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# Modelling the Significance of Value-Belief-Norm Theory in Predicting Solid Waste Management Intention and Behavior

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Urbanization and rapid use of natural resources worldwide led to a massive increase in the solid waste produced daily. The processing of solid waste is significantly lower than solid waste production. Sustainable solid waste processing requires collective efforts and a change in the general public mindset to reduce and effectively process solid waste. The current work aims to interpret the intention and behavior to mitigate the climatic issue of solid waste management among Malaysian adults under the value-belief-norm framework, which was extended with social norms. This study adopted a cross-sectional design and collected quantitative data through an online survey from 1571 household heads in Malaysia. Data were analyzed with the partial least square-structure equation modelling (PLS-SEM) technique given that the data were non-normal. Other relevant common method bias analyses were conducted to evaluate the influence of common method variance. The analyses demonstrated that the biospheric and altruistic values were essential for promoting the ecological worldview among the individuals. Following the VBN framework, the ecological worldview promotes the awareness of consequences, which facilitates the ascription of responsibility to perform corrective actions for the climate. Moreover, ecological worldview, awareness of consequences, and ascription of responsibility result in the personal norms towards the pro-climate behaviors. The social and personal norms effectively nurture the intention to engage in solid waste management practices. The VBN framework provides a guideline to promote the intention and behavior to adopt effective solid waste management practices, while education and public policy could harness public beliefs and norms to engage in pro-climatic behaviors.

**Keywords: solid waste management, value-belief-norm theory, Malaysians, intention, behavior**

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## INTRODUCTION

Urban life is increasingly becoming a choice among the global population. Urbanization exacerbates climate challenges in the shape of increased deforestation, transportation, air pollution, loss of biodiversity, and the negative impact on human health (Trautwein et al., 2021). In recent years, millions across the globe have faced issues with water scarcity, clear air, and increasing temperature, which have led to the most substantial impact on human life (Ünal et al., 2019). Urbanization causes

another issue in the daily production of solid waste. Currently, 50% of the world's population lives in cities, with that number expected to rise to 70% by 2050. (Pardini et al., 2019). According to data from the World Bank Group, solid waste output per capita has reached 1.2 kilos and is expected to reach 2.5 kg by 2025. (WorldBank, 2019). Solid trash is primarily generated by urban populations, with just 30% of solid garbage processed and controlled by city authorities around the world (Razali et al., 2019). Human solid waste production is a key driver of environmental dilemmas and a major contributor to rising greenhouse gas emissions (Yildirim and Semiz, 2019).

Moreover, inconsiderate consumption and intensive misuse of natural resources lead to climate challenges (Ünal et al., 2019). Proper management of solid waste is a sustainability issue and requires the responsibility of the world population to perform solid waste management in all stages of waste management (Razali et al., 2019). Solid waste management requires the minimization of irresponsible disposal of waste and interactive engagement in solid waste recycling. The illegal dumping of solid waste for land refill creates social and environmental challenges (Moh et al., 2017).

For the current work, solid waste management, defined as controlling, collection, storage, transportation, processing, and disposal of solid waste, is an ecological activity (Pardiani et al., 2019). General public support is vital for achieving the eco-friendly practice of disposing of solid waste to reduce the solid waste impact on public health, conservation, and the environment (Razali et al., 2019). The management of solid waste can only be achieved by collective support to achieve a clean environment and promote solid waste management practices among the individuals to separate the solid waste and exhibit pro-environmental behavior responsibly. Social and personal norms play a significant role in promoting ecological behaviors (Richter et al., 2021). Consequently, the present work aims to examine solid waste management intentions and behavior among Malaysian adults using the value-belief-norm (VBN) framework with social norms.

## Literature Review

### Study Context: Malaysia

In Malaysia, solid waste management is becoming a necessity given that the daily solid waste produced in Kuala Lumpur reaches 30,000 tons per day (Razali et al., 2019). This management denotes the collective responsibility of the urban communities to help and maintain the environment and work with the local city administration to manage the solid waste from the household business firms and other enterprises or institutions (Pardini et al., 2019). Solid waste management could be achieved by the waste management behavior assumed by Malaysian individuals.

