

Article

What Influences Home Gardeners' Food Waste Composting Intention in High-Rise Buildings in Dhaka Megacity, Bangladesh? An Integrated Model of TPB and DMP

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Abstract: Composting is a sustainable way of transforming organic waste into valuable organic fertilizers which have the potential to act as soil conditioners by controlling various biological processes. The prime objective of the current study was to determine the influencing factors behind the intent of home food waste composting, by employing the combined model of Theory of Planned Behavior (TPB) and Dualistic Passion Model (DMP). The combined model showed a higher predictive ability in comparison to the individual TPB model. The fit statistic of the integrated model was deemed good, and 65% of the variance for home composting intention was explained. Using a face-to-face questionnaire survey, a total of 203 valid responses were gathered from home gardeners and tested via a unique two-step methodology: the PLS-SEM and the artificial neural network (ANN). The results revealed that the composting intention can be significantly influenced by attitude, subjective norms, and perceived behavioral control. The study also confirmed the positive effect of harmonious passion and the negative effect of obsessive passion on the intention of food waste composting. Furthermore, the hybrid method produced more reliable results because HP was found to be the most important variable in both ANN and PLS-SEM results, while PBC was observed to be the second most important variable in ANN and the fourth most important in PLS-SEM. The results of the current study not only highlight the importance of passion in determining food waste composting intention in Dhaka, Bangladesh, but also provide helpful information for designing effective, sustainable tactics for encouraging residents to compost food waste at home.

Keywords: behavioral intention; composting; food waste; harmonious passion; obsessive passion; artificial neural network



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1. Introduction

Municipal solid waste (MSW) management has become a top concern of local governments in developing nations due to its environmental and economic consequences. The majority of municipal solid waste is generated by urban residents, in turn resulting in substantial management expenses for local governments [1]. As a result of growing urbanization and population expansion, the global quantity of waste generated is projected to increase from 2 billion tons to 3.5 billion tons over the next 30 years [2,3]. MSW is generated from different sectors, including households, commercial or business, and industry [4]. The volume of waste generated is increasing in metropolitan areas more than in small communities. For instance, the daily waste generation in cities ranges from 0.47 to 0.5 kg per capita [5].

On the other hand, the rate of waste production is almost half in small communities [6]. In Bangladesh, households and commercial or industrial sectors are the two major sources

of organic waste. Approximately 75% of total solid waste generated comes from households, and the remaining 25% from commercial areas [7]. Approximately 4.86 million tons of solid waste is generated annually in Bangladesh's metropolitan regions, in which organic waste accounts for 75% to 85% of the total [6]. Despite its potential for reuse, only a small percentage of the total organic waste is composted into organic fertilizers and recycled [8].

Household solid waste accounts for approximately 90% of the total municipal solid waste streams, and 80% to 90% of this waste is organic [5]. Households are responsible for the majority of food waste generation during consumption [9]. Food waste accounts for 50% of all municipal solid waste in Europe, and 55% of all municipal waste in both developing and developed countries [10]. Bangladesh has an abysmal record, with food waste accounting for 68.3–81.1% of total municipal solid waste [11]. The vast amount of food waste being generated has resulted in adverse consequences and hazards to human health and societal development. For instance, a huge part of the planet's resources are absorbed by the storage and disposal of waste. When the balance is upset, groundwater, soil, and air are polluted, giving rise to excess flies, mosquitoes, and detrimental bacteria [12]. In addition, if food waste is not treated properly, it releases methane, which is 84 times more destructive than the carbon dioxide pollution caused by transportation. Additionally, the accumulation of food waste in landfills can result in big explosions because of the accumulated methane gases trapped inside [13].

Food waste, or kitchen waste, is a valuable resource that can be converted into biofertilizer and biofuel using advanced biotechnological methods in order to achieve sustainable development [14]. Composting is widely used to treat kitchen waste [15,16] due to its high moisture content and putrefaction capability [17]. Compost is the end product of the aerobic breakdown of organic substances [18]. It is considered a soil conditioner and is widely used as a natural fertilizer in agriculture [6]. Home composting includes the biodegradation of municipal organic waste, including food or kitchen waste [19]. In terms of sustainable waste management practices, home composting is considered to be a productive option for handling kitchen waste at the source. It has numerous benefits, such as creating valuable products capable of enhancing soil structure and fertility [20–23], as well as the joy of experimentation and an environmentally friendly lifestyle. Home composting can potentially be a feasible option for managing the biological fraction of municipal waste, especially in developing countries, due to its simplicity and quick setup process. Furthermore, this process is cost-effective in comparison to other recycling alternatives, which need sophisticated resources for both operation and maintenance. Therefore, composting is considered to be a more sustainable, efficient method of food recycling because it is less harmful to the environment and has lower economic costs [14]. Additionally, prior studies have stated that composting is a more eco-friendly recycling option than any other food or organic waste recycling method such as landfills or incineration [24,25]. Home composting also makes it easier for the individual homeowner to recycle organic waste in a sustainable way [21]. An exploratory study by Fernando [26] concluded that the reasons for people's participation in home composting include it being a convenient way to dispose of food waste, using it as an organic fertilizer in home gardening, and also being concerned about the environment, good health, and overall economic benefits.

However, composting at home is not considered an option for overall MOWs [21]; this method can only be considered the best household-level waste management strategy [27,28]. Despite its significance in organic waste management, it is not yet widely used around the world. In the South Asian region, only 16% of the total MSW generated is composted, while the remaining 75% is deposited in open landfills, according to the MSWM method [29]. Therefore, it is essential to first identify the underlying factors that influence food waste composting at the household level.

Attaining an integrated MSW management begins with identifying people's attitudes, social norms, and behavioral intentions, and supporting of the solid waste management structure by the local government and commercial sectors [30]. Attempts in poorer nations, including Bangladesh, to achieve an effective solid waste management system have been

highly focused on the 3R strategy, effective collection methods, and source separation [5]. Despite the tremendous social, economic, and environmental benefits of these programs, social factors such as a lack of understanding and poor participation in recycling initiatives have hampered their implementation [31].

