback, posting of red and yellow boards on buildings and the feedback score of HSW separation by mobile phones have not yet played a role in promoting residents to improve their behavior. This may be because managers have not taken effective feedback measures. The effectiveness of feedback needs to be further explored in future research. Similarly, the policymakers need to improve feedback methods (e.g., using gamified feedback) to increase residents' perceptions of the effects of feedback.

5. Conclusions

In summary, the present study found support for using the extended TPB to predict intention and behavior regarding HSW separation. First, contrary to the previous researches with TPB that attitudes are the most decisive predictor of behavioral intention, this study finds that attitude cannot predict HSW separation intention in both urban and rural groups. Meanwhile, the moral norm, as the complement of attitude, contributes to the interpretation of waste separation intention in urban residents. Second, the expanded conceptualization of the subjective norm component improves the predictive power. The subjective norm and self-identify proved to be the principle psychological factor on the intention of HSW behavior. As for the beliefs, family and CCP members have the most social influence in both urban and rural residents, while the secondary factor is government influence in the urban group and neighbors influence in the rural group. Third, the perceived behavioral control has a direct effect on intention in both urban and rural groups, but the direct influence on HSW separation behavior is only in the rural area. In terms of control beliefs, except for some control factors that affect both urban and rural residents (like knowledge and convenience), rural residents are more sensitive to money-related factors (free waste bin/bag and fine).

The study provides a series of intervening policy for community and government. First, providing information about common responsibility and moral meaning in brochures and mass media advertisement is a good strategy, because moral norm is an important psychological driving force to promote their behavior. Second, CCP members are key in providing modeling of recommended behaviors. In China, the CCP members are also seen as block leaders. The communities, especially in rural areas, let the CCP member play a pioneering role through various techniques. In the countryside, it is effective to set up a group with CCP members as the center to conduct collective assessment to promote waste separation. Lastly, monetary rewards may serve effectively for rural residents, and the local government and community could use material incentives to initiate repaid changes in residents' waste separation behavior, such as providing free waste separation bins and waste bags. However, for urban residents, the community managers should consider more about situational factors that will facilitate or inhibit waste separation behavior, such as the distance from the house to garbage room, setting clear identification of waste separation on site, and providing more feedback about their waste separation behavior.

Although this research has several significant contributions, such as the use of the division of belief structure, the actual behavioral measurement, and comparison of urban-rural differences, it also has some limitations that need to be focused on in future research. First of all, some specific beliefs, like resource conservation and feedback, are contrary to previous research results. These beliefs should be tested and analyzed individually by the laboratory or field experiments in future studies.

Further, we used self-reports for measuring actual behavior according to Ajzen’s recommendation [31]. However, self-reporting may bias the authenticity of the data. Future research should use other methods, such as measuring the number of different types of waste recycled, to find the actual waste separation behavior. Moreover, this study discusses the urban-rural differences in HSW separation, but the regional differences, such as developed/developing economies and cultural differences, are unclear. This also requires follow-up research.

Supplementary Materials: The following are available online at <http://www.mdpi.com/2071-1050/12/18/7778/s1>, Table S1: Original research data.

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Appendix A. Scales and Descriptive Statistics

Table A1. Scales and Descriptive Statistics.

Scale	M ¹	SD ²
Behavior (measure after one week)		
1 How often did you classify your waste last week? (never to nearly all the time)	5.4	1.998
2 How effective was your waste separation last week? (bad to good)	5.29	1.95
Intention		
1 Are you planning to classify waste next week? (not at all to very much)	5.52	2.005
2 Do you want to classify waste next week? (not at all to very much)	5.52	1.957
3 How likely are you to classify waste next week? (unlikely to likely)	5.6	1.987
Attitudes		
1 I think waste separation is (bad to good)	6.63	0.968
2 I think waste separation is (not worthwhile to extremely worthwhile)	6.56	1.049
3 I think waste separation is (strongly meaningless to strongly meaningful)	6.56	0.996
4 I think waste separation is (extremely unpleasant to extremely pleasant)	5.95	1.391
Subjective norms (strongly disagree to strongly agree)		
1 People who influence my decisions support me to classify waste.	5.47	2.045
2 People who influence my decisions want me to classify waste.	5.21	2.037
3 People who influence my decisions think that I should classify waste.	5.36	2.055
Perceived behavioral control		
1 I think I will be able to classify waste last week. (strongly disagree to strongly agree)	5.95	1.778
2 If it were entirely up to me, I am confident that I would be able to classify waste next month (strongly disagree to strongly agree)	5.78	1.86
3 If I classify waste it would be (difficult to easy)	5.78	1.677
Self-identity (strongly disagree to strongly agree)		
1 I consider myself an environmentalist.	5.81	1.427
2 I think I am very positive about waste separation.	5.467	1.553
3 Classifying waste has become a part of my life.	5.785	1.683
Moral norm (strongly disagree to strongly agree)		
1 Because I have an obligation to the environment and others, I should classify waste.	5.839	1.46
2 No matter what others do, I have an obligation to sort the garbage.	5.927	1.427
3 If I put the recyclable waste in trash bins, I will feel sad.	5.589	1.602
Behavior beliefs (belief strength) (strongly disagree to strongly agree)		
1 I will benefit from classify recyclable waste.	5.46	2.03
2 I can save resources by waste separation.	6.35	1.061
3 I can protect environment by waste separation.	6.52	0.952
4 I can promote social progress by waste separation.	6.38	1.096