The waste management-related legislation was introduced in Malaysia in the 1970s. In this period, three prominent acts were introduced Street, Drainage and Building Act 1974, Environment quality Act 1974, and Local Government Act 1976, which raised the Malaysian Governments' concern to regulate waste recovery and processing to achieve better environmental quality for the Malaysians (Razali et al., 2019). The Solid Waste Management and Public Cleansing Act 2007 provides straightforward assistance in managing solid waste in all parts of Malaysia (Moh et al., 2017). The Malaysian Ministry of Urban Wellbeing, Housing, and Local Government established the National Waste Management Department to promote solid waste management (Razali et al., 2019). Essentially, solid waste management requires population support to achieve sustainable progress. Since early 2010, the Malaysian solid waste and public cleansing program has prioritized trash separation at the source (Pardini et al., 2019). Separation of garbage fosters responsible citizenship and engages the general population in addressing environmental issues (Razali et al., 2019). The waste separated by users allows the local administration to reduce waste separation efforts and engage in environmentally friendly waste disposal (Pardini et al., 2019).

United Nations Sustainable Development Goals (UNSDGs) are endorsed by Malaysia and followed closely in Malaysia. Specifically, SDG # 11 and 12 describe sustainable cities and communities and engagement in responsible consumption (FAO, 2018). The Malaysian government began the implementation of the separation at source initiative (SSI) in 2016 for mandatory waste separation at the house in every household. However, only 22% of the solid waste produced in Malaysia was processed and recycled effectively (Razali et al., 2019).

## Theoretical Framework

Individual engagement with green behaviors is broadly based on personal values and norms to develop an appropriate mindset in which the protection of the environment is necessary for the current state of life and future life on the Earth (Kim and Seock, 2019). As highlighted in the norm activation theory (NAT), personal values nurture the beliefs involved in the environment and social behaviors (Nordfiaern and Zavareh, 2017). Stern (2000) highlighted that the norms activated through acquiring the right values instigate a multiple set of beliefs, which describe the theory as the VBN theory that predicts environmental behaviors.

Multiple values facilitate human behavior through the development of beliefs and norms. Two significant sets of values that facilitate environmental behaviors are biospheric and altruistic values (Sanchez et al., 2015). Biospheric values are the sets of standards which create the innate understanding that the environment is a necessary aspect of human life on the Earth (Stern, 2000). Human life is significantly influenced by the living and non-living species, which are the significant parts of human life (Ünal et al., 2019). Altruistic values are the personal sets of moralities that determine the individual engagement with pro-climate attitudes (Dhir et al., 2021). Kim and Seock (2019) reported a significant impact of altruistic values that raise concern for the environment.

Climate mindset is fostered by biospheric and altruistic beliefs, which are aligned with the idea that the climate is an important aspect of human life and should be conserved (Fornara, et al., 2016). The first belief is based on the ideals of an environmental worldview (Yildirim and Semiz, 2019). It also denotes the personal understanding that the environment is necessary and

requires attention to reduce the climate damage made by humans (Ghargkvouzi et al., 2019). The personal environmental worldview creates another belief known as awareness of consequences (Zeiske et al., 2020). As a personal belief, this awareness is based on the realization that climate change is real and impacts human life (Stern, 2000). It also promotes the next set of beliefs known as the ascription of responsibility, which depicts the sense of obligation that emerges from the severity of the climatic challenges to perform climate-protecting actions to mitigate the climatic issues (Landon et al., 2018).

Social and personal norms nourish the intention to engage in environmental practices (Yildirim and Semiz, 2019). Social norms are epitomized as the perception that important people around the individual regulate their actions. Individuals believe that it is critical to behave in a socially acceptable manner, which aids in accepting and engaging in pro-climatic behaviors. Social norms facilitate the individual's personal norms to perceive environmental issues actively and engage in pro-environmental actions. Personal norms illustrate individual understanding and moral sensitivity that taking care of the environment is essential. Multiple beliefs instigate personal norms to protect the climate and participate in environment-friendly practices (Zeiske et al., 2020). Intentions to engage in eco-friendly actions promote an individual's actual pro-climate behavior (Ghargkvouzi et al., 2019).

