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# Model of Chinese Household Kitchen Waste Separation Behavior: A Case Study in Beijing City

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**Abstract:** High participation rates by the public in authority projects are key in increasing resident recycling levels. Understanding waste separation behavior is crucial to achieving sustainable waste management within such household-based schemes. To identify the driving forces behind the seldom-discussed kitchen garbage separation behavior, five psychological factors, namely, attitude, perceived behavior control, subjective norms, moral norms, and responsibility denial, are established. Our data originate from a social study of Beijing citizens conducted in July 2013 ( $n = 362$ ). Through structural equation modeling, we find that moral norms are consistently the most important predictor of household kitchen waste (KW) separation behavior. Subjective norms have a larger effect on such behavior than responsibility denial. Data analysis shows that perceived behavior control contributes significantly and independently to the explanation of such behavior. By contrast, attitude towards KW separation is found to be significantly negatively correlated with separation behavior. In conclusion, the model with direct and indirect effects of psychological factors explains 50.3% of the variance in household KW source separation behavior. Implications of the results for the promotion of household KW separation programs are discussed.

**Keywords:** organic waste; recycling behavior; sustainable waste management; structure equation modeling; China

## 1. Introduction

It is a great challenge for governments to successfully manage household waste in city areas around the world. In this respect, source separation by the generator has been widely recognized as the crucial way for reducing, reusing, and recycling waste [1–8]. Many researchers have identified means of how to successfully conduct source separation in developed countries, such as in Sweden by Dahlén et al. [9], and in Spain by Gallardo et al. [10,11]. Meanwhile, variables that affect household separation in developed countries have also been discovered, such as the distance between containers and citizens [11,12], convenient infrastructure [5], environmental policy [13], and waste charges [14–17]. Furthermore, several studies have recognized how household waste charges affect a household's source separation behavior in developing countries, and most of the residents prefer household kitchen waste separation services with frequent, evening, plastic bag attributes and without instructors in big cities of developing countries [3,18].

The metropolis of Beijing, as one of the rapidly growing cities in China, covers an area of approximately 1400 km<sup>2</sup> and has a population of more than 20 million, approximately 86% of whom live in the urban area. In Beijing, organic waste comprises more than 60% of household waste [19,20]. The local authorities have been undertaking kitchen waste (KW) source separation campaigns since 2010. Although great efforts (Green KW containers, clearly labeled and bearing detailed usage instructions, are placed in front of each residential building. In addition, the local government issues handbooks that detail the KW separation system and free provisions to each household of two types of waste containers (barrels and a half-year supply of biodegradable plastic bags). Meanwhile, the local government has hired KW classification instructors (each overseeing 80–120 households) for every pilot community to provide guidance. For convenience, respondents can put their KW in community garbage bins in front of their residential building without time limitations or extra fees.) [3,4,18] have been made by local governments to obtain the residents' cooperation, the program remains largely ineffective [21,22] because of problems such as citizens' resistance, political complexity, and those related to culture. Therefore, understanding the determinants of resident KW separation behavior are key for governments and decision makers to design more effective policies to involve more households join in household KW source separation program.

A number of scholars have identified a lot of socioeconomic factors affecting waste management behaviors, such as age, gender, and education [1,2,23,24]. However, socioeconomic variables have also been criticized because they explain only modest levels of variance when referring to the measures of environmental behavior [25]. Therefore, in the past two decades, there has been a growing concentration of the influence of psychological variables on resident waste management behavior [7,8,23]. Furthermore, Bortoleto et al. [26] undertook a detailed literature review and noted that three main psychological theories have been widely used by scholars when explaining the waste management behavior of individuals [27], namely the theory of reasoned action [28], the theory of planned behavior [29], and the norm action model [30]. However, these three theoretical models produced inconsistent results in the study of Davies et al. [31]. Therefore, there is a need for further investigation of the theoretical models for waste management behavior.

Many researchers have studied the psychological determinants of residents' source separation or waste recycling activities all over the world [1,24,32–34]. A wide variety of psychological factors, such as attitude, perceived behavior control, and subjective norms, have been identified as influential in household waste recycling behavior. Furthermore, in recent years, there has been increasing awareness towards household KW, especially towards how to reduce household KW at the source in developed countries [35–40]. However, few researchers have considered the KW separately in developing countries, or the difference between recyclable (e.g., paper, aluminum, plastic, glass, cardboard, and batteries) and KW, and all have treated the entire waste as a whole in their studies. In China, KW is the main part of household solid waste, accounting for about 60%. As we know, KW has many special features compared with recyclable waste, like being perishable and odorous. Therefore, for the KW separation programme to be successful, the policy makers must have a thorough understanding of residents' attitudes towards KW separation and their perceptions of the barriers to separation.

In this context, the research questions of this investigation are as follows:

- (a) Which factors have a significant effect on KW separation behavior? To what extent do these factors predict the separation behavior of KW? How strong are the relationships of these factors to KW separation behavior?
- (b) How do the separation behavior between recyclable and KW differ?
- (c) How may the KW separation behavior model improve the effectiveness of pro-environmental household solid waste management policies?

To answer these questions, we initially adopted a hypothetical model that was empirically applied to a questionnaire data through structural equation modeling (SEM). In order to obtain a model that indexes, a fit, modified model was developed by merging the theoretical models (the theory of reasoned action [28], the theory of planned behavior [29], and the norm action model [30]) and other environmental behavior models [24,26,27,41].

## 2. Theoretical Basis and Research Hypotheses

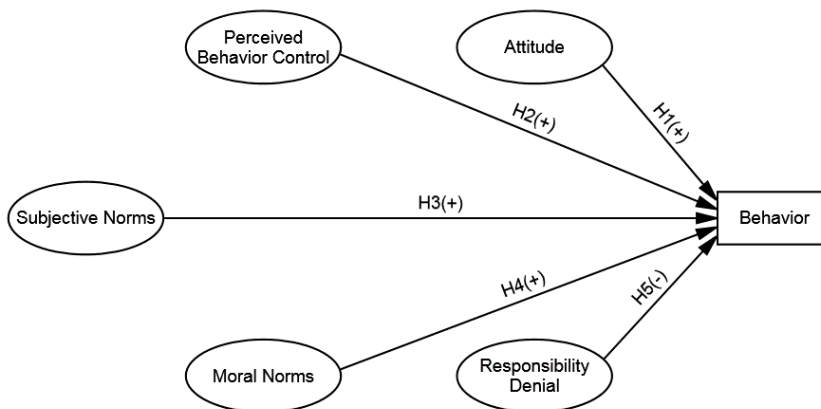
### 2.1. Structural Equation Modeling

SEM was selected to calculate the direct and indirect effects of psychological factors [42,43] on household KW separation behavior. It can construct latent variables and test the predictive power of various models. Furthermore, SEM has the advantages of accounting for measurement error and of obtaining an indicator of how well a model with multiple criteria fits the data.

