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Drivers of Residents' Home Composting Intention: Integrating the Theory of Planned Behavior, the Norm Activation Model, and the Moderating Role of Composting Knowledge

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Abstract: Home composting is judged as an effective municipal waste management option in which household contribution is essential, but it has a low adoption. The objectives of the study were to determine the factors that influence home composting intention and identify the moderating role of composting knowledge in the model, using the combined model of the theory of planned behavior (TPB) and norm activation model (NAM). A structured questionnaire was applied to a sample of 367 residents of Isfahan city, Iran, randomly selected. Data were analyzed using cluster analysis, discriminant analysis, PLS-SEM, and PLS-MGA. Cluster analysis grouped the three clusters based on the constructs of the integrated model, and this result was confirmed by discriminant analysis. Findings show that attitude, subjective norm, and perceived behavior control can predict the intention to compost. Study results confirmed the positive effect of awareness of the consequences of composting on ascribed responsibility to compost at home, of responsibility to the personal norm, and of the personal norm on intention to compost at home. Furthermore, it was observed that composting knowledge moderates the relationship between subjective norm and behavioral intention, and the one between perceived behavioral control and behavioral intention. The integrated model had more predictive power than the TPB model. The fit statistic of the integrated model was good and 71% of the variance for intention behavior toward home composting. The insights on factors affecting residents' intention to compost obtained from this study can be used in measures and programs that reinforce and stimulate home composting.

Keywords: composting; food waste; norm activation model; theory of planned behavior; pro-environmental behavior; pro-social behavior

1. Introduction

Urban households produce a large proportion of municipal waste, imposing a high cost on local governments to manage this waste [1]. About 20 million tons of waste are produced annually in Iran, and the daily waste generation per capita is 0.60 kg [2,3]. Consequently, municipal solid waste management has a special place in municipal services [4]. It also has a significant environmental impact and other adverse effects, such as soil and underground water pollution, greenhouse gas emissions, consumption of ample land resources for storage, deterioration of residents' quality of life, public health risks [5–8]. A closer look at health plans, population growth rates, urban development, and urbanization shows that presenting appropriate waste management is recognized as an important duty in many societies, including in developing countries [9]. These countries often do not have

a solid waste collection system, or they have an inadequate system. At the same time, it was proven that municipal solid waste disposal has a severe negative environmental impact [10].

The best economical way to deal with these problems is to decrease limit waste production [11,12]. Recycling is also useful in removing such environmental hazards [13]. Composting was indicated as a viable option for municipal waste, due to its high moisture and low calorific value [14]. The use of compost can improve soil quality contributing to the increase of agricultural productivity. The compost quality and its effects depend on various compost parameters, such as carbon-nitrogen ratio, microbial activity, germination index, cation exchange capacity (CEC), humic substances content, compost concentration of water soluble carbon (WSC), dissolved organic matter, ratios of NH_4^+—N and NO_3^-—N, WSC/TN, and WSC/organic-N [15,16]. Compost quality and stability depend on the organic wastes used for the compost production and therefore compost quality evaluation should be made for each case in order to determine the cost–benefit ration, suitable uses, etc.

Composting can bring economic benefits, reduce the negative environmental impact of waste (such as resource use—e.g., land use, use of chemical fertilizers), and improve soil conditions (through water retention and soil quality improvement) [17]. Also, it can be used by farmers as a means to improve soil quality [18]. Compared to other waste disposal methods, composting was found to be more efficient in terms of economic benefit, investment level, operating cost, and with high reduction of land use, [19]. Composting of municipal waste, especially food waste, has net advantages compared to landfilling or incineration, such as the production of harmless, stable, and rich in nutrients soil and reduction of waste volume and weight [20]. Some studies recommended its use in combination with other methods, such as recycling [21] or anaerobic digestion [17]. A study about the biowaste in Tunisia, including food waste, recommended that the consideration of a combination of social, environmental, and economic objectives (and not only the profit) must be considered in selecting the waste management option, for example reducing environmental burden, generating work opportunities and revenues, and increasing public awareness [22]. A study in Ahvaz city, Iran, indicated that although the composting option showed benefits, its combination with other waste management options was the most suitable solution [23], thus suggesting that particular features of each city and of municipal waste composition must be considered.

There are also risks associated with compost use besides its benefits. Studies revealed that the low level of separate waste collection decreases composts quality, generating higher levels of heavy metals and other polluting substances [24]. The main heavy metal contamination sources for compost are paints, electronics, ceramics, plastics, and inks/dyes [24]. Consequently, compost composition must be closely monitored to avoid the accumulation of harmful substances in soils and plants and their harmful effects on human health and the environment [25–28].

Global statistics show that more than half of all solid wastes are recyclable, while significant amounts of recyclable wastes are mixed with other wastes [29], and 13.5% of municipal solid waste (MSW) is recycled [30], thus indicating the need for sustainable waste management systems.

Food waste represents a significant part of household waste. Food waste also represents the main part of urban sold waste and shows an increasing trend over the years [31]. It was suggested that, due to its energy and nutrient content, food waste treatment through anaerobic digestion or composting could generate net environmental benefits [32]. Production of organic compost brings advantages such as the decreased amount of collected waste and consolidation of pro-environmental consciousness and behavior by engaging people in this action. The use of organic compost is more environmentally friendly compared to chemical soil quality enhancers. Similar to composting agricultural waste [33], composting household waste can reduce emissions and provide organic fertilizer and soil amendment. Moreover, organic compost has the property of retaining toxic elements such as cadmium, zinc, and lead, so it can be used to reduce the pollution of contaminated soils [34]. Globally,

only 5.5% of municipal solid waste is composted, while 44% of municipal solid waste is food and green [30], so it has the potential to be used. A study on an Ethiopian city highlighted the high share of household waste (87%) in the total municipal waste and its high recycling potential [35]. Therefore, household waste generators play a significant role in the management of MSW. In Iran, due to the lack of public participation in recycling programs and the lack of funding required to employ public participation, concerns are raised about municipal waste management [36]. Studies have reported that 60–80% of MSW in developed countries is returned to the consumption cycle through recycling [9]. In high and upper-middle-income countries, the share of composted waste is 8% and of recycled waste (and other advanced methods) is 35%, while in lower-middle and low-income countries, composted and recycled waste account for 10% each [37]. In Iran, 43% of the country's waste is organic waste, and only 8% of household waste is recycled [38].