# HYPOTHESES DEVELOPMENT

## Development of Ecological Worldview

Individual values foster personal beliefs that encourage environmentally friendly behavior (Maichum et al., 2016). Biospheric values represent the distinctive personal conscience that the living and other non-living species are the critical parts of human life on earth (Stern, 2000). Fornara et al. (2016) highlighted that the biospheric values significantly impact the mindset to protect the environment. Moreover, altruistic values represent the individual inclinations to be interested and engage in building and promoting equivalence, congruence, and justice (Kiatkawsin and Han, 2017). Ünal et al. (2019) found a positive and significant effect of the individual biospheric values that nurture the ecological worldview among the European respondents. The following hypotheses were proposed:

Hypothesis ($H_{1a}$): *Biospheric values positively affect ecological worldview.*

Hypothesis ($H_{1b}$): *Altruistic values positively affect ecological worldview.*

## Development of Awareness of Consequences

The first belief that emerges from the ecological worldview is that the awareness of consequences from the climate challenges result from the industrial revolution (Sanchez et al., 2015). The environmental mindset initiates the attempt to consider the negative impact on the climate and natural human lifestyle (Fornara et al., 2016). Ünal et al. (2019) emphasized that an ecological worldview accelerates the awareness of consequences of the climate damages that are produced by human populations. Accordingly, the following hypothesis was suggested:

Hypothesis ($H_2$): Ecological worldview positively affects awareness of consequences.

## Development of the Ascription of Responsibility

According to the VBN framework, awareness of consequences constantly affects the ascription of responsibility. Following the personal realization that climate issues are essential and lead to further issues in human life, taking the personal responsibility to protect and mitigate climate issues is vital in reconsidering climate issues (Nordfiaern and Zavareh, 2017). Zhang et al. (2020) suggested that the awareness of consequences further significantly contributes to the belief of taking the personal responsibility for correcting the climate damages caused by humans. Recently, Gkargkavouzi et al. (2019) advised that the awareness of consequences for climate challenges promotes the belief that the responsibility for mitigating climate issues is essential. The following hypothesis was proposed:

Hypothesis ($H_3$): Awareness of consequences positively affects ascription of responsibility.

## Development of Personal Norms

Personal norms are activated by precise environmental beliefs to take pro-climate actions (Zhang et al., 2020). The ecological worldview refers to the view that climate is an integral part of human life, which requires personal actions to protect the nature of a prosperous human life (Kiatkawsin and Han, 2017). Han, Hwang, and Lee et al. (2020) presented a clear indication that the ecological worldviews instigate personal norms. Accordingly, the following hypothesis was developed:

Hypothesis ($H_{4a}$): Ecological worldview positively affects personal norms.

The awareness of consequences creates the obligatory acceptance that the sustainability of life on the Earth requires responsible actions to mitigate climate issues (Zieske et al., 2020). Yildirim and Semiz (2019) highlighted that the awareness of consequences fosters the personal norms to perform the obligatory action to reduce water waste. Meanwhile, Ünal et al. (2019) highlighted that awareness of consequences contributes to the personal environmental norms. Hence, the following hypothesis was suggested:

Hypothesis ($H_{4b}$): Awareness of consequences has a positive effect on personal norms.

Developing a sense of responsibility suggests the personal norms to perform pro-environmental behavior (Zhang et al., 2020). Gkargkavouzi et al. (2019) suggested that the ascription of responsibility enhances the personal norms to contribute to climate mitigation practices among European adults. Zhang et al. (2020) identified an encouraging and notable effect of ascription of responsibility on the Chinese farmers' personal

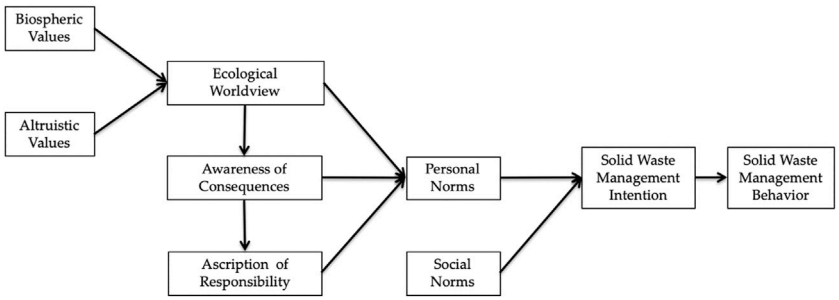


**FIGURE 1 |** Research framework.

norms to follow climate-friendly farming practices. The following hypothesis was proposed:

Hypothesis ($H_{4c}$): Ascription of responsibility has a positive effect on personal norms.