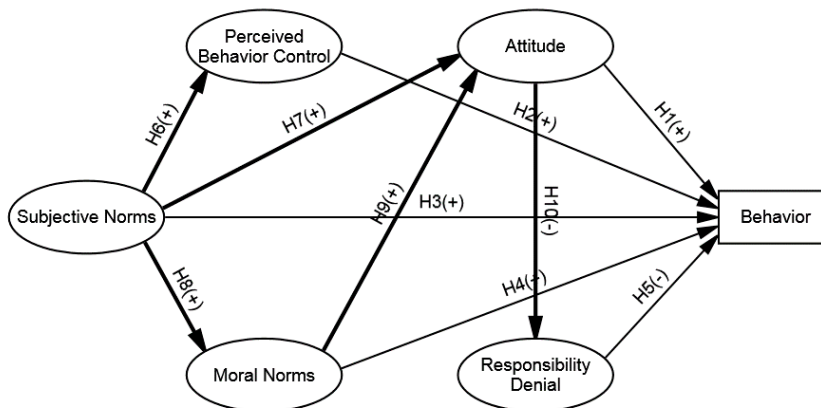
### 2.2. Research Framework and Hypotheses Development

The present study focused on the self-reported household actual KW separation behavior. The findings regarding psychological determinants in previous studies set a good basis for the current investigation. Specifically, the great majority of studies on the psychological antecedents of waste management behaviors [8,23,24,26,27,41] has focused on variables such as attitude, perceived behavior control, subjective norms, moral norms, and responsibility denial.

Figures 1 and 2 show the initial and modified hypothetical SEM of household KW separation behavior that we applied. The hypotheses regarding household KW separation behavior are explained below.



**Figure 1.** Initial model to explain kitchen waste separation behavior. Circles stand for latent variables; square stands for observed variable.



**Figure 2.** Modified model to explain household kitchen waste separation behavior.

Hypothesis 1 (H1): If an individual has more positive attitudes towards KW separation, then he/she will be more likely to conduct the separation behavior.

Most studies in the literature [28,33] have found that when a proposed activity is evaluated by an individual as having positive consequences, these positive attitudes probably have a positive influence on their behavior. Therefore, their attitude could be a good predictor of their behavior. In detail, personal positive attitudes on separation probably have positive and direct influences towards their behavior.

Hypothesis 2 (H2): If an individual perceives more behavioral control of KW separation, then he/she will be more likely to conduct the separation behavior.

The perceived behavior control measures an individual's perceptions of their ability to conduct the relevant activity. The previous studies [39,41] revealed that perceived behavior control indeed influences residents' separation behavior. An individual's perceived behavior control provides positive and direct effects towards their KW separation behavior.

Hypothesis 3 (H3): If an individual has more positive subjective norms towards KW separation, then he/she will be more likely to conduct the separation behavior.

Subjective norms refer to the individual's perception of social pressures, such as those from family, neighbors, and the community, to conduct the proposed behavior [44]. Some studies [24,26,27,39,41] show that the recycling behavior of an individual is substantially influenced by the social norms that he/she perceives to be held by other people or social groups that are important to him/her. Thus, these norms could promote waste separation through serving as behavioral role models or through invoking concerns about self-regard. Subjective norms provide a positive and direct effect towards individual's behavior.

Hypothesis 4 (H4): If an individual has more positive moral norms towards KW separation, then he/she will be more likely to conduct the separation behavior.

Moral norms [24,45] are the individual's feelings of moral obligation or responsibility to conduct the particular activity, which may make a significant contribution in explaining the variance of the behavior. In some studies, including a moral factor as a predictor of behaviors has significantly improved the prediction of intentions such as Bortoleto et al. [26], who advocate Schwartz's approach as a more predictive model than either the theories of reasoned action or of planned behavior, as it incorporates the variable of moral norms. Thus, it is considered appropriate to include moral norms within this research model, and moral norms would provide a significant and direct influence towards separation behavior.

Hypothesis 5 (H5): If an individual perceives more social responsibilities of conducting KW separation, then he/she will be more likely to conduct the separation behavior. On the contrary, responsibility denial provides negative and direct influences towards KW separation behavior.

Saha and Idsø [46] suggested that individuals with high level social responsibilities are prone to undertaking environmental actions. According to Bortoleto et al. [26], incorporating individuals' responsibility denial for the desired behavior in the model could facilitate the prediction of their actions.

Based on previous research, five more indirect effect hypotheses were developed for the modified model (Figure 2).

Hypothesis 6 (H6): Subjective norms provide positive and direct effects towards perceived behavioral control. Perceived behavioral control mediates the effects of subjective norms on separation behavior. As subjective norms about separation behavior become more positive, the individual's perceived behavioral control on the desired separation behavior increases.

Previous studies demonstrated that subjective norms influence separation behavior indirectly through the perceived behavior control [27,47,48]. This implies that social pressures from those persons who are important to the individual also facilitate or inhibit the individual's actions.

Hypothesis 7 (H7): Subjective norms provide positive and direct effects towards attitudes. Attitudes mediate the influences of subjective norms on separation behavior. As subjective norms about the separation behavior become more positive, the individual's attitude towards the separation behavior becomes more positive.

The performance of environmental behaviors may be affected indirectly by subjective norms towards particular actions through attitudes [27,47]; therefore, particular attention should be paid to the influence of subjective norms on attitudes.

Hypothesis 8 (H8): Subjective norms provide positive and direct effects towards moral norms. Moral norms mediate the effects of subjective norms on separation behavior. As subjective norms regarding the separation behavior become more positive, a person's moral norms towards separation become more positive.

It has also been demonstrated that subjective norms determine environmental action through moral norms [26,27,47–49]. In general, individuals tend to look to society before determining their actions. The social pressure that individuals receive from those around them—and especially from those persons who are important to them—affects their moral perception about what is and is not correct. This leads to this study's sixth hypothesis.

Hypothesis 9 (H9): This study proposed that moral norms influence separation behavior indirectly through the attitude predictor.