Achieving integrated municipal solid waste management begins with understanding people's norms, attitudes, and behavioral intentions and providing solid waste management (SWM) infrastructure by the local government [39] or private actors. Attempts to develop SWM in developing countries, including Iran, have concentrated on cost-effective collection, separation, and recycling plans. Although these programs have numerous environmental, social, and economic benefits, their implementation has faced social issues, such as the absence of recognition and engagement in recycling actions [9]. It is worth mentioning that few studies have examined norms, attitudes, knowledge, and behavioral intentions concerning household composting. Accordingly, this research aimed to contribute to sustainable waste management in Isfahan city by generating knowledge about residents' intention to compost at home. The study objective was to determine the drivers for home composting intention (HCI), using the combined model of the Theory of planned behavior and the Norm activation model. Besides, the moderating role of composting knowledge was highlighted. Isfahan city was selected from Isfahan province, Iran, as the study area. This city has a large population, and consequently, it has problems with waste generation, and the local government incurs many municipal waste management costs. Despite the implementation of the waste management program, it still faces problems. To promote organic waste management, it is necessary to design public participation programs that require understanding citizens' waste management behavior. A conceptual model was developed to understand the constructs affecting organic waste recycling behavior by combining the two models of norm activation and planned behavior. It was assumed that the level of composting knowledge played a moderating role in this integrated model.

The theoretical model based on the theory of planned behavior (TPB) and norm activation model (NAM) is first introduced in the following sections, and then research hypotheses are developed. Subsequently, the research method and data analysis are presented. Next, discussions and suggestions regarding the results are made. The limitations of the study and future research directions are highlighted in the following. Finally, the conclusions section highlights the main implications of the results.

2. Literature Review

2.1. Norm Activation Model

The NAM has been broadly utilized to predict an individual's pro-social and pro-environmental behaviors [40]. Pro-social behavior refers to an individual's performance that is aimed to support others and includes a wide range of behaviors, such as aid, sharing resources, interests, and collaborating. This feature is closely related to a person's morality. Value, other personal and social factors influence a persons' pro-social behaviors [41]. Pro-environmental behavior is marked as pro-social behavior because pro-environmental behaviors have affirmative outcomes for others [42]. According to NAM, pro-environmental behaviors are estimated by three main components, namely awareness of the consequences (AC), ascription of responsibility (AR), and personal norm (PN) [43]. AC refers to whether one is knowledgeable of the positive or negative consequences of a behavior [44,45]. AR is defined as a sense of responsibility for the consequences of one's

behavior that affects society [40]. PN is regarded as an ethical duty to do or not to do a specific behavior [44,45]. Behavioral intention (BI) represents people's intention to behave in a certain way. Intention is considered to be the immediate antecedent of behavior [46]. According to this theory, awareness of waste recycling results leads to a higher ascription of responsibility. As a result, this sense of responsibility positively influences personal norm [47]. Ultimately, this leads to a person who has an ethical personal norm, which positively affects BI [48]. The opposite is also true and means that if a person has a low personal norm, he/she is less likely to recycle his/her household waste [47].

Several environmental and social studies have examined the relationship between AC, AR, PN, and BI [40,44,49–54]. For example, Bamberg et al. [44] showed that behavioral intent to use public transport is influenced by the personal norm. Zhang et al. [54] showed that employees' ascription of responsibility and personal norm positively affected awareness of the consequences of power loss in organizations. The results of De Groot & Steg [40] and Xiaojie et al. [52] showed that personal norm is influenced by personal awareness of the consequences and by ascription of responsibility for decreasing car use. Bamberg and Moser [49] and Chen and Tung [50] showed that awareness of the consequences is positively related to pro-environmental behavior. Ibtissem [51] reported the positive influence between awareness of consequences and ascription of responsibility on BI concerning energy conservation. Yuan et al. [53] showed that personal norm positively and significantly affected citizens' behavior towards kitchen waste recycling. Similarly, the influence of personal norm on the willingness to adopt a greywater treatment system was proved in a study on households in Ghana [55]. In the present study, the following hypotheses were developed in line with this theory.

Hypothesis 1 (H1). *AC of composting positively affects AR to compost at home.*

Hypothesis 2 (H2). *AR to compost at home positively affects PN about home composting intention.*

Hypothesis 3 (H3). *PN related to composting positively affects BI to compost at home.*

2.2. Theory of Planned Behavior

The TPB was developed by adding perceived behavioral control (PBC) to the theory of reasoned action. TPB has been widely employed in predicting different types of human behavior [56]. TPB theory is one of the leading theories for predicting socio-psychological behaviors [57]. TPB assumes that human beings act reasonably. They look at the information available and implicitly or explicitly consider the consequences of their actions. The theory considers that three factors, namely, attitude (ATT), subjective norm (SN), and perceived behavioral control (PBI), predict behavioral intention (BI) [58]. Attitude (ATT) refers to a person's favorable or unfavorable assessment of a certain behavior [40]. SN is defined as the understanding of social pressure to do or not to do a behavior [59]. PBC refers to how people perceive the easiness or difficulty of doing a particular behavior [60]. Therefore, the theory assumes that a person with a more desirable ATT, SN, and better PBC is more likely to demonstrate stronger BI [57]. Numerous studies have examined various human behaviors, including environmental and social, using the TPB [50,61–64]. The intention towards green composting and green composting adoption in Malaysia was investigated through TPB and extended TPB which added new variables, such as perceived benefits and eco-literacy [65]. Yuan et al. [53] indicated that SN, ATT, and PBC positively impact household waste recycling. SN, ATT, and PBC and perceived availability influenced the Belgian consumers' intention to consume sustainable dairy [66]. Davies et al. [61] showed that SN, ATT, and PBC significantly affect recycling intention. Mosler et al. [64] indicated that ATT affects household waste recycling intention. Chen & Tung [50] showed that the main determinants of recycling intention include SN, PBC, and ATT. Khan et al. [62] showed that SN, ATT, and PBC influence recycling intention. Soorani and Ahmadvand (2019) used the TPB and observed that the feeling of guilt was a major stimulant in decreasing food waste. Pakpour et al. (2014) also used TPB and found out that ethical norms best-predicted

household waste behavior. Also, subjective time pressure (as a form of PBC) hindered citizen participation in composting [67]. In this research, the following hypotheses were developed in line with the TPB.