This study is among the first to examine the underlying factors which govern the intentions of food waste composting in Bangladesh by considering the most significant and leading role of home gardeners. Three major contributions are envisioned from the outcomes of this study. Firstly, this research examined the food waste composting intention of Bangladeshi home gardeners. Next, the combined model of TPB and DMP was employed as the theoretical framework for empirical analysis for confirming the feasibility and validity of the estimation outcomes. Finally, this study reached comprehensive findings and proposes strong policy implications by considering the intentions of the target group. The willingness of residents to take part in composting activity has been examined previously in the context of composting behavior. Loan et al. [32] measured composting behavior within sustainable MSW management in developing nations. In order to measure the intention of green composting, Mamun et al. [33] examined the perceived benefits, normative beliefs and the required start-up resources in the Malaysian context. Dwinadine & Dewi [34] examined the intention to use waste for composting and found significant factors viz. perceived value, trust, and knowledge.

The current study aims to fill the knowledge gap in waste recycling literature and attempts to answer the following research questions: (i) what are the key drivers behind the intention to compost food waste? and (ii) how important are the factors in predicting intention to compost food waste? This study uses a two-tier analytical approach by combining structural equation modelling (SEM) to explore the first question and the artificial neural network model (ANN) to evaluate the second question, as intended by prior researchers [30–33]. The second research question was evaluated using ANN to consider non-compensatory and non-linear relationships [35,36]. Furthermore, this systematic hybrid technique presents a detailed insight into the subject and simultaneously, the benefits of a single method offset the drawbacks of another method. Thus, to support theoretical developments and practical approaches, this research aims to develop a model that exhibits the home gardener's intention to compost food waste.

2. Literature Review

2.1. Theory of Planned Behavior

Theory of planned behavior (TPB) was formed by including Perceived Behavioral Control from the reasoned action theory. TPB is extensively employed to predict various types of human behavior [37] and is considered one of the most popular theories for investigating social and psychological behaviors [38]. TPB suggests that people act rationally by implicitly or explicitly considering the outcomes of their actions. This theory postulates three major factors viz. attitude (ATT), subjective norm (SN) and perceived behavioral control (PBC), to predict behavioral intention (BI) [39]. Attitude indicates a person's positive or negative judgement of a particular behavior [38]. Subjective norm is described as the understanding of social force as a reason for a particular behavior [40]. PBC refers to how people perceive the ease or difficulty of a particular behavior [41]. Thus, the theory posits that a person with more desired ATT, SN, and a better PBC is expected to exhibit a stronger BI [38].

In addition, TPB has been integrated and expanded by numerous other factors. Wang et al. [42] conducted a China-based study on the impact of environmental awareness, norms, convenience of recycling, income, cost of recycling and attitudes on the consumers' intention to recycle. The effect of disclosure of information, awareness of consequences and the attribution of responsibility were analyzed in another study by Wang et al. [43]. In the area of food waste, Mak et al. [44] extended the TPB theory to include economic incentives, logistics and managerial incentives, administrative incentives, and business support. Abbasi et al. [45] employed TPB factors to explore the intention to revisit a destination.

The effectiveness of TPB, in terms of composting food waste, was preferred as the theoretical grounds for this research. Although TPB has been extensively studied in the past, the predictive power of this theory has been criticized as being insufficient and does not adequately explain a specific environmental behavior [46,47]. In order to improve the predictive power of the model, researchers have stated that further variables need to be included in the model, based on the specific research context and background [42,48]. Similarly, Ajzen [49] posited that “TPB is an open theory and additional variables can be added if they are able to capture a significant fraction of the variance in behavioral intention”. Therefore, this study aims to understand the intention of food waste composting by including the DMP (Dualistic model of passion-harmonious passion and obsessive passion).

2.2. Dualistic Model of Passion

Vallerand and his colleagues [50–52] developed a passion model for the inherent dualism of passion. Similar to the self-determination theory proposed by Deci & Ryan [53], DMP states that humans are motivated to examine their surroundings in order to grow. Vallerand et al. [51] characterized passion as a strong tendency towards a self-defined activity that one prefers, deems necessary, and in which one invests time and energy on a regular basis. Moreover, self-determination theory, as well as other research carried out, found that elements from the environment can either be controlled or be autonomously internalized [54,55]. Therefore, it can be said that DMP divides passion into obsessive and harmonious, based on how the passionate action has been integrated into an individual’s self-identity.

Harmonious passion appears from the autonomous incorporation of an event in the self which arises when individuals voluntarily acknowledge the activity and prefer to take part with a passionate interest and without any contingency [56]. Additionally, willingly engaging in the activity creates a motivating force and generates a sense of will and personal validation to continue the activity. In harmonious passion, activity involves an important but not dominating place within one’s personality. Consequently, the activity is under the individual’s control and is harmonious with other crucial aspects of life [57,58]. Obsessive passion (OP) is an unmanageable urge to engage in an activity that one loves [51,59]. The person feels a pressure to continue pursuing the activity. Additionally, people who have an OP may have an irrepressible need to participate in the activity they value and appreciate. The passion for the activity controls the person’s action. Thus, engagement in a passionate activity brings rigid persistence in the activity. This rigid attachment can lead to other matters in the individual’s life being neglected (such as when one should be doing something else), creating tension and conflict and thus leading to a poor integrative experience in task accomplishment and hence negative emotional experiences [60].

Afsar et al. [61] recommended further research on the connection among the DMP and within the context of pro-environmental behavior. Li et al. [62] studied harmonious passion to predict organizational-level environmental behaviors of employees. Akhshik et al. [63] applied DMP and mindfulness to tourism. We have expanded our search by including SLR (see Supplementary Table S1 for details); to the best of the authors’ knowledge, neither HP nor OP have yet been tested along with TPB to predict the intention to compost food waste. Thus, the current approach would fill the gap of limited knowledge on the application of DMP in food waste recycling research, though limited empirical studies hamper investigating more robust factors behind food waste recycling and composting at the individual level.

Food waste is a major problem worldwide. Especially in developing countries like Bangladesh, food waste disposal is undervalued and not well managed due to poor management by local communities. Bangladesh has an unfavorable record, with food waste accounting for 68.3–81.1% contain from municipal solid waste [64]. A significant amount of food waste does not generate economic value due to immature waste recycling practices [65,66]. Lack of government intervention and inappropriate dumping make food waste management a serious challenge for Bangladesh.