Various studies have determined that moral norms have a positive influence towards the resident's attitudes in the context of various behaviors [24,27,50–53]. That is to say, the individual's perception of what is good and bad leads to a positive or negative valuation of which conduct to display.

Hypothesis 10 (H10): The resident's attitude on KW separation has a negative and direct influence towards responsibility denial.

Responsibility denial is connected with the individual's sense as to whether performing the activity is their responsibility. Previous studies, such as Hooper and Nielsen [54], have shown that the performance of environmental behaviors may be affected indirectly by attitudes towards particular actions through denial of responsibility. This means that those who feel morally obliged to perform a particular environmental behavior are more likely to perform that behavior when they have a belief in the positive consequences of the behavior in question. In regard to KW separation, residents can make a close link between their actions and the environment or direct responsibility towards others such as the authority.

### 3. Methodology

The present study focused on KW source separation behavior of residents in Beijing apartments. The questionnaire included four parts. The first part contained questions about respondents' knowledge and awareness about organic waste management in general. Respondent household KW separation behavior was reviewed in the second part. The current study followed the definition of household KW that was defined by local government in 2010. Unlike the concept of organic waste, the definition of household KW excludes some of the organic waste that is not easy to handle and belongs with other waste. To ensure the reliability of responses, the definition of not only household KW (KW refers to the perishable food waste produced by the family and mainly includes uneaten able vegetables, fruit peels, leftovers, waste food, etc.), but also that of other waste (Items such as large bones, corn cobs, nut shells, cling film, and paper towels belong to other waste.), was asked before the self-reported KW behavior was proposed to the respondents. The measures for household KW separation behavior were designed on a five-point scale from Never, Before, but Not Now, Sometimes, Most Times, and Always. The questionnaire was then designed to fulfill the key requirements presented in the research hypothesis part of this study. Respondents were asked psychologically based questions

relating to KW separation that included attitude, perceived behavior control, subjective norms, moral norms, and responsibility denial. These questions (please see Appendix A) were derived from the recycling behavior literature [39,55–58]. Specifically, for each questionnaire item of these psychological aspects, individuals were asked to indicate the extent of their agreement with the proposed statements, using a five-point Likert scale in which responses could range from 1 (strongly disagree) to 5 (strongly agree). Finally, respondents' socioeconomic characteristics were collected in the fifth part.

This survey was conducted in the communities of Beijing that is involved with the pilot project for KW separation. This survey took about 40 days, from 20 June to the beginning of August in 2013. To prevent potential problems and biases of the questionnaire, a pre-test was administered during the first week to 30 participants in Beijing. The survey employed a three-stage sampling technique. During the first stage, Haidian and Dongcheng districts were randomly selected from six center districts (Beijing proper and urban) of Beijing City, which includes: Dongcheng, Xicheng, Haidian, Chaoyang, Fengtai, and Shijingshan. Furthermore, 12 communities were randomly selected from all of the 651 pilot communities of the aforementioned two districts. Finally, respondents were selected in convenience and interviewed face-to-face in each selected community. Because each target community has a different number of residential buildings with a different number of households, to make sure the selected households cover all parts of the area, we visited the community service center of each target community before conducting a survey. In addition, in order to avoid interviewing only a particular group of respondents such as the unemployed, seniors or retirees, the interviewers visited the communities at different times of the day. In total, 401 respondents were approached, and 385 of them provided valid responses (96% of the respondents).

The socioeconomic characteristics of the sample—age, gender, education experience, and income, along with the general features of the households—are summarized in Table 1. In particular, the gender distribution in the samples was about 57.9% female, higher than the average level, 50%. This high percentage may be because the survey was mainly conducted in the daytime, making it more difficult to interview working male respondents. About 58.1% of the respondents were ages 30–59. In addition, the highest percentage of respondents had attained a four-year university degree or a higher level of education (42.3%). These are higher than the average Beijing statistical levels, 48% and 32%, but are reasonable because central urban areas of Beijing typically have more middle-aged highly-educated residents than suburban areas. In addition, the main purpose of the study is to derive useful policy implications; thus, those differences between our sample and statistics appear acceptable.

**Table 1.** Socioeconomic characteristics of the respondents.

Characteristics	Distribution of Respondents (%)	% <sup>s</sup>
Gender	Female (57.9); male (42.1)	(50; 50)
Age (in years)	Less than 29 (16.1); 30–59 (58.1); over 60 (25.7)	(38; 48; 14)
Education	No high school (31.4); high school or equivalent (26.2); college or above (42.3)	(44; 22; 32)
Local	No (38.4); yes (61.6)	(37; 63)
Household size (in person)	1 (6.5); 2 (17.7); 3 (35.1); 4 (19.2); over 5 (21.6)	(22; 31; 31; 9; 7)
Economical level	Low income (8.6); middle lower income (23.4); middle income (50.1); middle higher income (15.8); high income (2.1)	-

Sample size is 385. <sup>s</sup> stands for the column of the data calculated by Beijing Statistic Yearbook [59].



## 4. Results and Discussion

### 4.1. Dependent Variable: Kitchen Waste Separation Behavior

Table 2 shows that 62.3% of the respondents reported that they knew the definition of household KW, and 24.7% reported that they knew the definition of other waste very well. While 52.5% of them did not have any KW separation experience, only 17.9% could always correctly separate KW from other waste.

**Table 2.** Knowledge and separation experience of household kitchen waste.

Definition	Distribution of Knowledge and Behavior (%)
Kitchen Waste	Very well (62.3); otherwise (37.7)
Other Waste	Very well (24.7); otherwise (75.3)
Separation Experience	Always (17.9); most times (11.7); sometimes (13.0); before, but not now (4.9); never (52.5)

Sample size is 385.

After excluding four inconsistent responses, as well as 19 “Before, but Not Now” responses, the self-reported frequency of behavior ranging over four levels, from 1 (“Never” with 201 responses), 2 (“Sometimes” with 49 responses), 3 (“Most times” with 44 responses), to 4 (“Always” with 68 responses), was used to determine the dependent variable; this included 362 responses (94% of the valid sample).

Furthermore, Table 3 shows knowledge sources regarding source separation for respondents who always or most of the time separate their KW. It appears that the community is the most important intermediary, followed by TV and newspapers.

**Table 3.** Sources of kitchen waste separation knowledge for respondents who always or most of the time separate their waste.