Hypothesis 4 (H4). *ATT towards home composting positively affects BI to compost at home.*

Hypothesis 5 (H5). *SN related to home composting positively affects BI to compost at home.*

Hypothesis 6 (H6). *PBC related to home composting positively affects BI to compost at home.*

2.3. Merging NAM and TPB

NAM and TPB have been employed to investigate pro-environmental and pro-social behaviors. Numerous socio-psychological studies have shown that the two constructs of TPB and NAM have been successfully integrated into one another, increasing the predictive power of environmental models [68–70]. Park & Ha [71] showed that PN of NAM, together with SN, ATT, and PBC of TPB, impact pro-environmental behavior. Han & Hyum [71] used the combination of NAM and TPB to investigate museum travelers' pro-environmental intentions and showed that the combined model's predictive ability was significantly improved compared to that of the TPB and the NAM. Rezaei et al. [72] also proved that the predictive power of the TPB-NAM combined model for the intention to use integrated pest management was superior to that of TPB alone. Combined TPB and NAM were successful in predicting the recycling behaviors of Taipei City residents [73].

This study proposes a relationship between four variables of AC, ATT, SN, and PN by combining NAM and TPB. Firstly, the relationship between AC and ATT has been validated through existing studies. For example, Meng & Han [74] reported the direct influence of AC on ATT and its indirect effect on BI. Also, Han & Hyun [75] showed that individuals with a high AC level of a specific behavior could have a positive ATT toward that behavior. Based on the above relationships, the hypothesis mentioned below is suggested.

Hypothesis 7 (H7). *AC of composting positively affects ATT on home composting.*

Secondly, the causal relationship between SN and PN has been approved by many studies. SN precedes PN because SN reflects the social pressure on a person that guides him/her to decide whether or not a behavior is correct [44,76,77]. Park & Ha [71] showed that a person's understanding of recycling is socially acceptable and will guide his/her decision to feel required to recycle. Furthermore, Han et al. [78] recognized SN's significant impact and confirmed the positive causal relationship between SN and PN. The influence of SN on household recycling behavior was investigated in collectivistic societies, and it was demonstrated that it supports the recycling act [79]. However, SN is surpassed by economic rewards, which work better in promoting waste separation [80]. Based on the above, it is reasonable to infer that the social pressure linked to eco-friendly behavior in the home composting could influence peoples' ethical duty to act pro-environmentally. Therefore, the following hypothesis is presented:

Hypothesis 8 (H8). *SN about composting positively affects PN related to composting.*

2.4. The Moderating Role of Composting Knowledge

Having enough knowledge of a particular subject can reinforce the ability to do or not do a specific activity in various ways [81]. In this study, composting knowledge means that a person knows how to compost organic waste. Several studies have pointed to knowledge, as a moderator of the relationship between TPB and NAM, on BI [82,83]. For example, Barr [84] showed that more knowledge leads to a stronger intention towards waste management actions. Furthermore, Fu & Elliott [85] reported that having sufficient knowledge of technologies can have a moderating effect on BI relationships. They concluded that knowledge has a significant moderating effect on the relationship between mental norm

and behavioral intention. Besides, Edgerton et al. [86] showed the significant effect of composting knowledge on BI. Additionally, Takahashi et al. [87] indicated that composting knowledge is an essential variable for BI. Wang et al. [88] tested the moderating roles of knowledge and other variables on the relationship between perceived behavior control and low-carbon household waste sorting behavior. According to the above, composting knowledge can play a significant role in BI. In order words, knowledge shows its effect by intervening in the relationship between the independent variable and the dependent variable (see Figure 1). This effect can be to enhance or decrease the effect of independent variables. Based on the empirical background, the below-mentioned hypotheses were defined as follows:
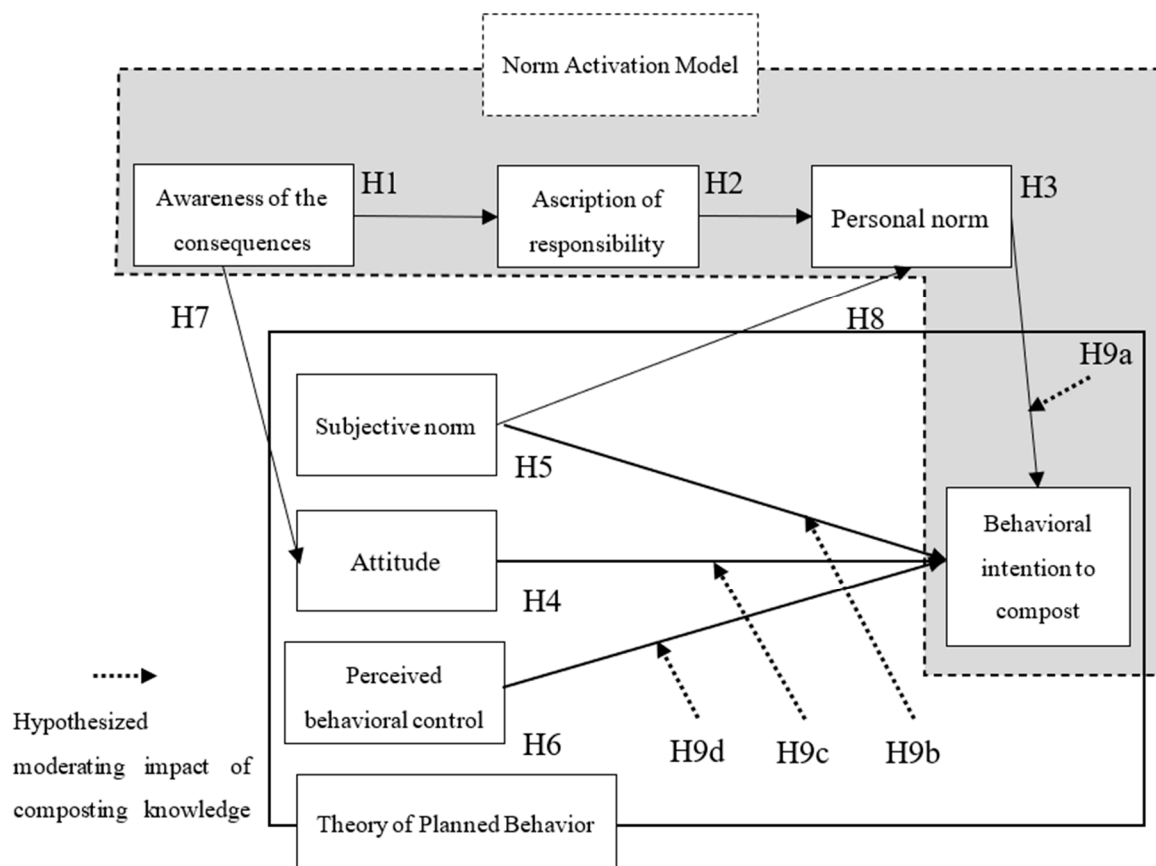