## Solid Waste Management Intention

Han (2015) recorded a considerable effect of social norms on the development of the intention to engage in climate-friendly behaviors among the USA-based respondents. Zhang et al. (2020) stated that social norms' influences mitigate the climate challenges among rice farmers from China. The personal norms shape the personal stipulation to protect the ecology and engage in green behaviors (Ünal et al., 2019). Nordfjaern and Zavareh (2017) demonstrated a substantial influence of the personal norms in encouraging the willingness to use green transport for school students in China. Therefore, these hypotheses were proposed:

Hypothesis ($H_{5a}$): Social norms has a positive effect on solid waste management intention.

Hypothesis ($H_{5b}$): Personal norms have a positive effect on solid waste management intention.

## Solid Waste Management Behavior

The intention is the prominent predictor of environmental behaviors (Ünal et al., 2019). Zhang et al. (2020) suggested that the intention to engage in climate-friendly practices directs the individual to conduct conservative farming practices among the Chinese farmers. Intention as a predictor of sustainable behavior also applies to solid waste management. This study suggests that the intention to perform solid waste management is to harness the solid waste management behavior. Following that, this hypothesis was developed:

Hypothesis ($H_6$): Solid waste management intention positively affects solid waste management behavior.

All the hypothesized associations are presented in **Figure 1** below:

# RESEARCH METHODOLOGY

The deductive research strategy was adopted. Survey-based cross-sectional data were collected to identify the intention and behavior of solid waste management among Malaysians under the premises of the VBN theory.

## Population and Sample

In the current study, the respondents comprised adult Malaysians. The G-Power 3.1 was employed to calculate the sample size required for the current study with the parameters (e.g., power = 0.95 and effect size = 0.15) and eight input variables. The calculation suggested a minimum of 160 participants for the study (Faul, Erdfelder, Lang and Buchner, 2007). Furthermore, Hair, Risher, Sarstedt, and Ringle (2019) suggested that PLS-SEM is employed with sample sizes of at least 200 participants. The data collection was performed by circulating the survey form on social media platforms like Facebook and WhatsApp. Moreover, the qualifying question was used to evaluate the appropriateness of the study respondents. The final analysis was performed with 1,571 valid responses.

## Survey Instrument

A structured questionnaire was used as the survey instrument in this study. All questions (presented in **Supplementary Appendix SA1**) were adopted from earlier studies with minor modifications. Furthermore, the seven-point Likert scale (not important at all, not important, slightly not important, neutral, slightly important, important, and very important) was used to measure biospheric and altruistic values, while the seven-point Likert scale (strongly disagree, disagree, somewhat disagree, neither agree nor disagree, somewhat agree, agree, and strongly agree) was used to determine other variables.

## Common Method Bias

The single factor accounted for 40.725%, which was below the recommended limit of 50% and indicated that common method bias was not a significant issue for the study (Podsakoff et al. 2012). Moreover, common method bias evaluated the current study by testing the full collinearity for all study constructs (Kock, 2015) that regressed on the common variable. Variance inflation factor (VIF) values for biospheric values (2.157), altruistic values (2.458), ecological worldview (2.987), awareness of consequences (3.548), the ascription of responsibility (3.208), social norms (2.718), personal norms (3.281), solid waste management intention (3.558), and solid waste management behavior