Source	Always (68 Samples)				Most of the Time (44 Samples)			
	Yes		No		Yes		No	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Community	53	77.9	15	22.1	26	59.1	18	40.9
Newspaper	8	11.8	60	88.2	21	47.7	23	52.3
Broadcast	8	11.8	60	88.2	13	29.5	31	70.5
TV	23	33.8	45	66.2	26	59.1	18	40.9
Internet	6	8.8	62	91.2	15	34.1	29	65.9
Family	4	5.9	64	94.1	9	20.5	35	79.5
Friends	1	1.5	67	98.5	5	11.4	39	88.6

### 4.2. Latent Psychological Predictor Variables

Before the estimation of the models, reliability (Table 4) was assessed with the aim of ensuring that the questions shown as variables in Appendix A were all measuring the same underlying attributes. A confirmatory factor analysis was conducted by computing Cronbach’s alpha coefficients for each latent variable using Statistical Package for Social Sciences (SPSS) software (IBM, New York, NY, USA) [60]. Specifically, the reliability coefficient for attitude was 0.850; perceived behavior control was 0.664; subjective norms were 0.831; moral norms were 0.726; and responsibility denial was 0.631. According to Chen and Bishop [61], a reliability coefficient of greater than 0.7 indicates that the measure has achieved acceptable reliability, while Kline [62] proposed reliability coefficients of around 0.8 as very good, with those between 0.7 and 0.6 as adequate. In summary, the measurement model demonstrated adequate reliability and validity. The correlation matrix (Table 4) shows that all the constructs are highly correlated.

**Table 4.** Bivariate correlations and reliability check.

Psychological Factors	1	2	3	4	5
1. Attitude	0.850				
2. Perceived Behavior Control	0.529	0.664			
3. Subjective Norm	0.218	0.395	0.831		
4. Moral Norm	0.473	0.525	0.297	0.726	
5. Responsibility Denial	−0.172	−0.509	−0.162	−0.295	0.631

Cronbach's alpha values are reported in the diagonal. All correlations are significant for  $p < 0.03$  or lower. Sample size is 362.

#### 4.3. Estimation Results

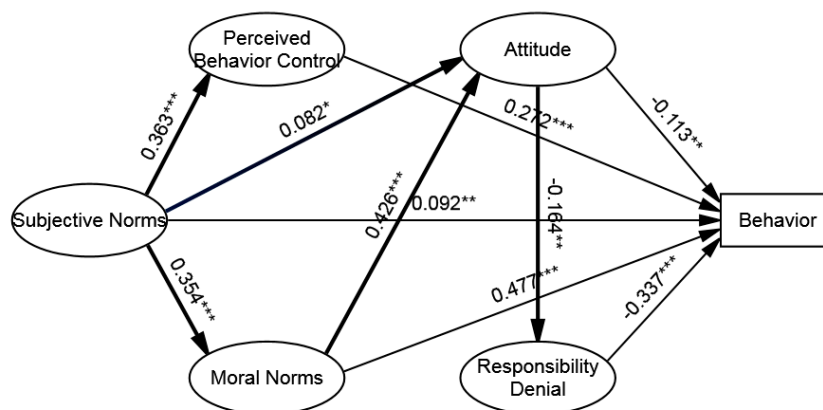
The current study applied AMOS 22.0 (IBM, New York, NY, USA) with the maximum likelihood method to test the hypothesized saturated model shown in Figures 1 and 2. In considering the dependence of the chi-squared test on the sample size (The larger the sample size, the more likely it is that the model will be rejected by a chi-squared test.), the evaluation of the absolute fit of the model relied on a number of recommended fit indices [63], such as robustness of mean squared error approximation (RMSEA), in which values lower than 0.08 and 0.05 indicate adequate and good model fit, respectively; Comparative fit index (CFI), which ranges from 0, no fit, to 1, perfect fit; Goodness of fit index (GFI), which ranges from 0, no fit, to 1, perfect fit and for which values higher than 0.9 suggest a good fit; and Adjusted goodness of fit index (AGFI) and Normed fit index (NFI), which range from 0, no fit, to 1, perfect fit and for which values higher than 0.8 suggest a good fit.

For the initial structural model, chi-squared = 677.017, RMSEA = 0.067, CFI = 0.893, GFI = 0.867, AGFI = 0.819, NFI = 0.840, which means that it has an acceptable model fit. In addition, the squared multiple correlation ( $R^2$ ) for KW separation behavior is 0.45, suggesting that 45% of the variability in this latent variable can be explained by the combined influences of the five latent psychological variables. The results indicate that all proposed paths are statistically significant, except for that between attitude and behavior (Due to the theoretical importance of the influence of subjective norms towards household KW separation behavior, the attitude is still considered in the modified model.). Thus, attitude towards separation does not have a statistically significant influence towards behavior.

Compared with the initial structural model, the revised structural model with fit indices chi-squared = 498.839, RMSEA = 0.052, CFI = 0.937, GFI = 0.911, AGFI = 0.876, and NFI = 0.882 indicating a better fit to the data. Meanwhile, the variance of behavior explained by this model is relatively higher at 50.3% ( $R^2 = 0.503$ ) than the initial model's 45%. Furthermore, the majority of the structural coefficients are significant. Figure 3 shows the estimated standardized path coefficients for the revised structural model (Figure 2). Four out of the five proposed direct relationships are significant ( $p$ -value < 0.05) and have expected signs and the corresponding research hypotheses (H2–H5) are supported. In the case of attitude, it shows a strong significant negative direct effect (equal to  $-0.113$ ) towards the positive KW separation behavior. This negative sign of attitude is opposite to the H1, which means that respondents with a stated positive attitude towards the household KW separation program do not display actual KW separation behavior. An examination of the indirect paths shows that all are statistically significant ( $p$ -value < 0.1) and with expected signs; therefore, the corresponding hypotheses (H5–H10) are supported by the data.

Estimations of the standardized and indirect influences of each psychological variable towards separation behavior (Table 5) permit the estimation of the relative contribution of each predictor variable. If we take into account the absolute size of the standardized influences, the respondents' behavior is affected by the predictors in the following order: moral norms (0.453), subjective norms (0.346), responsibility denial ( $-0.337$ ), perceived behavior control (0.272), and attitude ( $-0.057$ ).





**Figure 3.** Estimated standardized path coefficients for Figure 2. \* Significant at the 10% level; \*\* significant at the 5% level; \*\*\* significant at the 1% level.