In 2014, domestic waste generation in Bangladesh amounted to 23,688 tons/day for a total of 41.94 million metropolitan population and an average of 0.56 kg/capita/day due to the growth of metropolitan areas and population increase. This excessive amount of waste is mainly generated by high-rise dwellers [65]. Previous research examined 2736 buildings in a large area of Dhaka city and found that 36.4% of the buildings have a roof garden where residents were involved in gardening at home [64]. The literature review (see Supplementary Table S1 for details) shows that previous researchers thoroughly examined residents in a general way rather than distinguishing them based on their hobbies or activities. However, only a limited number of empirical studies have investigated home gardeners' intention to compost or recycle food waste. Therefore, the current study focuses solely on home gardeners, as they use fertilizer for growing their plants and vegetables, though it is mentioned in previous studies that composting can minimize food waste issues at household level. Therefore, it is imperative to examine individuals who engage in home gardening, such as home gardeners.

2.3. Hypotheses Development

The following sections discuss the hypotheses examining the behavioral aspects of home gardeners with regard to food waste composting in Dhaka, Bangladesh. The overall model emphasized on interactions between different predictors, as illustrated in Figure 1.

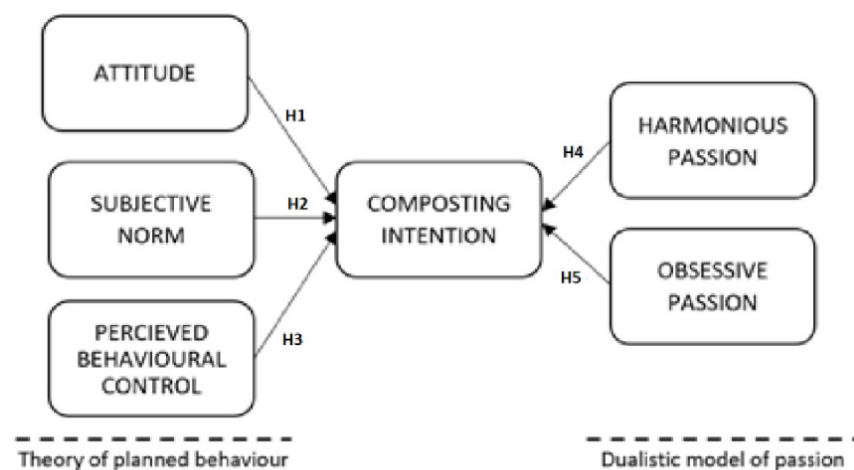


Figure 1. Conceptual framework.

2.4. Attitude

TPB, postulated by Ajzen [49], is the most commonly used theory to predict human behavior. The model proposed in this theory includes the three important constructs of attitude, subjective norms and perceived behavioral control. These three factors are determinants of predicting the individual's behavioral intention. One of the variables, attitude, has long been acknowledged as a major element of intention and behavior and has a significant impact on it. In the study of the green composting adoption, Mamun et al. [33] discovered that attitude was one of the most important elements in predicting composting intention. Onel & Mukherjee [66] observed in their study that attitude played a major role in the domestic waste recycling intentions. A study by Lam et al. [67] identified that attitude was a potential factor of environmentally conscious behavior. Additionally, Zhang et al. [68] and Stoeva & Alriksson [69] observed the positive relation between attitude and an individual's waste recycling intention. Thus, having a favourable attitude towards certain behavior improves the behavioral intention. Hence, the following hypothesis is proposed.

Hypothesis 1. *Attitude positively affects the intention of composting food waste at home.*

2.5. Subjective Norm

Subjective norm is concerned with everything surrounding an individual, such as social norms, social pressure, cultural norms, or other group beliefs [70]. This variable is associated with social pressure, which shapes an individual's behavior in specific situations where they may execute certain behavior with their social peers' consent [71]. Subjective norms are used to understand how social norms affect municipal solid waste minimization, as they take into account general public hurdles such as a lack of awareness, motivation, and influences [72]. Ajzen [49] found that significant others were the primary source of social influence for an individual; in other words, their family, friends, neighbors and the community. The current study also states the relevance of subjective norms and their significant connection with the intention of food waste composting. According to Yuan et al. [73], social pressures from significant others might either motivate or oppose a person's aim to recycle kitchen waste. The findings of Ramayah et al. [74] stated that subjective norm was a major contributor to recycling intention in areas of poor waste management. Numerous earlier empirical studies have observed that an individual's recycling intention was significantly influenced by their social norms, which were fundamentally derived from others' attitudes to waste recycling intention [75–77]. Hence, the subjective norm directly influences and increases the food waste composting intention among home gardeners in mega cities when the social norm respectively reveals certain role models and inspirations towards waste separation for composting. Therefore, the following hypothesis can be posited.

Hypothesis 2. *Subjective norm positively affects the intention of food waste composting at home.*

2.6. Perceived Behavioral Control

PBC, the third predictor of the TPB framework, refers to the perceived ease or complexity of carrying out certain behavior. PBC functions as a twofold concept and includes views about one's capacity to carry out an activity with the accessibility of the required resources and opportunities to perform the behavior, the beliefs about an individual's abilities to execute an action and the availability of essential resources and prospects to engage in the behavior [49]. Other elements are money, time, knowledge, and skills, which can intensely affect one's control over the behavior [78]. Prior research suggests a strong and positive correlation between perceived behavioral control and pro-environmental intention. The study by Yuan et al. [73] validated the significant effect of PBC on the recycling intention of kitchen waste. The findings of their study were in line with the findings of Wang et al. [79], who demonstrated that PBC was the strongest predictor to influence the intention to recycle household waste of Chinese residents. The implication of these studies was that people who had a good command over their self-actions and who had access to resources for implementation were prone to certain behaviors. With these implications, the following hypothesis is proposed.

Hypothesis 3. *Perceived behavioral control positively affects the intention of food waste composting at home.*

2.7. Harmonious Passion

Vallerand et al. [51], proposed in their dualistic model of passion (DMP), that an individual's intention or behavior should be analyzed by distinguishing two different passions—harmonious passion (HP) and obsessive passion (OP). HP and OP have been used in past studies to understand the home gardener's composting intention. Harmonious passion has significant implications for environmentally conscious behavior [63]. HP is positively related to alertness, focus, the motion during activity, as well as a positive effect, quality relationships, and psychological well-being. Individuals with HP generally experience many positive effects [80]. This positive effect mediated between harmonious passion and the student's intention to drop out [58]. A harmoniously passionate

individual experiences positive emotions, which is considered to be the most important factor in energy-saving intentions [81]. Research on environmental behavior has indicated that positive emotions may be associated with more environmental behavior [82]. It has also been found that HP was positively connected with the endorsement of mainstream behaviors [83]. Therefore, for this study, the following relationship can be hypothesized.