**TABLE 1 |** Respondent profile.

| | N | % | | N | % |
|---|---|---|---|---|---|
| Gender | | | Marital status | | |
| Female | 874 | 55.6 | Single | 1252 | 79.7 |
| Male | 697 | 44.4 | Married | 288 | 18.3 |
| Total | 1571 | 100.0 | Divorced | 21 | 1.3 |
| | | | Widowed | 10 | 0.6 |
| Age group | | | Total | 1571 | 100.0 |
| 18–25 years | 1112 | 70.7 | | | |
| 26–35 years | 210 | 13.3 | Education | | |
| 36–45 years | 68 | 4.3 | Secondary school certificate | 256 | 16.3 |
| 46–55 years | 127 | 8.0 | Diploma certificate | 263 | 16.7 |
| 56–65 years | 47 | 2.9 | Bachelor's degree or equivalent | 983 | 62.6 |
| Above than 65 years | 7 | 0.4 | Master degree | 62 | 3.9 |
| Total | 1571 | 100 | Doctorate level | 7 | 0.4 |
| | | | Total | 1571 | 100.0 |
| Average monthly income (RM) | | | | | |
| Below RM2500 | 1036 | 65.9 | Employment status | | |
| RM2501-RM5000 | 317 | 20.2 | Job seekers | 850 | 54.1 |
| RM5001-RM7500 | 108 | 6.9 | Employed full-time | 459 | 29.2 |
| RM7501-RM10,000 | 58 | 3.7 | Employed part-time | 216 | 13.7 |
| RM10,001-RM12,500 | 20 | 1.3 | Retired | 46 | 2.9 |
| More than RM12,501 | 32 | 2.0 | Total | 1571 | 100 |
| Total | 1571 | 100.0 | | | |

(2.527). All VIF values were lower than 5, which suggested that no issue of common method bias was present in the data (Kock, 2015).

## Multivariate Normality

Multivariate normality for the study data was evaluated with the Web Power online tool (source: https://webpower.psychstat.org/wiki/tools/index). The calculated Mardia's multivariate *p*-value exhibited multivariate normality issues given that Mardia's *p*-values were below 0.05 (Cain et al., 2017). Because of the multivariate non-normality issue, this study used PLS-SEM to analyze data as recommended by Hair et al. (2019).

## Data Analysis Method

The study model was analyzed with the PLS-SEM using Smart-PLS 3.1 software. Smart PLS is a multivariate analysis instrument that evaluates path models using latent constructs (Hair et al., 2014). PLS-SEM analyzes small data sets and handles complex models with composites without estimation of goodness-of-fit assessment (Hair et al., 2019). A two-stage evaluative process is recommended for the SmartPLS data analysis. The first measurement is performed on the model to test the reliability and validity of the study constructs (Hair et al., 2014). The second stage was accomplished with the structural model relations, and the study hypotheses with significance levels were performed with the bootstrapping technique (Hair et al., 2019). Hair et al. (2014) Model quality estimation was accomplished with $r^2$, $Q^2$, and the effect size $f^2$ that pronounces the path effect from input constructs to outcome construct. Moreover, blindfolding analysis is used to measure the predictive relevancy by the mean of having $Q^2$ for two latent constructs (Hair et al., 2019).

# DATA ANALYSIS

## Demographic Details

The demographic details, including the respondents' gender, age groups, marital status, education, average monthly income, and employment status are presented in **Table 1**. Findings revealed that the majority of the respondents were female (55.6%). Most of the respondents aged between 18 and 25 years old constituted 70.7% of the total respondents. Furthermore, most of the respondents (79.7%) were single, while the remaining respondents were married or divorced. The respondents who had completed secondary school education accounted for 16.3% of the total respondents, while 16.7% of the respondents had completed a diploma or technical school level education, 62.6% of the respondents had fulfilled Bachelor's level education, 3.9% of them had fulfilled Master's level education, and the remaining respondents had obtained a Doctorate level education. Respondents with a monthly income below RM2,500 accounted for 65.9% of the total respondents.