**Table 5.** Results of hypotheses tests and effects analysis of an individual's separation behavior for revised model.

Latent Variables	Direct effect		Indirect effect			Total Effect
	s.e.	Hypotheses	s.e.	Mediator	Hypotheses	
Attitude (AT)	-0.113	H1 opposed	0.055	RD	H10 supported	-0.057
Perceived behavior control (PBC)	0.272	H2 supported	-	-	-	0.272
Subjective norms (SN)	0.092	H3 supported	0.254	PBC AT MN	H6 supported H7 supported H8 supported	0.346
Moral norms (MN)	0.477	H4 supported	-0.024	AT	H9 supported	0.453
Responsibility Denial (RD)	-0.337	H5 supported	-	-	-	-0.337

s.e.: standardized effects. n.s.: non-statistically significant ( $p > 0.1$ ). Total effect = Direct effect + Indirect effect.

#### 4.4. Mediation Analysis

As the results from the analysis of total effects suggest that both perceived behavior control and attitude mediate the relationship between subjective norms and behavior, it is worthwhile to explicitly test for these potential mediating effects. To do so, our analysis draws on Hair and Hult [64], Mondéjar-Jiménez and Ferrari [39] and Sarstedt et al. [65] by answering the following three research questions:

- Is the direct effect between subjective norms and behavior significant when the mediator variable is excluded from the path model;
- Is the indirect effect via the mediator variable significant after perceived behavior control and attitude have been included in the path model, and
- How much of the direct effect does the indirect effect via the mediator absorb?

In order to answer the first question, it is necessary to exclude the perceived behavior control and attitude from the path model and run the bootstrapping routine with the previously described specifications. As a result, the direct effect between subjective norms and behavior is 0.17 and significant at  $p \leq 0.01$ . Answering the second question requires re-estimating the full model (e.g., with the mediators included) and tests the significance of the indirect effects. The indirect effects of subjective norms on behavior with respect to perceived behavior control and attitude are found to be significant at 1% level. Finally, the variance accounted for (VAF) are computed as the ratio between the indirect effect and total effect of subjective norms. The results give values of 28.18% and 10.11%, suggesting that both perceived behavior control and attitude partially mediates [64] the relationship between subjective norms and behavior.

## 5. Conclusions

This study focuses on a lack of understanding topic of household KW separation behavior by investigating it through SEM. The purposes of this research are to detect the psychological driving forces and determinants that are likely to lead to successful household KW separation policies. This study examined the direct and indirect roles of attitude, perceived behavior control, subjective norms, moral norms, and responsibility denial on the self-reported household actual KW separation behavior. SEM was used to test 10 hypotheses in both initial and modified models. A social survey of 362 participants from Beijing pilot communities provided empirical support for eight of 10 hypotheses. The presented models make it possible to identify the main forces that determine household behavior with regard to KW source separation. Specifically, as expected, results of the proposed structural equation indicate that moral norms, subjective norms, and negative responsibility denial are the top three significant predictors of source separation behavior. In detail, behavior is influenced positively by moral norms and subjective norms. With the predicted negative coefficient, responsibility denial significantly influence the prediction of KW recycling behavior. An immediate positive relationship between perceived behavior control and separation behavior was also identified. However, it is worth noting that the coefficient of the attitude is negatively significant in an unexpected direction. This implies that attitude towards KW separation, in turn, negatively predicted source separation behavior. The results indicated that the latent psychological variables examined in this study were able to predict 50.3% of variance in KW separation behavior. The results of this research have several implications for the improvement of KW separation programs in homes via communication campaigns for Beijing city and for the development of KW separation programs in other areas of China.

Moral norms towards KW separation are identified as the most important forces of the respondents' reported actual KW separation behavior. Therefore, it is necessary to strengthen the awareness of responsibility in individuals on their moral obligations of KW source separation. Norms should be visible because it is easier for residents to aware them. For example, communities could provide convenient monthly feedback by a meeting, radio program, or newsletters for households that are separating their KW in order to share their experiences.

The results also show that subjective norms have a marked effect towards KW separation behavior, which confirm the results found in previous studies [24,26,27,39,41]. Therefore, a helpful way of maximizing participation in household KW separation program would be through social pressure because individuals consider the opinions of family, peers, and community as powerful inducements to engage in KW separation.

The model findings also suggest that waste separation policies need to focus on responsibility denial. In other words, effective behavior change could be achieved by means of removing barriers to the desired activity. Time, space, convenience, and lack of knowledge may be barriers for individuals to separating KW at home. In other words, a successful KW separation policy should be put forward with convenience in mind and be based on the needs of individuals for time and space.

Perceived behavior control, as an internalized subjective norm, directly and significantly influences KW separation behavior, thus confirming the evidence found in literature for perceived behavior control [39,41]. It may be concluded that the option of promoting separation behavior through perceived behavior control should be an important aspect of strategy. Thus, in order to lead residents to be more environmentally responsible, detailed information should be publicized not only to raise people's consciousness, but also to make them feel more responsible regarding the consequences of not separating.

Based on the findings of this study, respondents with positive attitudes towards KW separation programs display negative engagement in their current KW separation behavior. It appears that households do not like to engage in KW separation programs even when they believe in such programs and view the outcomes positively. According to the behavioral economics, this phenomenon can be explained by Retain the Status Quo [66–68], Knowledge–Action Gap [67,69], and Attitude–Action Gap [67,70]. People tend to resist change and go with the flow of pre-set options, even where

alternatives may yield better (e.g., more financially rewarding) personal or collective outcomes. Moreover, what people say and what they do are sometimes very different things. People may hold positive attitudes. However, often these things do not translate into actual behavior. Furthermore, this finding is not consistent with many of the previous studies [1,8,33] that residents will engage in recycling programs when they have a more positive attitude. A possible interpretation of this might be that unlike recyclable waste, KW is much more difficult to keep because of its feature of perishable, especially in summer. Furthermore, this result reviews that although there is a long history for household waste separation in China, KW is always excluded or not considered by the government and the residents. In other words, Chinese residents have not been habituated to separating KW. Therefore, this finding can be further explained by the results found by Yuan and Yabe [4]. In their study, residents who had higher positive attitudes towards household KW separation showed a higher willingness to pay for KW separation services. This means that residents with high awareness and recognition of the necessity for household KW separation are prepared to pay for special cleaners (Residents' failure to properly separate KW forced local government to establish special teams to perform resorting.) who separate KW for them, rather than conducting the KW separation at the source by themselves. In accordance with the current study, the results did not show that the higher the awareness and recognition of the necessity for household KW separation the residents have, the more they separate KW. Therefore, the challenge for the government is not only to design campaigns that strengthen the active attitudes of those who have realized the importance of KW source separation and change the attitudes of those who consider KW source separation programs inactively, but also to change their behavior to cultivate the habit of self-conducted KW separation. Therefore, local managers should try to reeducate citizens as to why it is necessary for KW separation to be conducted at home by themselves, rather than by the separator or refuse collector, in order to avoid resource wastage and secondary pollution.