Figure 1. Integrated conceptual model. Note: Dotted arrows indicate the moderating role of composting knowledge as combined into the Integrated conceptual model.

Hypothesis 9a (H9a). *Composting knowledge plays a moderating role in the relationship between PN about composting and BI to compost.*

Hypothesis 9b (H9b). *Composting knowledge plays a moderating role in the relationship between ATT towards composting and BI to compost.*

Hypothesis 9c (H9c). *Composting knowledge plays a moderating role in the relationship between SN concerning composting and BI to compost.*

Hypothesis 9d (H9d). *Composting knowledge plays a moderating role in the relationship between PBC on composting and BI to compost.*

2.5. Integrated Conceptual Model

The conceptual model of the research is presented in Figure 1. NAM is included AC, AR, PN, and BI, and TPB is embedded in the full range, including SN, ATT, PBC, and BI. The relationship between AC and ATT is obtained by integrating the two theories. Moreover, composting knowledge moderates direct relationships with BI. In general, the conceptual model consists of seven latent constructs and 12 hypotheses.

3. Methods

3.1. Study Area

Isfahan is a city in Iran with a population of around 0.7 million households and with 2.2 million persons. Iran's third-largest city by population is Isfahan. Isfahan is an important city as it is placed at the crossing of the two principal north-south and east-west paths that traverse Iran, and it has a dry climate. Isfahan waste production per capita is about 0.5 kg/day. In Isfahan, 1000 tons of solid waste is generated daily by residents, which includes 650 tons of compostable organic waste. There are about 70 fixed waste stations in Isfahan that receive waste from households based on defined processes, and these stations manage, separate, and transfer the waste to special centers [89,90].

3.2. Research Tools, Statistical Population, and Data Collection

The research measurement tool was based on the components of the research model based on previous research. The five items of awareness of the consequences were adapted from Bronfman et al. [91] and Chen & Tung [50]. Besides, ascription of responsibility was drawn by five items used by Schwartz [43] and Bronfman et al. [91]. Also, five items of personal norm were drawn from Tonglet et al. [92] and Liao et al. [63]. The five attitude items were taken from Liao et al. [63] and Zeweld et al. [93]. Subjective norm was adopted using three items by Oztekin et al. [94]. Four items of perceived behavioral control were drawn from Liao et al. [63]. Finally, eight items of intention to compost were measured from Taylor & Todd [95]. In addition, composting knowledge was measured with a binary question (low or high) adapted from Zhou et al. [96].

All constructs except for BI were measured using a 5-point Likert scale from strongly disagree = 1 to strongly agree = 5. The BI was assessed on a 5-point Likert scale from not at all = 0 to very high = 4. The questionnaire items were obtained from an English-language study, then, they were translated into Persian, and then back to English to assure correctness. The questionnaire's validity was assessed by a panel of specialists. The questionnaire was pre-tested in a pilot study on 30 persons. Khomeini Shahr (a county in the province of Isfahan). A family member who was in charge of managing the house was interviewed. Cronbach's alpha was higher than 0.6. As a result, the questionnaire's reliability was validated [97]

The survey was conducted using a face-to-face questionnaire. Respondents were randomly selected from the specified statistical population, including household heads managing their own homes in Isfahan City, Iran. The sample size was calculated by the Cochran formula (Equation (1)) [98] (*n* = 367), selected through a random sampling method.

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

4. Data Analysis

4.1. Descriptive Statistics

Table 1 shows the demographic characteristics of the respondents. According to Table 1, 36.2% of samples were males (*n* = 133) and 234 were females (63.8%). This outcome supported prior research indicating females were more sensitive to trash management than males [64,99]. Age classification showed that most people were in the 41–50 class. Their mean age was 45 years old, with a mean household of 3.7 persons. In addition, most of

them had a high school education. (56.9%, *n* = 209). Lastly, most of the samples indicated that they were housekeepers and retirees (73.3%, *n* = 269).

Table 1. Demographic characteristics of the sample (*n* = 367).

Variable	*n*	Percentage
Gender		
Male	133	36.2
Female	234	63.8
Education level		
Less than 12 years of education (primary school, secondary school, part of high school)	65	17.7
12 years of education (high school)	209	
Associate 14 years of education (high school + 2 years of academic education)	59	56.9
Bachelor and higher (high school + 4 years or more of academic education)	34	16.1
Employment status		
Employed	98	26.7
Housekeeper and/or retiree	269	73.3
Type of home		
House with a yard	170	46.3
Apartment	197	53.7
Composting knowledge		
Low	222	60.5
High	145	39.5
Age (average)	(45 years old)	
20–30	11	2.9
31–40	67	18.2
41–50	168	45.7
51<	121	32.9
No of household members (average)	3.7	

Almost half of the interviewed people have a garden at city level, 46.3% of people have a garden. Regarding the current and past composting behavior of the Isfahan residents, only a few of the interviewed people were composting and they were using home-made composters, buried in the home garden. None of the participants in the study used a composting bin purchased from the market.