Hypothesis 4. *Harmonious passion positively affects food waste composting intention at home.*

2.8. Obsessive Passion

According to Junot et al. [80], OP is linked to negative emotions, a connection to nature, and environmental behaviors. Generally speaking, negative emotions cause self-centeredness and self-centred behavior. People become egotistical and cut themselves off from others and the rest of the world when harbouring negative emotions [82,84]. Individuals experiencing unpleasant emotions are more likely to concentrate on urgent problem-solving methods because they are less likely to be interested in matters that have a minor direct influence on them, such as environmental issues. A study by Akhshik et al. [63] examined the link between OP and pro-environmental behavior, and suggested that visitors who have OP were less likely to demonstrate pro-environmental behavior (PEB). OP has also been strongly associated with the intention to engage in both mainstream and radical behaviors [83]. Thus, the following hypothesis can be formulated.

Hypothesis 5. *Obsessive passion negatively affects food waste composting intention at home.*

3. Methods

3.1. Measures of Constructs

The measurement tool for the current study was based on the components of research models of previous research. All TPB items were adapted from Rastegari Kopaei et al. [85] and the DMP items from Akhshik et al. [63], respectively. All constructs were measured using a 7-point Likert scale ranging from strongly disagree = 1 to strongly agree = 7. Since data collection was carried out in Dhaka city, the questionnaire was therefore translated to Bengali. The questionnaire was evaluated by a panel of five experts prior to the data collection process in order to ensure that it met the requirements of face and content validity. Furthermore, a pilot study was also carried out with 30 sample respondents, whereby a composite reliability of all the variables was found to be greater than 0.708. The questionnaire section comprised of 21 items linked to ATT, SN, PBC, HP, OP and composting intention. To follow the purposive sampling method, this study also included three screening questions in the survey questionnaire in order to identify the appropriate respondents for this study. For example, (1) Do you have composting knowledge? (2) Are you involved in rooftop/home gardening? (3) Are you involved in throwing/discarding food waste into the kitchen bin?

Respondents were required to respond to these questions first before they proceeded to answer the main questionnaire items. If the screening questions were not relevant to them, they were requested to stop their response as per the instructions given in the questionnaire. Table 1 highlights the list of constructs and measurement items.

Table 1. List of constructs and measurement items.

Research Variable	Code	Questions	Reference Scale
Attitude	ATT1	I think composting is rewarding.	[85]
	ATT2	I think composting is hygienic.	
	ATT3	I think composting is a good idea.	
	ATT4	I think composting is necessary.	

Table 1. Cont.

Research Variable	Code	Questions	Reference Scale
Subjective norm	SN1	Many of my friends find food waste composting is useful.	[85]
	SN2	Many of my relatives/neighbours find food waste composting is useful.	
	SN3	People who influence my decisions think that I should compost food waste.	
Perceived behavioral control	PBC1	I know what items can be composted among my food waste.	[85]
	PBC2	I have tools to compost my food waste.	
	PBC3	I know how to compost my food waste.	
	PBC4	I have enough time for composting.	
Harmonious Passion	HP1	My composting practices are in harmony with the other activities in my life.	[63]
	HP2	The new things that I discover with composting activity allow me to appreciate it even more.	
	HP3	My composting activities are well integrated in my life.	
Obsessive Passion	OP1	I have difficulties controlling my urge to do composting at home.	[63]
	OP2	My composting activities are so exciting that I sometimes lose control over them.	
	OP3	If I could, I would only do composting activities.	
Composting Intention	INT1	I have the intention to buy the waste composting equipment.	[85]
	INT2	I have the intention to compost kitchen waste/food waste.	
	INT3	I have level of planning to buy the composting equipment.	
	INT4	I have level of planning to compost kitchen waste/food waste.	

3.2. Study Area & Respondents

Dhaka, the capital city of Bangladesh, was selected as the study location due to its large population (19.5 million), record amounts of daily waste production causing serious issues, and the huge municipal waste management costs incurred by the government as a result [86]. Dhaka is also considered to be “one of the largest and most densely populated cities in the world”, with a density of 23,234 people per square kilometer within a total area of 300 square kilometers. Approximately 38% of Bangladesh’s urban population reside in Dhaka [87,88]. Geographically, this city is located at 23.8103° N latitude and 90.4125° E longitude. The average annual rainfall is 2077.2 mm and daily average temperature is 26.6 °C, fluctuating between 21.7 °C and 30.8 °C [6]. Dhaka City Corporation (DCC) area was used as a study area as the percentage of rooftop gardeners was promising in number [65]. The number of high-rise buildings in Dhaka city increased remarkably over the last decade. Therefore, the population of the city grew drastically with its vertical high-rise development [6]. Thus, it is essential to identify the residents of high-rise buildings who have alternative food and organic waste recycling techniques. This study focused primarily on exploring the residents’ (home gardeners) food waste composting intention in high-rise residential buildings in Dhaka. All home gardeners/rooftop gardeners were the target respondents for this study. Consequently, an empirical study that particularly concentrates on home gardeners could be important and beneficial to policy makers in order to develop the home gardeners’ food waste and composting recycling behavior.

3.3. Data Collection Procedure

A face-to-face questionnaire was used for conducting the survey. The study was conducted in three overpopulated areas of Dhaka city viz. Dhanmondi, Mirpur and Mohammadpur. Followed by a cross-sectional method, primary data was collected during the period of 15 March 2022 to 23 April 2022. Data collection was carried out in three steps. First, the apartments with rooftop gardens were identified through information

gathered from the Dhaka City Corporation. Secondly, the questionnaires were circulated to the households through the apartment management office. Finally, out of a total of 500 questionnaires that were distributed, only 203 valid questionnaires (a 41% response rate) were ready for the final analysis.