Table A1. Cont.

Scale	M ¹	SD ²
Behavior beliefs (outcome evaluations) (strongly disagree to strongly agree)		
1 Whether or not I benefit from classify recyclable waste is an important decision factor affecting my waste separation behavior.	4.68	2.399
2 Helping to save resources is an important decision factor affecting my waste separation behavior.	5.03	1.924
3 Helping to protect environment is an important decision factor affecting my waste separation behavior.	5.23	1.895
4 Helping to promote social progress is an important decision factor affecting my waste separation behavior.	4.98	1.957
Normative beliefs (descriptive belief strength) (strongly disagree to strongly agree)		
1 my family classifies waste.	5.47	2.016
2 Most of my friends and relatives classify waste.	5.12	2.07
3 Most of my neighbors classify waste.	4.91	2.109
Normative beliefs (identification with the referent) (strongly disagree to strongly agree)		
1 When you classify your waste, how much do you want to be like your family?	5.81	1.822
2 When you classify your waste, how much do you want to be like your friends and relatives?	5.72	1.714
3 When you classify your waste, how much do you want to be like your neighbors?	5.83	1.644
Normative beliefs (injunctive belief strength) (strongly disagree to strongly agree)		
1 CCP members thinks I should classify my waste.	5.01	2.174
2 Cleaners thinks I should classify my waste.	4.01	2.095
3 Community thinks I should classify my waste.	5.46	2.056
4 Government thinks I should classify my waste.	4.89	1.927
Normative beliefs (motivation to comply) (strongly disagree to strongly agree)		
1 With respect to waste separation, I want to do what CCP members thinks I should do.	5.9	1.523
2 With respect to waste separation, I want to do what cleaners thinks I should do.	5.12	1.818
3 With respect to waste separation, I want to do what community thinks I should do.	6.38	1.114
4 With respect to waste separation, I want to do what government thinks I should do.	5.76	1.391
Control beliefs (belief strength) (strongly disagree to strongly agree)		
1 I have knowledge about waste separation.	5.74	1.522
2 I have time to classify my waste.	6.02	1.532
3 There is enough space for me to keep my recyclable waste at home.	5.42	1.988
4 Community or governments often promote the information of waste separation to me.	4.1	2.062
5 Facility of waste separation is convenient.	5.14	1.944
6 I follow feedback about my waste separation behavior.	3.85	2.041
7 I can get free waste bin or bag of classifying.	5.84	2.034
8 If I don't classify my waste, someone will fine me.	4.6	2.319
Control beliefs (power) (extremely unimportant to extremely important)		
1 Whether or not having knowledge about waste separation for me is a _____ decision factor affecting my waste separation behavior.	6.32	1.144
2 Whether or not having time to classify my waste for me is a _____ decision factor affecting my waste separation behavior.	3.26	2.337
3 Whether or not there is enough space for me to keep my recyclable waste at home for me is a _____ decision factor affecting my waste separation behavior.	3.08	2.364
4 Whether or not promote information of waste separation to me is a _____ decision factor affecting my waste separation behavior.	4.92	1.8
5 Whether or not convenience of waste separation facility for me is a _____ decision factor affecting my waste separation behavior.	6.11	1.22
6 Whether or not having feedback about my waste separation behavior for me is a _____ decision factor affecting my waste separation behavior.	4.14	1.837
7 Whether or not getting free waste bin or bag of classifying for me is a _____ decision factor affecting my waste separation behavior.	5.98	1.63
8 Whether or fine to me is a _____ decision factor affecting my waste separation behavior.	5.47	1.874

¹ "M" stands for mean, ² "SD" stands for Standard deviation.

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