4.2. Confirmatory Factor Analysis

Confirmatory factor analysis in SmartPLS 2.0. M3 software was used to evaluate the measurement model. According to Table 2, all factor loadings were from 0.4 to 0.9, and they were significantly loaded to their associated construct at *p* > 0.001. Also, Cronbach's alpha for all variables was more than 0.6 [97]. The range of composite reliability (0.948–0.770) showed a high internal consistency level for each variable [100].

As indicated in Table 3, the average variance extracted (AVE) was more than 0.400 [101], which verified the convergent validity of all constructs. In addition, the AVE values for each construct exceeded squared correlations (R^2) between all the possible pairs of variables, indicating discriminant validity [102]. Lastly, the correlation coefficient of variables was less than 0.8, so there was no collinearity between variables [103]. Besides, tolerance (Tol) and the variance inflation factor (VIF) were calculated to detect multicollinearity. Tol and VIF of all variables can be seen in Table 3, indicating no multicollinearity.

Table 2. Confirmatory factor analysis: items and loadings.

Construct and Scale Item	Standardized Loading
Awareness of the consequences	
(α = 0.685, Composite reliability = 0.793)	
Composting helps to protect the environment.	0.764
Composting reduces the amount of waste that goes into landfill.	0.493
Composting preserves natural resources.	0.703
Composting saves money and energy.	0.745
Composting creates a better environment for the future generation.	0.572
Ascription of responsibility	
(α = 0.681, Composite reliability = 0.770)	
Everyone should be responsible for recycling waste.	0.860
Recycling my household waste is always worth the effort.	0.594
The responsibility of recycling waste is borne by the people who produce it.	0.448
I feel a duty to increase the culture of waste recycling.	0.535
Despite the low volume of waste produced in my home, I feel a duty to protect the environment through recycling.	0.699
Personal norms	
(α = 0.933, Composite reliability =0.949)	
It would be wrong of me not to recycle my household waste.	0.900
I would feel guilty if I did not recycle my household waste.	0.931
Not recycling goes against my principles.	0.898
I feel morally committed to protecting the environment.	0.909
Everybody should share the responsibility to recycle household waste.	0.802
Subjective norms	
(α = 0.625, Composite reliability =0.787)	
Many of my friends find compost useful.	0.9
Many of my relatives find compost useful.	0.489
People who influence my decisions think that I should compost.	0.805
Perceived behavioral control	
(α = 0.765, Composite reliability = 0.850)	
I know what items can be composted.	0.694
I have tools to compost my household waste.	0.851
I know how to compost my household waste.	0.728
I have enough time for composting.	0.782
Attitude	
(α = 0.708, Composite reliability = 0.808)	
Composting is sensible.	0.439
Composting is rewarding.	0.811
Composting is hygienic.	0.817
Composting is a good idea.	0.824
Composting is necessary.	0.429
Behavioral intention	
(α = 0.87, Composite reliability = 0.899)	
Intention to buy the waste composting equipment	0.902
Intention to compost home-grown plant waste such as tree leaves, branches	0.466
Intention to compost kitchen waste	0.414
Intention to compost garden weeds	0.671
Level of planning to purchase the waste composting equipment	0.888
Level of planning to compost home-grown plant waste such as tree leaves, branches	0.737
Level of planning to compost kitchen waste	0.739
Level of planning to compost home garden waste	0.899

According to the structural model, SEM based on the PLS method was used to obtain Q^2 and R^2 coefficients. Therefore, the prediction accuracy and power of the model can be evaluated. As shown in Table 4, the Q^2 value ranged from 0.161 to 0.442, indicating the robustness of the model [104]. The R^2 was 71.18%, which shows the model's high prediction power [105]. In the next step, the overall suitability of the model was evaluated based on the fit index. Goodness-of-fit (GoF) is used to test the model fit. It is defined as

the geometric mean of the average communality and average R^2. According to Table 4, the GoF value was 0.446, and the overall fit of the model was evaluated to be at an appropriate level and enough support to verify the PLS model [106].

Table 3. Descriptive statistics and associated measures.

	VIF	Tol	Mean	AVE	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) AC	1.21	0.826	2.989	0.441		0.271 [a]	0.385	0.088	0.238	0.324	0.379
(2) AR	1.665	0.601	3.246	0.414	0.073 [b]		0.534	0.474	0.521	0.431	0.703
(3) PN	2.051	0.488	3.167	0.791	0.148	0.285		0.52	0.471	0.597	0.698
(4) SN	1.64	0.61	2.946	0.566	0.008	0.224	0.27		0.515	0.451	0.608
(5) PBC	1.79	0.559	3.668	0.587	0.057	0.271	0.222	0.265		0.546	0.637
(6) ATT	1.844	0.542	3.185	0.476	0.105	0.186	0.356	0.203	0.298		0.648
(7) BI	-	-	2.182	0.543	0.144	0.494	0.487	0.369	0.406	0.42	

Notes 1: Tol: Tolerance; VIF: Variance Inflation Factor. Notes 2: a. Correlations are above the diagonal and b. squared correlations are below the diagonal.

Table 4. Evaluation of R^2 and Q^2 of the integrated model.

Construct	SSO	SSE	Q^2(=1−SSE/SSO)	R^2 TPB Model	Integrated Model
HCI	2936	1635.5968	0.4429	0.675	0.7118
AR	1835	1538.2386	0.1617		0.1419
ATT	1835	1359.9951	0.2589		0.1204
PN	1835	586.8599	0.3202		0.4586

4.3. Structural Equation Modeling

SEM-based on PLS was used to test hypotheses 1 to 8. Based on the results, all hypotheses were confirmed. More accurately, Hypothesis 1, which pointed to the effect of AC on AR, was statistically confirmed ($\beta = 0.376$, $p < 0.0001$). Moreover, AR had a significant positive effect on PN ($\beta = 0.173$, $p < 0.0001$), so Hypothesis 2 is confirmed. The results indicated that PN positively affects BI ($\beta = 0.302$, $p < 0.0001$); thus, Hypothesis 3 was also confirmed. According to the TPB model, attitude ($\beta = 0.276$, $p < 0.0001$), SN ($\beta = 0.349$, $p < 0.0001$) and PBC ($\beta = 0.198$, $p < 0.0001$) showed a positive and significant effect. Therefore, Hypotheses 4, 5, and 6 were confirmed (Table 5). As assumed, AC positively affects ATT ($\beta = 0.347$, $p < 0.0001$), and Hypothesis 7 was confirmed. Finally, the results showed that SN influenced PN; thus, Hypothesis 8 was confirmed. The significance level of 0.0001 means that the error in the estimates obtained is less than 0.0001. In other words, more than 99.9999 H_0 has been rejected. The existence of strong relationships between independent variables on behavioral intention and the lack of VIF and Tol (Table 3) between them are factors affecting the level of significance.