3.4. Common Method Bias

This study used the Harman's one-factor test and a Marker variable to measure the overall common method bias [89], since the same individual answered all the survey questions. In this test, the risk of bias from the common method was deemed high when a single factor was responsible for more than half of the variance [89–91]. The findings of this study confirmed that neither factor strongly dominated the explanation of the variance (the most significant factor reported for 20.92 percent of the variance). Furthermore, a marker variable was also included in the model which tested the correlations between the marker variable and all other variables of this study. The lack of correlations between the marker variables and other variables in the main model revealed that common variance was not an issue in this study.

3.5. PLS-SEM and ANN

PLS is considered a second-generation SEM instrument that is capable of conducting simultaneous analysis with multiple dependent constructs. In addition, PLS-SEM has a marked advantage over traditional regression-based techniques with more variations from the data, even when the model is complex and fails to meet linearity and normality assumptions [35,91–93]. Therefore, PLS-SEM was chosen to obtain the maximum explanation from the source. Once the significant hypothetical relationships were identified by using PLS-SEM, further estimation was done by using ANN, an artificial-intelligence-based system designed to function similarly to the human brain. In ANN, the algorithm works in feed-forward-back-propagation, which is a method where knowledge development is based on an iterative learning process by feed-forward and then compared to the actual output (back-propagation). PLS-SEM has been shown to be able to analyze linear hypotheses but unable to deal with nonlinear interactions, whereas ANN is better at capturing nonlinear relationships [35,91,92].

3.6. Data Analysis Strategy

Descriptive statistical analysis was performed to analyze the data using the statistics packages SPSS version 21.0 software and the correlation between constructs was analysed by employing PLS3.0 software. In order to obtain more robust results, this study used a two-stage hybrid PLS-SEM-ANN approach to capture the maximal explanation from the hypothesized relationships [91,92]. Finally, a bootstrapping technique (500 resamples) was used to assess the significance of the path [94,95].

4. Results

4.1. Descriptive Statistics

The demographic information of the respondents stated in Table 2 was retrieved from the descriptive analysis by performing SPSS. According to the data in Table 2, 16.2% of sample respondents ($n = 33$) were males and 170 (83.7%) were females. This bias was caused by targeted interviewees (women) who mostly resided at home and engaged in household activities, which was similar to a previous study performed by Nasrin et al. [96]. Age categorization of the respondents indicated that most belonged to the 41–50 age group. This statistical finding was similar to [96], where the majority of the rooftop gardeners in Bangladesh belong to the group of 41–50. Finally, the majority of the respondents highlighted that they were housewives and non-employed (73.3%, $n = 149$). The descriptive analysis also identified that most of the participants (43.8%) had a monthly family income of Tk 70,001–Tk 90,000 (see Table 2).

Table 2. Descriptive statistics.

Variable	<i>n</i>	Percentage
Gender		
Male	33	16.2%
Female	170	83.7%
Employment status		
Employed	54	26.6%
Housewives/Non-employed	149	73.3%
Income level (Tk/month/family)		
Tk 10,000–30,000	16	7.8%
Tk 30,001–50,000	75	36.9%
Tk 50,001–70,000	23	11.33%
Tk 70,001–90,000	77	43.8%
>TK90,000	12	5.9%
Age		
18–30	11	5.4%
31–40	42	20.6%
41–50	115	53.2%
>51	35	17.2%

4.2. Convergent Validity

The reliability and convergent validity of measurement model were established by analysing the construct loading, composite reliability, and average variance extracted, according to a prior study [97]. Table 3 highlights that CRs were greater than 0.7 and each construct's average variance extracted (AVE) was higher than 0.5, which means that the convergent validity of the measure of this study was established [98].

Table 3. Results of the confirmatory factor analysis.

Constructs	Standardized Factor Loading	Cronbach's Alpha	Composite Reliability	rho_A	AVE
Attitude	ATT 1	0.763	0.821	0.881	0.827
	ATT 2	0.827			
	ATT 3	0.839			
	ATT 4	0.794			
Harmonious passion	HP 1	0.867	0.839	0.903	0.839
	HP 2	0.877			
	HP 3	0.864			
Intention	INT 1	0.743	0.744	0.839	0.751
	INT 2	0.824			
	INT 3	0.767			
	INT 4	0.672			
Obsessive passion	OP 1	0.923	0.899	0.934	0.998
	OP 2	0.911			
	OP 3	0.892			
Perceived behavioral control	PBC 1	0.827	0.845	0.896	0.847
	PBC 2	0.825			
	PBC 3	0.830			
	PBC 4	0.820			
Subjective norm	SN 1	0.901	0.898	0.937	0.905
	SN 2	0.926			
	SN 3	0.907			

AVE: average variance extracted.

4.3. Discriminant Validity

The discriminant validity of the outer model was examined by calculating the square root of the AVE for each construct with the correlations among the variables [99]. As

demonstrated in Table 4, the square root value of the AVE for each variable was greater than all associated construct correlations and discriminant validity of all scales was determined.

Table 4. Discriminant validity.

	ATT	HP	INT	OP	PBC	SN
ATT	0.806					
HP	0.422	0.869				
INT	0.588	0.599	0.753			
OP	0.010	0.076	−0.055	0.908		
PBC	0.316	0.265	0.506	0.048	0.826	
SN	0.350	0.372	0.560	0.167	0.337	0.912

ATT: Attitude; HP: Harmonious passion. SN: Subjective norms; OP: Obsessive passion PBC: Perceived behavior control; INT: Intention.

4.4. Structural Model

This study measured the hypotheses using a structural model after examining the validity of the outer model. The proposed model exhibited a R^2 value of 64.7% variance on the composting intention, which was greater than the minimum R^2 value of 25% [100]. In addition to R^2 values, the present study also assessed the predictive relevance (Q^2) by running a blindfolding technique. Table 5 shows the values of both R^2 and Q^2 . Values greater than zero were indicative that the model had overall predictive relevance [100,101]. Moreover, the current study's findings demonstrated a satisfactory predictive relevance for the endogenous construct—composting intention (0.33), where the Q^2 values were more than zero. Additionally, this study also investigated the effect size (f^2) to detect whether a specific exogenous construct had a substantial impact on an endogenous variable [102]. The results of the study revealed that the f^2 for the supported hypotheses was acceptable. Table 6 highlights the effect size for the hypothesized relationship.

Table 5. Predictor power of construct (R^2 & Q^2).