## Reliability and Validity

Following the direction from work by Hair et al. (2019), the current study latent construct reliabilities were accomplished and evaluated with the Cronbach's alpha (CA), DG rho, and composite reliability (CR). The CA values for each construct were above the minimum value of 0.65, while the lowest score of the CA amounted to 0.769 (Hair et al., 2014). Furthermore, the DG rho values of every construct were above the threshold of 0.70, with the minimum value of DG rho amounting to 0.772 (Hair et al., 2019). Moreover, CR values were above the minimum value of 0.70, with 0.852 as the lowest CR value (Hair et al., 2014). As shown in **Table 2**, the results demonstrated that the latent

**TABLE 2 |** Reliability and validity.

| Variables | No. items | Mean | Standard deviation | Cronbach's alpha | Dijkstra-Henseler's *rho* | Composite reliability | Average variance extracted | Variance inflation factors |
|---|---|---|---|---|---|---|---|---|
| BOV | 5 | 5.847 | 0.891 | 0.884 | 0.888 | 0.915 | 0.685 | 1.699 |
| ALV | 4 | 5.907 | 0.848 | 0.769 | 0.772 | 0.852 | 0.590 | 1.699 |
| EWV | 5 | 5.840 | 0.568 | 0.817 | 0.819 | 0.872 | 0.577 | 2.577 |
| AOC | 6 | 6.086 | 0.561 | 0.886 | 0.886 | 0.913 | 0.637 | 3.094 |
| AOR | 5 | 5.913 | 0.647 | 0.883 | 0.884 | 0.914 | 0.682 | 2.805 |
| SON | 5 | 5.683 | 0.927 | 0.872 | 0.872 | 0.907 | 0.662 | 2.180 |
| PNS | 5 | 5.524 | 0.993 | 0.892 | 0.892 | 0.920 | 0.698 | 2.180 |
| WMI | 6 | 5.462 | 0.956 | 0.876 | 0.877 | 0.906 | 0.617 | 1.000 |
| WMB | 5 | 5.156 | 1.126 | 0.864 | 0.866 | 0.902 | 0.647 | - |

*BOV, biospheric values; ALV, altruistic values; EWV, ecological worldview; AOC, awareness of consequences; AOR, ascription of responsibility; SON, social norms; PNS, personal norms; WMI, solid waste management intention, WMB, waste management behavior.*

**TABLE 3 |** Discriminant validity.

| | BOV | ALV | EWV | AOC | AOR | SON | PNS | WMI | WMB |
|---|---|---|---|---|---|---|---|---|---|
| Fornell–Larcker Criterion | | | | | | | | | |
| BOV | 0.827 | | | | | | | | |
| ALV | 0.641 | 0.768 | | | | | | | |
| EWV | 0.635 | 0.699 | 0.760 | | | | | | |
| AOC | 0.637 | 0.705 | 0.751 | 0.798 | | | | | |
| AOR | 0.591 | 0.619 | 0.720 | 0.774 | 0.826 | | | | |
| SON | 0.612 | 0.565 | 0.624 | 0.624 | 0.679 | 0.813 | | | |
| PNS | 0.529 | 0.492 | 0.545 | 0.526 | 0.585 | 0.736 | 0.835 | | |
| WMI | 0.498 | 0.466 | 0.508 | 0.502 | 0.581 | 0.714 | 0.713 | 0.786 | |
| WMB | 0.352 | 0.279 | 0.331 | 0.266 | 0.355 | 0.569 | 0.608 | 0.746 | 0.805 |
| Heterotrait–Monotrait Ratio | | | | | | | | | |
| BOV | | | | | | | | | |
| ALV | 0.773 | | | | | | | | |
| EWV | 0.744 | 0.878 | | | | | | | |
| AOC | 0.716 | 0.851 | 0.880 | | | | | | |
| AOR | 0.666 | 0.748 | 0.845 | 0.874 | | | | | |
| SON | 0.697 | 0.692 | 0.738 | 0.710 | 0.773 | | | | |
| PNS | 0.597 | 0.600 | 0.637 | 0.593 | 0.660 | 0.834 | | | |
| WMI | 0.570 | 0.575 | 0.603 | 0.574 | 0.663 | 0.817 | 0.807 | | |
| WMB | 0.406 | 0.349 | 0.394 | 0.305 | 0.407 | 0.654 | 0.692 | 0.852 | |

*BOV, biospheric values; ALV, altruistic values; EWV, ecological worldview; AOC, awareness of consequences; AOR, ascription of responsibility; SON, social norms; PNS, personal norms; WMI, solid waste management intention; WMB, waste management behavior.*

constructs showed suitable reliabilities. The average value extracted (AVE) was utilized for the current study to evaluate the convergent validity, followed by the results that the AVE values for each construct were higher than 0.50. The result also indicated the appropriate level of convergent validity to establish the uni-dimensionality of each construct (Hair et al., 2019). VIF scores for every construct were below the minimum score of 3.3, which indicated that multicollinearity issues were not present (Hair et al., 2014).