Table 5. Standardized parameter estimates of the structural model.

Path	TPB Model Coefficients (β)	*t*-Value	Integrated Model Coefficients (β)	*t*-Value	Hypothesis
ATT→BI	0.412	5.054 *	0.276	4.218 *	Supported
SN→BI	0.356	5.247 *	0.349	6.034 *	Supported
PBC→BI	0.215	2.740 *	0.198	3.458 *	Supported
AC→AR	-	-	0.376	9.924 *	Supported
AR→PN	-	-	0.173	5.869 *	Supported
PN→BI	-	-	0.302	5.847 *	Supported
AC→ATT	-	-	0.347	7.903 *	Supported
SN→PN	-	-	0.301	5.740 *	Supported

Notes 1: * $p < 0.0001$.

4.4. Moderating Role of Composting Knowledge

PLS-MGA is a multi-group analysis method that was employed to test the moderating role of composting knowledge. According to this test, if the p-value is less than 0.05 for the mean difference of group-specific path coefficients, the result is significant at 5% probability.

The relationship between PBC and BI was significantly moderated by composting knowledge. ($p < 0.05$), so Hypothesis 9d was confirmed (Table 6). More precisely, the high-knowledge group's path coefficient ($\beta = 0.545$) was higher than the low-knowledge group ($\beta = 0.087$). Besides, the moderating role of composting knowledge on the relationship between SN norm and BI was confirmed. This showed that the role of SN on BI was significantly different from composting knowledge. Therefore, hypothesis 9c was confirmed. According to the composting knowledge group, the path coefficient was positive in the high-knowledge group and negative in the low-knowledge group. Finally, the moderating role of composting knowledge in hypotheses 9a and 9b was not statistically confirmed as expected.

Table 6. Results of testing the moderating role of composting knowledge.

	Path	The Low Knowledge		The High Knowledge		The Difference in Slopes Test	Hypothesis
		β	t-Value	β	t-Value	t-Value	
H9a	PN→BI	0.1153	0.0762	0.0139	0.0868	0.793	Not supported
H9b	ATT→BI	0.2002	0.1488	0.2224	0.1074	0.123	Not supported
H9c	SN→BI	−0.2833	0.1583	0.5084	0.1044	5.037	supported
H9d	PBC→BI	0.0879	0.1094	0.5455	0.1169	2.620	supported

5. Cluster Analysis

To group the individuals, cluster analysis k-mean was used. For this purpose, research model variables were used. As shown in Table 7, the respondents were grouped into three groups: 53% belonged to the first group, 17% belonged to the second group, and 30% belonged to the third group. As can be seen, the groups have a significant difference from each other in all variables of the integrated model. The results of ANOVA (analysis of variance) confirm this issue. ANOVA is used to analyze the differences among means and in this study, it shows that the first cluster is different from the other two clusters in terms of home compost intention. This cluster tends to produce compost at home by a large margin. The first cluster is different from the other two clusters regarding all constructs except for the subjective norm construct.

Table 7. Analysis of variance of integrated model constructs for the three clusters.

Construct	The Average Construct of Cluster			F	Sig.
	1 (n = 196)	2 (n = 65)	3 (n = 106)		
HCI	3.785 [a]	2.486 [b]	2.494 [b]	276.408	0.000
AC	3.250 [a]	2.273 [b]	2.945 [c]	65.257	0.000
AR	3.687 [a]	2.680 [b]	2.775 [b]	167.266	0.000
PBC	4.040 [a]	3.334 [b]	3.184 [b]	77.302	0.000
PN	3.874 [a]	2.218 [b]	2.464 [c]	316.005	0.000
SN	3.334 [a]	3.421 [a]	2.109 [b]	222.558	0.000
ATT	3.565 [a]	2.600 [b]	2.839 [c]	96.652	0.000

Different letters indicate a significant difference between the average of each row.

A chi-square test was then performed to determine the differences between the clusters in terms of demographic characteristics. According to the Chi-square test, clusters are significantly different in terms of the type of home, gender, composting knowledge, and occupation, but in the two cases, age and level of education are not significantly different.

As it turns out, gender is an influential factor in the set of tendencies. This result has also been evident in the type of answering questions. This finding is consistent with previous findings by researchers such as Chu and Chiu [99] and Mosler [64].

Having a courtyard is one of the most important issues in the field of home composting. As it is visible in Tables 7 and 8, cluster number one has a significant and appropriate difference with other clusters in most variables, including having a yard at home. However, there were people who, despite not having a yard, intended to produce compost at home. Moreover, according to the chi-square results, retirees, housewives, women in general, and people with high composting knowledge were more inclined to home composting. It can be argued that being a housekeeper, having adequate space for composting and sufficient knowledge for this work are demographic factors influencing the intention to compost. Also, the association of motivational and normative factors such as the desire to perform a pro-environmental behavior increases the likelihood to intend to compost.

Table 8. Demographic differences of the three clusters.