Construct	R^2	Q^2
INT	0.647	0.33

Table 6. Strength of effect.

Relationship	Effect Size	Remark
ATT→INT	0.163	Medium
SN→INT	0.174	Medium
PBC→INT	0.141	Small
HP→INT	0.223	Medium
OP→INT	0.055	Small

Note: ATT: Attitude; HP: Harmonious passion. SN: Subjective norms; OP: Obsessive passion PBC: Perceived behavioral control; INT: Intention.

4.5. Hypotheses Testing

To investigate the proposed hypotheses relationships, the path coefficients were assessed. As proposed by Hair et al. [103], the bootstrapping method was carried out on 5000 subsamples. Consequently, at 1% level of significance, all hypotheses were found to be significant. Specifically, HP ($\beta = 0.382$, $p < 0.01$) was found to have the highest path coefficient value, which contributed to the existence of HP in an individual's intention in terms of food waste composting. ATT ranked as the second highest path coefficient ($\beta = 0.274$, $p < 0.01$), which explained that the existence of individual's favorable attitude towards food waste composting. Furthermore, SN and PBC had the 3rd and 4th highest influence on CI, which was valued at $\beta = 0.274$, $p < 0.01$ and $\beta = 0.241$, $p < 0.01$, respectively, and showed the impact of social circle on the home gardener's intention to compost food waste, whereas

the perceived easiness of the individuals also makes them compost food waste. Finally, CI was observed to be negatively affected by OP ($\beta = -0.127, p < 0.05$). It can be said that each of the hypotheses were significant in the current study. The significant relationships were consistent with the findings of previous research studies and TPB’s proposal; nonetheless, the discrepancy is due to changes in path coefficients and their relative relevance. The hypothesis testing estimations and outcomes are presented in Figure 2 and Table 7.

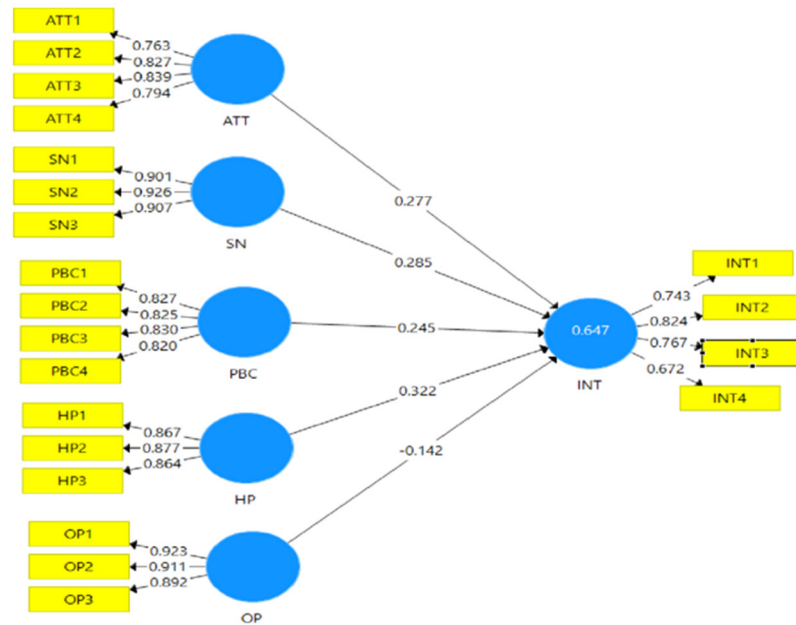


Figure 2. PLS results.

Table 7. Hypothesis test result.

Hypothesis	Relationship	Path Co-Efficient	T Statistics	p-Value	Remark
H1	ATT → INT	0.277 ***	5.298	0.000	Supported
H2	SN → INT	0.285 ***	4.752	0.000	Supported
H3	PBC → INT	0.245 ***	4.298	0.000	Supported
H4	HP → INT	0.322 ***	6.359	0.000	Supported
H5	OP → INT	−0.142 *	2.381	0.018	Supported

ATT: Attitude; HP: Harmonious passion. SN: Subjective norms; OP: Obsessive passion PBC: Perceived behavior control; INT: Intention. * $p < 0.05$, *** $p < 0.001$.

4.6. Outputs of Neural Network Analysis

The Statistical Package for Social Science (SPSS) software version 24 was used to examine the ANN model for this study. The supported variables of the PLS-SEM analysis were used as input neurons in the model. As illustrated in Figure 3, there are five significant drivers of intention (ATT, SN, PBC, HP, and OP). Through the software, the total number of neurons in the hidden layer was created simultaneously. However, according to more recent studies, identifying an accurate number of neurons in the hidden layer is a continuing challenge [36]. In order to avoid the overfitting error that commonly occurs in the ANN model, a 10-fold cross-validation process was employed. Around 90% of the answers were used for learning and the remaining 10% for prediction [93,95] (see Figure 3). Table 8 highlights the mean and standard deviation of the root mean squared error (RMSE) values for both training (learning) and testing (predicting), whereby the possible lower limit of the RMSE is zero (0) with an unlimited upper limit. However, the closer the RMSE values are to zero (0), the greater the ANN model’s predictive capacity [104–106]. The results of this study demonstrated that the RMSE mean for training and testing was 0.392 and 0.355, respectively, highlighting that the neural network models seemed to be extremely reliable in capturing the linear/nonlinear relationships, coinciding with a prior study [92]. The RMSE

mean values were reasonably small with negligible standard deviations both in the learning and prediction phase, and the ANN models seemed to have a higher level of accuracy when measuring the relationships, similar to those obtained in previous studies [36,92].