Media outlets such as TV, radio, and the community are useful tools when it comes to promoting knowledge and pro-environmental action. In addition, policymakers should constantly devote efforts at all educational levels to teach people what KW is and how to separate it, because this kind of knowledge would influence their recycling participation. Most importantly, the government's communication programs and related educational work should include and take the children into consideration.

With regard to the limitations of this research and to directions for future studies, it would be important for future studies to consolidate behavior intention, individual difference variables, and situational factors within a broader theoretical framework. Secondly, the sample used was obtained from 12 randomly selected pilot communities. Thus, it is necessary for the following studies to increase the sample size and include more pilot communities to obtain a more representative sample of the population. Before the question about the current situation regarding household KW separation was asked, questions relating to households' knowledge and awareness of the environment and KW, in general, were covered. These are very essential for reducing potential information bias because of the limitation of respondents' knowledge in terms of source separation. Since KW at the household level is a fairly new research topic, especially in China, the main dependent variable (self-reported frequency of KW separation behavior) in this tentative study was self-reported and recoded from 1 (Never) to 4 (Always). Firstly, the respondents might be self-aware or environmentally conscious or have even overstated their participation in recycling when they were asked to answer [23,34]. To overcome these problems, future studies could adopt Gamba and Oskamp's [71] approach to observing actual recycling behavior, although it is costly. Furthermore, the transformation of the scale used for the dependent variables need to be tested.

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## Appendix A

Psychological Factors	Survey Statement
Attitude	1. Household KW separation is good for the environment. 2. It's a good activity to separate household KW. 3. Household KW separation should be further promoted. 4. KW separation could save landfills.
Perceived Behavior Control	5. There are many opportunities to separate kitchen waste. 6. If I wanted to separate KW, I could. 7. It's an easy task to separate KW at home. 8. My household KW separation depends on me. 9. I will separate KW when my neighbors do it. 10. I would like to go far to conduct KW separation 11. Everybody should separate KW. 12. My apartment has enough space to keep KW.
Subjective Norms	13. In my neighbor's opinion, I should separate KW. 14. In my friend's opinion, I should separate KW. 15. My community thinks I should separate KW 16. In my family member's opinion, I should separate KW.
Moral Norms	17. It makes me feel guilty if I do not separate KW. 18. I hope I can be thought as an environment-friendly person. 19. I have proper knowledge on how to separate KW. 20. It makes me feel guilty if I don't put recyclable inside the right bins. 21. I feel guilty if my daily items have no environmentally-friendly label.
Responsibility Denial	22. It can not motivate me to separate by voluntary policy. 23. It's difficult to separate KW without family cooperation. 24. I do not want to separate. 25. KW separation is inconvenient.

Attitude stands for attitudes towards KW separation; Perceived Behavior Control stands for perception of the respondents' ability to perform the behavior; Subjective Norms stands for perception of the respondents' social pressure to separate KW; Moral Norms stands for conscious of pre-environment; Responsibility Denial stands for excuse for KW source separation [39,55–58].

## References

- Zhang, D.; Huang, G.; Yin, X.; Gong, Q. Residents' waste separation behaviors at the source: Using SEM with the theory of planned behavior in Guangzhou, China. *Int. J. Environ. Res. Publ. Health* **2015**, *12*, 9475–9491. [[CrossRef](#)] [[PubMed](#)]
- Zhang, H.; Wen, Z.-G. Residents' household solid waste (HSW) source separation activity: A case study of Suzhou, China. *Sustainability* **2014**, *6*, 6446–6466. [[CrossRef](#)]
- Yuan, Y.; Yabe, M. Residents' preferences for household kitchen waste source separation services in Beijing: A choice experiment approach. *Int. J. Environ. Res. Publ. Health* **2014**, *12*, 176–190. [[CrossRef](#)] [[PubMed](#)]
- Yuan, Y.; Yabe, M. Residents' willingness to pay for household kitchen waste separation services in Haidian and Dongcheng districts, Beijing city. *Environments* **2014**, *1*, 190–207. [[CrossRef](#)]
- Bernstad, A. Household food waste separation behavior and the importance of convenience. *Waste Manag.* **2014**, *34*, 1317–1323. [[CrossRef](#)] [[PubMed](#)]
- Owusu, V.; Adjei-Addo, E.; Sundberg, C. Do economic incentives affect attitudes to solid waste source separation? Evidence from Ghana. *Resour. Conserv. Recycl.* **2013**, *78*, 115–123. [[CrossRef](#)]
- Karim Ghani, W.A.; Rusli, I.F.; Biak, D.R.; Idris, A. An application of the theory of planned behaviour to study the influencing factors of participation in source separation of food waste. *Waste Manag.* **2013**, *33*, 1276–1281. [[CrossRef](#)] [[PubMed](#)]