Demographics	Cluster 1 (n = 196)	Cluster 2 (n = 65)	Cluster 3 (n = 106)	X^2 (*df*)	Sig.
Type of home					
House with a yard	110	20	40	17.30 (2)	0.0001
Apartment	86	45	66		
Gender					
Male	38	35	60	51.83 (2)	0.0001
Female	158	30	46		
Composting knowledge					
Low	7	51	76	197.75 (2)	0.0001
High	189	14	30		
Education level					
High school	33	9	23	6.09 (6)	0.4120
Diploma	120	36	53		
Associate	28	11	20		
Bachelor and higher	15	9	10		
Job					
Employed	42	25	31	7.72 (2)	0.0210
Housekeeper and/or retiree	154	40	75		
Age					
20–30	2	0	1	4.330 (6)	0.631
31–40	39	15	21		
41–50	93	31	41		
>51	62	19	43		

A discriminant analysis was used to determine the accuracy of clustering performance. According to the results of the discriminant analysis, two functions were used for this purpose. The first function could explain 74% of the variance and its canonical correlation equal to 0.873, and the second function could explain 26% of the variance and its canonical correlation of 0.728. Wilks' Lambda's results show that the second function has played a dominant role in clustering individuals; the values of Wilks' Lambda = 0.111 and Chi 2 = 792 in the first function and the values of Wilks' Lambda = 0.469 and Chi 2 = 273 in the second function confirm this. Overall, 94.2% of the clustering done by diagnostic analysis was correctly performed. Canonical discriminant functions can be seen in Figure 2.
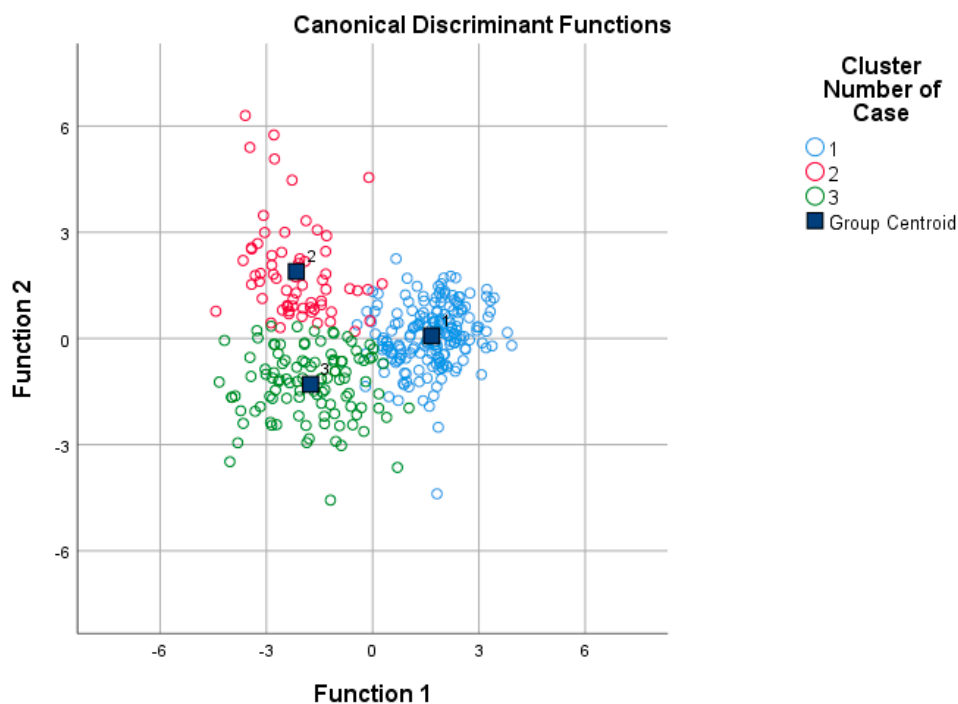
Figure 2. Clustering diagram of discriminant analysis.

6. Discussions and Implications

This study aimed to combine NAM and TPB into one theoretical framework to examine eco-friendly BI to use home composting. Also, the study demonstrated that composting knowledge as a moderating variable played a role. In other words, a person's behavior is greatly influenced by his/her knowledge. Data analysis was performed on data collected from 367 residents of Isfahan city, Iran, randomly selected. All research hypotheses were statistically confirmed. Furthermore, composting knowledge played a moderating role in the relationship between PBC and BI (H9d) and SN and BI (H9c). This means that the strength of the relationships depends on a person's knowledge and pro-environmental behavior. According to the research findings, the following theoretical and managerial implications are provided.

6.1. Theoretical Implications

The present study attempted to combine two NAM and TPB models to describe the creation of eco-friendly BI in the context of home composting. The proposed conceptual model was used in previous studies to specify the essential determinants of various environmental behaviors [71,75,77].

According to the results, this model had a high ability to predict BI. The results showed that the constructs of NAM and TPB were significantly associated with each other. More specifically, AC positively affected ATT (Hypothesis 7). This means when a person is aware of the positive results of composting at home, he or she is likely to respond positively to home composting. Besides, SN played an essential role in the creation of PN (hypothesis 8). Thus, individuals are more likely to be influenced to pursue environmentally-friendly behavior under social pressure [49,71,77]. Therefore, the present study reinforces the literature by presenting study results on the relationships among critical constructs of composting at home. It is said that the behavior leading to composting is a manifestation of being pro-environmental. So, raising awareness of waste composting increases a person's AR, which points to pro-environmental behavior. On the one hand, individuals who have a high level of pro-environmental behavior show higher AR. On the other hand, having an AR had a positive impact on PN (Hypothesis 2). In addition, the results of data

analysis showed that the other two constructs of the integrated model are significantly and positively correlated. More precisely, a person's BI was better predicted by social factors and PN (Hypothesis 3). Also, PN played a prominent role in explaining BI ($\beta = 0.302$, $p < 0.05$). The present study is in line with various environmental research sectors that stressed the important role of ethical duty [40,78,107].

The results showed that the greatest effect on BI belonged to the SN ($\beta = 0.349$, $p < 0.05$). It can be argued that friends and family's pressure on the individual for home-based composting drives him/her to do so. These outcomes are similar to those of previous studies (for example: [53,62,64]). PBC had a positive effect on BI ($\beta = 0.198$, $p < 0.05$), indicating that the more knowledge a person has about the stages of home composting, the higher his/her tendency to do home composting is. The results are consistent with previous research in environmental protection [50,53,62].

This study also attempted to investigate the moderating role of composting knowledge in enhancing the ability of the integrated model to interpret BI. The multi-group analysis results indicated that the moderating role of composting knowledge was significant in the relationship between PBC and BI (Hypothesis 9d) and SN and BI (Hypothesis 9c). These results suggest that having high knowledge about compost positively affects the relationship between PBC and BI. This means that people with increased knowledge of composting are more inclined to produce it at home. On the other hand, the hypothesis showed that social pressure on people with a low level of knowledge is opposite to those with high knowledge. That is, social pressure prevents low-skilled people from producing compost and encourages high-skilled people. The results were consistent with previous research [84,108,109]. Regarding the lack of mediating role of knowledge on the path of PN to BI (Hypothesis 9a) and ATT to BI (Hypothesis 9b), this shows that knowledge does not influence the effect that PN and ATT have on BI. For example, if PN and ATT include the individual's views of the environment and its protection, composting knowledge does not influence their effect on BI.