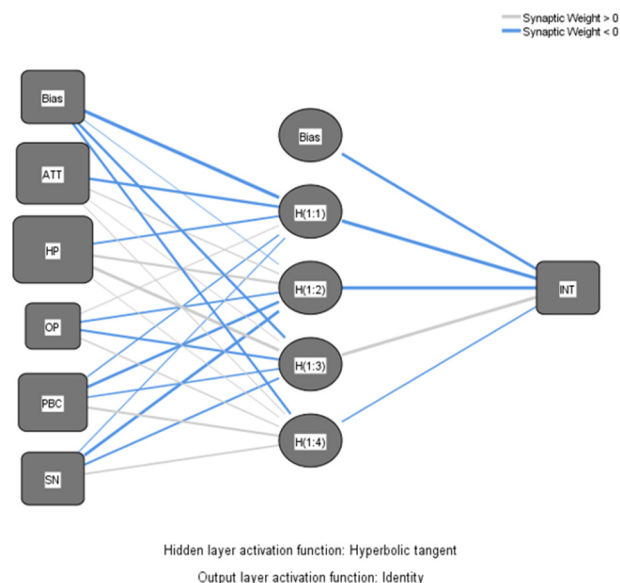


Figure 3. ANN model for the intention to compost food waste. (ATT, Attitude; HP, Harmonious passion; OP, Obsessive passion; PBC, Perceived behavioral control; SN, Subjective norm.)

Table 8. Root Mean Square Error (RMSE) for ANN model.

Network	Sample	Training	Sample	Testing	Total Sample
ANN1	181	0.350	22	0.312	203
ANN2	187	0.456	16	0.343	203
ANN3	181	0.416	22	0.302	203
ANN4	179	0.388	24	0.372	203
ANN5	182	0.469	21	0.461	203
ANN6	183	0.362	20	0.376	203
ANN7	181	0.383	22	0.380	203
ANN8	185	0.338	18	0.453	203
ANN9	178	0.353	25	0.327	203
ANN10	182	0.401	21	0.228	203
Mean	-	0.392	Mean	0.355	-
St. dev	-	0.045	St. dev	0.070	-

4.7. Ranking of Factors

A sensitivity analysis was calculated in the ANN model in order to rank the predictors based on their relative importance. Chong [106] stated that “the relative importance of the predictors is a measure the extent of the network model that predicted changes in the output values in relation to the changes in the values of independent variables.” The list of the normalized importance variables for the current study is shown in Table 9, wherein HP was the most important predictor of composting intention, followed by PBC, ATT, SN, and OP.

Table 9. Neural network sensitivity analysis.

Network	ATT	HP	OP	PBC	SN
1	0.64	1.00	0.29	0.89	0.88
2	0.65	0.58	0.09	1.00	0.19
3	0.72	1.00	0.33	0.98	0.82
4	1.00	0.97	0.10	0.44	0.55
5	0.47	0.71	0.28	1.00	0.25
6	0.68	1.00	0.29	0.67	0.72
7	0.65	1.00	0.10	0.56	0.59
8	0.80	1.00	0.25	0.68	0.49
9	1.00	0.79	0.22	0.78	0.55
10	0.59	1.00	0.26	0.72	0.75
Average importance	0.72	0.90	0.22	0.77	0.58
Normalized importance (%)	80%	100%	24%	85%	64%
Ranking	3	1	5	2	4

ATT: Attitude; HP: Harmonious passion. SN: Subjective norms; OP: Obsessive passion PBC: Perceived behavior control; INT: Intention.

5. Discussion and Implications

In the current study, a comprehensive model for studying the behavioral intention of food waste composting was developed incorporating both traditional cognitive elements (ATT, SN, and PBC) and other elements related to the concept of pro-environmental behavior (HP and OP). The results obtained show that the model was capable of justifying more than half of the variance in intention to compost food waste, thus proving that the integrated model had a significant possibility of explaining food waste composting behaviors by home gardeners in Dhaka. Additionally, the results emphasized the importance of DMP in shaping the intention to compost food waste.

The current study examined attitude as a significant construct for composting intention. Previous studies have also shown that attitude had the greatest impact on an individual's recycling intentions [107]. The findings of Ajzen and Fishbein [108] stated that recycling-specific attitudes were considered to be better predictors of recycling than general environmental attitudes. Considering the usefulness of composting, home gardeners have a positive attitude towards composting food waste. The present research is consistent with various areas of pro-environmental studies that emphasizes the importance of attitude towards recycling [109–113].

The results demonstrated the greatest effect on composting intention to the SN. This outcome is similar to those observed in previous studies [75–77]. Pressure on the individual for home-based composting from friends and family usually drives them to perform. For instance, when an individual cultivates organic food using organic fertilizer, it leads to better quality of vegetables and fruit [113], which in turn influences their society, neighbours and friends. The current study was conducted in the metropolitan city of Dhaka, where residents want organic food and household waste management is a big issue among high-rise buildings. The waste collection does not always collect the waste on time. To avoid these circumstances, residents tend to recycle their organic waste by composting. Thus, this alternative waste management technique will influence residents to have the intention to compost food waste.

The observations in the current study indicate that PBC positively impacts the intention to compost, which reflects the results of a cross-sectional study conducted earlier by Rastegari Kopaei et al. [85] in Iran. The result of PBC shows that the more information and practicality an individual has about the phases of home composting, the more likely they are to compost. PBC can therefore be considered as a non-volitional factor of composting intention. The results obtained in the current study indicated that home gardeners did not experience difficulties in purchasing equipment for composting. This result was similar to those obtained in prior research in environmental protection [75,114,115].

Furthermore, this study also observed a significant relationship between HP and composting intention. This implied that HP played a pivotal factor for home gardeners to freely accept this activity and choosing to engage in it without any contingency attached to it. Previous studies have proven that harmoniously passionate people were more likely to achieve pro-environmental behavior [63]. Thus, it can be stated that the results of the present study implied that HP is a crucial factor to home gardeners, which consequently had a profound impact on the home gardener's subjective well-being and their composting intention.

The outcomes of this study also showed that OP negatively affected the composting intention of home gardeners. This was consistent to the results observed in earlier studies by [115]. Descriptive analysis of the current study indicated that almost 83% of the respondents were women. In developing countries, women play a key role in maintaining household affairs by performing daily household chores. If they can manage both household activities and composting activities, they may experience a rigid conformance to the activity. Furthermore, such rigid perseverance may result in clashes with other elements of their life when engaged in the passionate activity (such as when one should be doing chores or other personal activities).

Other household members may also perform composting during the weekend and in doing so disregard their family, thereby causing conflict between the passionate interests (composting and other life events). Thus, this could potentially cause negative influences on the intention to compost. Furthermore, OP is linked to negative emotions, which may lead to single-mindedness and self-centred behaviors. As a result, home gardeners may tend not to the prioritize food waste composting activity and rather concentrate on their personal activities.