The discriminant validity for the current study model was evaluated with the Fornell-Larcker criterion (1981) and the Heterotrait–Monotrait (HTMT) ratio. The Fornell–Larcker criterion is based on the assessment of the square root of the respective construct and the correlation of all other variables in the study. The square root of AVE must be greater than the correlations for all other variables. The HTMT ratio must be less than 0.900 to confirm the discriminant validity among the study constructs. The Fornell–Larcker and HTMT ratios illustrated (in **Table 3**) that the model had sufficient discriminant and convergent validities (Hair et al., 2019). The item loadings and cross-loadings presented a reasonable level of discriminant validity for study constructs (see **Supplementary Appendix SA2**).

## Path Analysis

A study model measurement was implemented to examine the study hypotheses. As shown in **Table 4**, the $r^2$ value for the two exogenous latent constructs (e.g., biospheric and altruistic values) on the ecological worldview represented 54.8% of the change in the ecological worldview. The predictive relevance ($Q^2$) score for this part of the model amounted to 0.312, which indicated the medium predictive relevance (Hair et al., 2014). The $r^2$ value for

**TABLE 4 |** Hypothesis testing.

| Hypo | | Beta | CI - min | CI - Max | *t-Value* | *p-Value* | Decision | $r^2$ | $f^2$ | $Q^2$ |
|---|---|---|---|---|---|---|---|---|---|---|
| *Factors affecting ecological worldview* | | | | | | | | | | |
| $H_{1a}$ | BOV → EWW | 0.317 | 0.275 | 0.360 | 12.079 | 0.000 | Accept | | 0.131 | |
| $H_{1b}$ | ALV → EWW | 0.496 | 0.453 | 0.539 | 19.131 | 0.000 | Accept | 0.548 | 0.320 | 0.312 |
| *Factor affecting awareness of consequences* | | | | | | | | | | |
| $H_2$ | EWW → AOC | 0.751 | 0.730 | 0.773 | 53.890 | 0.000 | Accept | 0.564 | 1.495 | 0.356 |
| *Factor effecting ascription of responsibility* | | | | | | | | | | |
| $H_3$ | AOC → AOR | 0.774 | 0.753 | 0.795 | 58.605 | 0.000 | Accept | 0.599 | 1.495 | 0.404 |
| *Factors affecting personal norms* | | | | | | | | | | |
| $H_{4a}$ | EWV → PNS | 0.225 | 0.167 | 0.295 | 5.860 | 0.000 | Accept | | 0.040 | |
| $H_{4b}$ | AOC → PNS | 0.139 | 0.080 | 0.196 | 3.904 | 0.000 | Accept | 0.504 | 0.013 | 0.330 |
| $H_{4c}$ | AOR → PNS | 0.409 | 0.349 | 0.471 | 11.108 | 0.000 | Accept | | 0.121 | |
| *Factors affecting solid waste management intention* | | | | | | | | | | |
| $H_{5a}$ | SON → WMI | 0.411 | 0.367 | 0.465 | 13.155 | 0.000 | Accept | | 0.187 | |
| $H_{5b}$ | PNS → WMI | 0.412 | 0.358 | 0.460 | 13.096 | 0.000 | Accept | 0.587 | 0.188 | 0.360 |
| *Factor affecting solid waste management behavior* | | | | | | | | | | |
| $H_6$ | WMI → WMB | 0.746 | 0.723 | 0.765 | 58.299 | 0.000 | Accept | 0.557 | 1.256 | 0.357 |