8. Pakpour, A.H.; Zeidi, I.M.; Emamjomeh, M.M.; Asefzadeh, S.; Pearson, H. Household waste behaviours among a community sample in Iran: An application of the theory of planned behaviour. *Waste Manag.* **2014**, *34*, 980–986. [[CrossRef](#)] [[PubMed](#)]
9. Dahlén, L.; Vukicevic, S.; Meijer, J.-E.; Lagerkvist, A. Comparison of different collection systems for sorted household waste in Sweden. *Waste Manag.* **2007**, *27*, 1298–1305. [[CrossRef](#)] [[PubMed](#)]
10. Gallardo, A.; Bovea, M.D.; Colomer, F.J.; Prades, M. Analysis of collection systems for sorted household waste in Spain. *Waste Manag.* **2012**, *32*, 1623–1633. [[CrossRef](#)] [[PubMed](#)]
11. Gallardo, A.; Bovea, M.D.; Colomer, F.J.; Prades, M.; Carlos, M. Comparison of different collection systems for sorted household waste in Spain. *Waste Manag.* **2010**, *30*, 2430–2439. [[CrossRef](#)] [[PubMed](#)]
12. Roustia, K.; Bolton, K.; Lundin, M.; Dahlén, L. Quantitative assessment of distance to collection point and improved sorting information on source separation of household waste. *Waste Manag.* **2015**, *40*, 22–30. [[CrossRef](#)] [[PubMed](#)]
13. Organisation for Economic Co-operation and Development (OECD). *Green Household Behaviour: Overview from the 2011 Survey*; OECD: Paris, France, 2014.
14. Gomes, A.; Matos, M.; Carvalho, I. Separate collection of the biodegradable fraction of MSW: An economic assessment. *Waste Manag.* **2008**, *28*, 1711–1719. [[CrossRef](#)] [[PubMed](#)]
15. Ayalon, O.; Brody, S.; Shechter, M. Household waste generation, recycling and prevention. In *Green Household Behaviour: Overview from the 2011 Survey*; OECD: Paris, France, 2014.
16. Berglund, C. The assessment of households' recycling costs: The role of personal motives. *Ecol. Econ.* **2006**, *56*, 560–569. [[CrossRef](#)]
17. Jakus, P.M.; Tiller, K.H.; Park, W.M. Explaining rural household participation in recycling. *J. Agric. Appl. Econ.* **1997**, *29*, 141–148. [[CrossRef](#)]
18. Yuan, Y.; Takahashi, Y.; Yabe, M. Preferences for the attributes of household kitchen waste source separation services in China using latent class approach. *J. Faculty Agric. Kyushu Univ.* **2015**, *60*, 511–518.
19. Zhenshan, L.; Lei, Y.; XiaoYan, Q.; Yumei, S. Municipal solid waste management in Beijing city. *Waste Manag.* **2009**, *29*, 2596–2599. [[CrossRef](#)] [[PubMed](#)]
20. Qu, X.; Li, Z.; Xie, X.; Sui, Y.; Yang, L.; Chen, Y. Survey of composition and generation rate of household wastes in Beijing, China. *Waste Manag.* **2009**, *29*, 2618–2624. [[CrossRef](#)] [[PubMed](#)]
21. Deng, J.; Xu, W.; Zhou, C. Investigation of waste classification and collection actual effect and the study of long acting management in the community of Beijing. *Environ. Sci.* **2013**, *34*, 395–400. (In Chinese)
22. Nature, F.O. A Research Report on Garbage Separation of Pilot Communities in Beijing in 2012. Available online: <http://www.fon.org.cn/uploads/attachment/17641370277681.pdf> (accessed on 30 April 2013).
23. Swami, V.; Chamorro Premuzic, T.; Snelgar, R.; Furnham, A. Personality, individual differences, and demographic antecedents of self-reported household waste management behaviours. *J. Environ. Psychol.* **2011**, *31*, 21–26. [[CrossRef](#)]
24. Botetzagias, I.; Dima, A.-F.; Malesios, C. Extending the theory of planned behavior in the context of recycling: The role of moral norms and of demographic predictors. *Resour. Conserv. Recycl.* **2015**, *95*, 58–67. [[CrossRef](#)]
25. Sauer, U.; Fischer, A. Willingness to pay, attitudes and fundamental values—On the cognitive context of public preferences for diversity in agricultural landscapes. *Ecol. Econ.* **2010**, *70*, 1–9. [[CrossRef](#)]
26. Bortoleto, A.P.; Kurisu, K.H.; Hanaki, K. Model development for household waste prevention behaviour. *Waste Manag.* **2012**, *32*, 2195–2207. [[CrossRef](#)] [[PubMed](#)]
27. López Mosquera, N.; García, T.; Barrena, R. An extension of the theory of planned behavior to predict willingness to pay for the conservation of an urban park. *J. Environ. Manag.* **2014**, *135*, 91–99. [[CrossRef](#)] [[PubMed](#)]
28. Ajzen, I.; Fishbein, M. Attitude-behavior relations: A theoretical analysis and review of empirical research. *Psychol. Bull.* **1975**, *84*, 888–918. [[CrossRef](#)]
29. Ajzen, I. *Intentions to Actions: A Theory of Planned Behavior*; Springer: New York, NY, USA, 1985.
30. Schwartz, S.H. Normative influences on altruism. *Adv. Exp. Soc. Psychol.* **1977**, *10*, 221–279.
31. Davies, J.; Foxall, G.R.; Pallister, J. Beyond the intention-behaviour mythology an integrated model of recycling. *Mark. Theory* **2002**, *2*, 29–113. [[CrossRef](#)]
32. Chu, P.-Y.; Chiu, J.-F. Factors influencing household waste recycling behavior: Test of an integrated model. *J. Appl. Soc. Psychol.* **2003**, *33*, 604–626. [[CrossRef](#)]