5.1. Theoretical Implications

This study contributes to the body of existing knowledge in the field of IS, specifically waste management. This study has provided a comprehensive model that includes TPB factors and DMP while assessing the intentions behind food waste composting among home gardeners in Dhaka. The results of this study justified the home gardeners' ATT, PBC, SN, HP and OP in food waste composting. Thus, the outcome of this research has theoretical implications. In particular, this research contributes to the waste management/recycling literature by offering a more comprehensive model that includes passion constructs namely, HP and OP. The inclusion of the DMP factors increased the explanatory power of the proposed framework, wherein 64.7% of the variance of composting intention could be explained, implying that both HP & OP are accurate factors of food waste composting intention. Hair et al. [94] recommended R^2 values of 0.25, 0.50, or 0.75 for independent constructs as weak, moderate, or significance coefficients of determination. This current study also enriches the waste management domain by serving as a starting point for other future studies. To the best of the authors' knowledge, this study is among the first to prioritize the connection between DMP and home gardeners' food waste composting in high-rise building in Dhaka, Bangladesh. Nonetheless, there have been a few studies conducted in the past examining DMP along with TPB factors in waste recycling studies.

Finally, the current study used a unique two-stage analysis method by incorporating SEM and ANN for the validation of the proposed framework and to highlight the most important elements affecting composting intention. This was achieved by examining the relative importance of each supported variable. This study makes a distinction between the PLS-SEM ranking and ANN ranking for the predictors of composting intention and found significant differences. The disparities noted could be because the two approaches used were distinct in nature, with SEM measuring linear relationships and ANN measuring nonlinear relationships between predictors and target variables. Previous studies have noted that a neural network analysis could provide higher prediction accuracies in comparison to the SEM approach [91,116]. However, this study did not ignore the validity and necessity of traditional statistical methods, which past research has suggested to be a solid foundation for IS adoption studies. This current study proposes reinterpreting the prior IS

adoption studies by combining both linear and non-linear approaches, adding profundity to the present waste recycling literature.

5.2. Practical Implications

This study's findings have important practical implications for NGOs and the government for motivating the community to carry out food waste recycling through composting at home. Because of the significant contribution of ATT, PBC and SN in composting intention, the respective agencies can provide enhanced composting training courses and coordinate lectures on performing composting at the household level with proper equipment. Training sessions can also be conducted which should not only be theoretical but also practical in nature [8]. Residents may also face many difficulties while composting, thus necessitating the need for advice. Free field classes can be arranged involving both parents and children. However, if some residents cannot attend the field classes, farm visits can be organized by local authorities and composting consultations can be conducted. Additionally, local organic fertilizer manufacturers can provide composting tools to interested households and in turn purchase the generated organic fertilizer from them. This would prove beneficial to both parties and motivate other non-gardeners to take up food waste composting at home. Government and educational institutions should also educate the younger generation about the effectiveness of the composting system and the appropriate environmental agencies can convey awareness through social media campaigns. These practices can help individuals to understand the significance of food waste management and environmental protection. Furthermore, they help individuals develop a satisfactory and positive attitude, perceived behavioral control and subjective norm towards food waste composting and recycling at home. These measures can assist in enhancing an individual's daily food waste recycling abilities, as well as make them aware of their capacity, duty, and responsibility to protect the ecosystem and also change other individuals with low psychological motivation.

Since the home gardener's HP positively influences home composting intentions, the results may prompt the relevant environmental authorities to design a cost-effective and environmentally friendly composting infrastructure for residents. Therefore, government agencies or local communities must focus on stimulating and inducing positive emotions in households to show pro-environmental behavior and adjust sustainability. Training partners can design the composting training program to include fun activities and should focus not only on the economic benefits but also on the environmental benefits.

The current study found that OP had significant negative correlation with composting intention. Past research examined the reasons for which residents feel obsessed by composting, e.g., economic benefits or extra income, desire for organic food or fertilizer, a quick way to dispose of biodegradable organic waste and other non-economic factors [99]. To counter this, the government or the local municipality can provide the required facilities, financial assistance, and compost bins to the community at a lower price or free of charge, which in turn reduces the residents' economic burden of composting. Government assistance and economic support would help the residents perform their composting activities in an efficient manner, without hindering their daily life activities. NGOs or the private sector can be engaged to provide more scientific training or guidance to citizens in order to ensure their composting technique is more productive and less time consuming.

6. Conclusions and Limitations

The determinants in the integrated model used in this study influenced the food waste composting intention among home gardeners. The factors were attitude, subjective norm, harmonious passion, perceived behavioral control and obsessive passion, all of which supported and affected composting intention. Questionnaire surveys were used in high-rise residential areas in Dhaka city. The two-staged analysis demonstrated that harmonious passion was the most significant factor of the current integrated framework; harmonious passion, followed by subjective norm, attitude, perceived behavioral control and obsessive

passion. The results indubitably proved that harmonious passion influences food waste composting intention among home gardeners. Examining the behavioral intentions for food waste composting was deemed relevant and considered as an alternative household waste management system that provides a solid foundation for successful food waste management in developing countries like Bangladesh. A multi-analytical approach that integrates the PLS-SEM and ANN was applied in this research to test the proposed research model for developing a new approach to solving the analytical issues in other relevant research fields.

In this present study, there are certain limitations that should be taken into account for future studies. Firstly, the sample of this research only involved residents of Dhaka city. Thus, further research to determine whether the study results can be generalized at the national level should be executed. Next, the sample size of this research is small. The real scenario of food waste composting in various types of locations (high density vs. low density) may possibly be different. More sample data can be gathered from a wider research scope in future studies for analyzing the food waste composting issues countrywide, or nationwide. Additionally, the current study primarily focused on the behavioral intentions of households regarding food waste composting. Even though intention is a good predictor of behavior, it cannot fully represent actual behavior. Hence, future research is important to gather information from residents with home composting. A further improvement would be if the actual behavior of households undertaking food waste composting were further studied, taking into account the aspect of availability of composting bins and the respondents' preferences and needs. Demographic attributes such as occupation, type of house and gender can potentially be examined as moderators. Finally, the current study examined types of respondents who were involved in rooftop gardening. Future studies could include non-gardeners or other stakeholders to examine food waste composting.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su14159400/s1>, Table S1: Application of TPB in waste recycling studies (SLR).

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