6.2. Managerial Implications

The results showed that the constructs of NAM were positively and significantly related to BI. In other words, moral commitment plays an important role in stimulating household BI to home composting. Therefore, municipal solid waste management organizations should put green advertising on the agenda to educate consumers about the environmental role of home composting.

In this regard, research findings suggest conveying the significant environmental role of home composting to mobile users through message and info-graphic data [110,111]. Recent research also showed that green advertising raises citizens' awareness of environmental problems and induces a pro-environmental attitude of consumers [112,113]. Therefore, green advertising is a powerful method to excite the moral commitment of households. Since the data analysis results showed that AC and AR play an essential role in forming the moral norm, it is recommended to set up advertising about the positive results of home compost and the responsibility of households to minimize environmental pollutions. Also, the local governments should promote public awareness and morals in a variety of methods, such as through campaigns, the media, and education. Furthermore, motivation was identified as the most accurate predictor of organic recycling intention. In this case, providing incentives (such as monetary incentives, lottery tickets, or other items attractive for citizens) may encourage people to participate in waste source composting. As a result, the local government should think about implementing reward methods and plans to encourage waste composting.

This study showed that SN was an important construct in the development of environmentally friendly behavioral intention in home composting. Given this result, it can be argued that households are affected by suggestions from friends and family. Therefore, it is recommended to employ experts to increase social pressure to enhance consumer motivation for environmentally friendly behavior through mass media. In addition, when

the perceived success of incentive programs is strong, the subjective norm becomes effective. SN had little effect because home composting is still not publicly encouraged by the local government and continues at a low level in Isfahan city. Residents are observed to be less eco-centric and more anthropocentric when they engage in pro-environmental behaviors, therefore a high level of economic incentives is required to increase the organic recycling intention.

Finally, composting knowledge moderated the relationship between SN and BI, and between PBC and BI. It can be argued that people with a high level of knowledge make home compost an easy task. On the contrary, people with a low level of knowledge find it difficult to make compost at home. However, other studies observed that knowledge and positive attitude alone did not support the proper recycling practice, while face-to-face training leads to correct practice in solid waste recycling and source separation [114]. In a study on the residents of two Palestinian cities, it was observed that knowledge on waste management affects the willingness to pay for improved service of solid waste management, thus contributing to better waste management [115]. Therefore, organizations involved in municipal waste management are recommended to consider training programs to facilitate and clarify the process of home composting through brochures, video media, and cyberspace. The results also showed that people with high knowledge, unlike the low knowledge group, were under intense pressure from friends and family for home compost. By identifying these citizens, home composting can be increased. In other words, these people can be the primary target audience of organizations.

According to the results, people with yard houses were more inclined to produce home-made compost, so it is suggested that the local government donate a special bin and training packages to produce home-made compost to Isfahan residents to strengthen this behavior. Furthermore, results suggest that the focus of local government to stimulate home composting should be on women, people with backyards, housewives, and retirees.

7. Study Limitations and Future Research

The characteristics of the participants in the current study, such as low literacy rate, particularly among women, are a significant restriction to data collection. The researchers attempted to overcome this issue by using a face-to-face questionnaire, however, this resulted in a lengthy data gathering process. Moreover, the large number of questionnaire items led to a long completion time, which sometimes resulted in a loss of responsive focus. The sample of this study only included households in Isfahan city. Therefore, further investigation is required to determine whether the study results can be generalized to the country level.

Home composting is not common in Iran, so future studies are necessary to gather data from residents who have experienced home composting. Demographic characteristics, such as type of house, gender, and job, can be tested as moderators. Future research can focus on composting behavior. In this context, the characteristics of composting bins and people's preferences and needs related to them must also be studied.

8. Conclusions

The current environmental, social, and economic negative consequences triggered by the increasing waste generation impose the implementation of environmentally friendly alternatives, such as waste composting. Composting is a simple and rapid process compared to other technologies. Therefore, it can represent a highly viable management alternative to organic waste, especially in the context of the limitations of developing countries [34]. Household participation in this process is a sine qua non-condition to obtain sustainable results. This is a difficult task because of the complexity of the psychological mechanisms that govern human behavior. Consequently, citizens' engagement with waste composting can be efficiently stimulated only after a deep understanding of the factors that influence the adoption of composting behavior. The present study aimed to respond to this need

by studying BI of home composting using an integrated TPB and NAM model and the moderating role of knowledge.

The findings show that motivational factors such as knowledge, attitude toward home composting, subjective norm, gender, job, and availability of a yard influence households' intention and decisions to perform home composting. The local governments should emphasize the benefits of home composting, such as home composting not only for personal composter benefit but also for fostering a cleaner neighborhood, in addition to employing fact sheets or pamphlets to improve the understanding and attitude toward composting. The understanding of citizens' characteristics may help to influence behavior toward food composting. This study's results can be used by policymakers and business actors interested in compost-related products and by other stakeholders to promote intention to compost by using specific intention drivers in their campaigns. For example, concerning attitudes, it can be highlighted that composting is a good idea, and it is a hygienic action. Based on study results, it can be concluded that attitude, subjective norm, perceived behavioral control, and personal norm contributes to Isfahan residents' intentions to compost at home. The results also pointed out that the resident's awareness of the consequences of composting is positively and significantly associated with ascription of responsibility, and ascription of responsibility is positively and significantly related to personal norm. Moreover, composting knowledge moderates the effect of subjective norm on behavioral control to compost and of perceived behavioral control on intention to compost. Based on the results, theoretical and policy implications about how to motivate residents to separate waste were discussed, and future research directions were mentioned.

In the context of waste management in developing nations, this study considered new aspects of pro-environmental conduct. These pro-environmental practices should be introduced at the same time as home composting.

The current study enriched the research on citizens' behavior intention to compost and highlighted the role of composting knowledge. Overall, the study contributes to the efforts to reduce the adverse effects of waste generation and supports the development of green cities.

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