33. Chen, M.-F.; Tung, P.-J. The moderating effect of perceived lack of facilities on consumers' recycling intentions. *Environ. Psychol. Nonverbal Behav.* **2010**. [[CrossRef](#)]
34. Barr, S. Factors influencing environmental attitudes and behaviors a UK case study of household waste management. *Environ. Behav.* **2007**, *39*, 435–473. [[CrossRef](#)]
35. Secondi, L.; Principato, L.; Laureti, T. Household food waste behaviour in EU-27 countries: A multilevel analysis. *Food Policy* **2015**, *56*, 25–40. [[CrossRef](#)]
36. Stefan, V.; Herpen, E.V.; Tudoran, A.A.; Lähteenmäki, L. Avoiding food waste by romanian consumers: The importance of planning and shopping routines. *Food Qual. Preference* **2013**, *28*, 375–381. [[CrossRef](#)]
37. Quested, T.E.; Marsh, E.; Stunell, D.; Parry, A.D. Spaghetti soup: The complex world of food waste behaviours. *Resour. Conserv. Recycl.* **2013**, *79*, 43–51. [[CrossRef](#)]
38. Principato, L.; Secondi, L.; Pratesi, C.A. Reducing food waste: An investigation on the behaviour of Italian youths. *Br. Food J.* **2015**, *117*, 731–748. [[CrossRef](#)]
39. Mondéjar-Jiménez, J.A.; Ferrari, G.; Secondi, L.; Principato, L. From the table to waste: An exploratory study on behaviour towards food waste of Spanish and Italian youths. *J. Clean. Prod.* **2016**, *138*, 8–18. [[CrossRef](#)]
40. Aschemann-Witzel, J.; Bech-Larsen, T.; De Hooge, I.; Amani, P.; Oostindjer, M. Consumer-related food waste: Causes and potential for action. *Sustainability* **2015**, *7*, 6457–6477. [[CrossRef](#)]
41. Carrus, G.; Passafaro, P.; Bonnes, M. Emotions, habits and rational choices in ecological behaviours: The case of recycling and use of public transportation. *J. Environ. Psychol.* **2008**, *28*, 51–62. [[CrossRef](#)]
42. Chin, W.W. The partial least squares approach to structural equation modeling. *Mod. Methods Bus. Res.* **1998**, *295*, 295–336.
43. Jöreskog, K.G.; Sörbom, D. *Lisrel 7: A guide to the Program and Applications*; SPSS: Chicago, IL, USA, 1989; Volume 2.
44. Everett, J.W.; Peirce, J.J. Curbside recycling in the USA: Convenience and mandatory participation. *Waste Manag. Res.* **1993**, *11*, 49–61. [[CrossRef](#)]
45. Ajzen, I. The theory of planned behavior. *Organ. Behav. Hum. Decis. Process.* **1991**, *50*, 179–211. [[CrossRef](#)]
46. Saha, P.; Ids, J. New hydropower development in Norway: Municipalities attitude, involvement and perceived barriers. *Renew. Sustain. Energy Rev.* **2016**, *61*, 235–244. [[CrossRef](#)]
47. Quintal, V.A.; Lee, J.A.; Soutar, G.N. Risk, uncertainty and the theory of planned behavior: A tourism example. *Tour. Manag.* **2010**, *31*, 797–805. [[CrossRef](#)]
48. Peters, A.; Gutscher, H.; Scholz, R.W. Psychological determinants of fuel consumption of purchased new cars. *Transp. Res. Part F* **2011**, *14*, 229–239. [[CrossRef](#)]
49. Schwartz, S.H. Normative influences on altruism. In *Advances in Experimental Social Psychology*; Berkowitz, L., Ed.; Academic Press: New York, NY, USA, 1977; pp. 221–279.
50. Conner, M.; Armitage, C.J. Extending the theory of planned behavior: A review and avenues for further research. *J. Appl. Soc. Psychol.* **1998**, *28*, 1429–1464. [[CrossRef](#)]
51. Raats, M.M.; Shepherd, R.; Sparks, P. Including moral dimensions of choice within the structure of the theory of planned behavior. *J. Appl. Soc. Psychol.* **1995**, *25*, 484–494. [[CrossRef](#)]
52. Kaiser, F.G. A moral extension of the theory of planned behavior: Norms and anticipated feelings of regret in conservationism. *Personal. Individ. Differ.* **2006**, *41*, 71–81. [[CrossRef](#)]
53. Arvola, A.; Vassallo, M.; Dean, M.; Lampila, P.; Saba, A.; Lähteenmäki, L.; Shepherd, R. Predicting intentions to purchase organic food: The role of affective and moral attitudes in the theory of planned behaviour. *Appetite* **2008**, *50*, 443–454. [[CrossRef](#)] [[PubMed](#)]
54. Hopper, J.R.; Nielsen, J.M. Recycling as altruistic behavior normative and behavioral strategies to expand participation in a community recycling program. *Environ. Behav.* **1991**, *23*, 195–220. [[CrossRef](#)]
55. Halvorsen, B. Effects of norms and opportunity cost of time on household recycling. *Land Econ.* **2008**, *84*, 501–516. [[CrossRef](#)]
56. Halvorsen, B. Effects of norms and policy incentives on household recycling: An international comparison. *Res. Conserv. Recycl.* **2012**, *67*, 18–26. [[CrossRef](#)]
57. Afroz, R.; Hanaki, K.; Hasegawa-Kurusu, K. Willingness to pay for waste management improvement in Dhaka city, Bangladesh. *J. Environ. Manag.* **2009**, *90*, 492–503. [[CrossRef](#)] [[PubMed](#)]
58. Sidique, S.F.; Lupi, F.; Joshi, S.V. The effects of behavior and attitudes on drop-off recycling activities. *Res. Conserv. Recycl.* **2010**, *54*, 163–170. [[CrossRef](#)]



59. Beijing Municipal Bureau of Statistics. *Beijing Statistical Yearbook 2013*; Beijing Municipal Bureau of Statistics: Beijing, China, 2013.
60. SPSS for Psychologists. Available online: <http://europepmc.org/articles/pmc2465031> (accessed on 30 April 2013).
61. Chan, L.; Bishop, B. A moral basis for recycling: Extending the theory of planned behaviour. *J. Environ. Psychol.* **2013**, *36*, 96–102. [[CrossRef](#)]
62. Kline, R.B. *Principles and Practice of Structural Equation Modeling*; Guilford Publications: New York, NY, USA, 2015.
63. Byrne, B.M. *Structural Equation Modeling with Amos: Basic Concepts, Applications, and Programming*; Routledge: Oxon, UK, 2013.
64. Hair, J.F.; Hult, G.T.M.; Ringle, C.; Sarstedt, M. *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM) Nova*; Sage: Thousand Oaks, CA, USA, 2014.
65. Sarstedt, M.; Ringle, C.M.; Smith, D.; Reams, R.; Hair, J.F., Jr. Partial least squares structural equation modeling (PLS-SEM): A useful tool for family business researchers. *Long Range Plan.* **2014**, *46*, 184–185. [[CrossRef](#)]
66. Kassam, K.S. Emotion and decision making. *Annu. Rev. Psychol.* **2015**, *66*, 799–823.
67. Frederiks, E.R.; Stenner, K.; Hobman, E.V. Household energy use: Applying behavioural economics to understand consumer decision-making and behaviour. *Renew. Sustain. Energy Rev.* **2015**, *41*, 1385–1394. [[CrossRef](#)]
68. Kaenzig, J.; Heinzle, S.L.; Wüstenhagen, R. Whatever the customer wants, the customer gets? Exploring the gap between consumer preferences and default electricity products in Germany. *Energy Policy* **2013**, *53*, 311–322. [[CrossRef](#)]
69. Wegwarth, O.; Kurzenhäuser-Carstens, S.; Gigerenzer, G. Overcoming the knowledge–behavior gap: The effect of evidence-based HPV vaccination leaflets on understanding, intention, and actual vaccination decision. *Vaccine* **2014**, *32*, 1388–1393. [[CrossRef](#)] [[PubMed](#)]
70. Shaw, D.; McMaster, R.; Newholm, T. Care and commitment in ethical consumption: An exploration of the ‘attitude–behaviour gap’. *J. Bus. Ethics* **2015**, *136*, 251–265. [[CrossRef](#)]
71. Gamba, R.J.; Oskamp, S. Factors influencing community residents’ participation in commingled curbside recycling programs. *Environ. Behav.* **1994**, *26*, 587–612. [[CrossRef](#)]



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