*BOV, biospheric values; ALV, altruistic values; EWV, ecological worldview; AOC, awareness of consequences; AOR, ascription of responsibility; SON, social norms; PNS, personal norms; WMI, solid waste management intention; WMB, solid waste management behavior.*

ecological worldview was recorded with a 56.4% variance in awareness of consequences. The predictive relevance ($Q^2$) score for the portion of the model amounted to 0.356, which denoted a high predictive relevance (Hair et al., 2014). The $r^2$ score for awareness of consequences, which was an exogenous construct on the ascription of responsibility, exhibited a 59.9% variance for the ascription of responsibility. The model's predictive relevance ($Q^2$) score amounted to 0.404, which indicated high predictive relevance (Hair et al., 2014).

The $r^2$ value for the three exogenous variables (ecological worldview, awareness of consequences, and ascription of responsibility) demonstrated a 50.4% change in the personal norms of the respondents. This part of the model's predictive relevance ($Q^2$) value amounted to 0.330, suggesting a medium predictive relevance (Hair et al., 2014). The adjusted $r^2$ value for the social norms and personal norms as exogenous variables affected the intention to engage in solid waste management intention and denoted a 58.7% change in the intention to act on the solid waste management intention. The predictive relevance ($Q^2$) value for the slice of the model amounted to 0.360, which indicated a medium predictive relevance (Hair et al., 2014). The solid waste management intention demonstrated a 55.7% change in solid waste management behavior. This model section showed high predictive relevance with a $Q^2$ score of 0.357.

The model standardized path values, t-values, and significance levels are presented in **Table 4**. The path coefficient between biospheric values and ecological worldview indicated that the biospheric values significantly and positively influenced the ecological worldview. Overall, the result suggested considerable statistical support for the acceptance of H1a. The path value for the altruistic values and ecological worldview demonstrated that the altruistic values were significant, which supported H1b. Given that the path between ecological worldview and awareness of consequences illustrated that the influence of the ecological worldview on the awareness of consequences was positive and significant, the H2 was accepted. The path coefficient for the awareness of consequences and ascription of responsibility signified a positive and significant influence of awareness of consequences on the ascription of responsibility to engage in solid waste management activities. Therefore, H3 was accepted.

The path from ecological worldview to personal norms demonstrated the positive and significant impact of the ecological worldview on personal norms due to its support of H4a. The path between awareness of consequences and personal norms demonstrated the positive and significant influence of the awareness of consequences on the personal norms, which supported H4b. Following that, the path coefficient for ascription of responsibility and personal norms presented a positive and significant effect of the ascription of responsibility on the personal norms, and H4c was accepted.

The path between social norms and solid waste management intention proved the significant impact of social norms on the intention to engage in solid waste management practices, which supported H5a. The path between personal norms and solid waste management intention confirmed that personal norms significantly influenced the intention to engage in solid waste management practices, which indicated support for H5b. The path coefficient for the solid waste management intention and solid waste management behavior showed a positive and significant effect; therefore, H6 was supported.

## DISCUSSION

The results from the current study indicated that the VBN theory is ideal for an excellent explanation regarding Malaysian adults' intention and behaviors towards solid waste management practices. Biospheric and altruistic values contributed to the understanding that the environment is vital for the Earth, which is known as an ecological worldview (Walton and Austin, 2011). Notably, taking the necessary action to strengthen the climate is an important factor influencing the

human lifestyle in the environment (Sanchez et al., 2015). Overall, the study results were in line with the statement by Ünal et al. (2019), in which the biospheric values substantially influenced the ecological mindset. However, the data revealed that altruistic values have a greater impact on ecological worldview than biospheric values, which contradicts the findings of Ünal et al. (2019) and Zhang et al. (2020).

The study findings were in line with the work by Dhir et al. (2021), which suggests that the natural resources should be utilized carefully, considering that climate change evidently impacts human life on the Earth. The ecological worldview significantly contributes to the ecological awareness regarding the increase in climatic issues and environmental challenges faced by humans (Kim and Seock, 2019). The study results suggested that the ecological worldview boosted the awareness of consequences, which highly supported the ascription of responsibility for correcting the climate challenges at the personal level. The current findings were in line with Fornara et al. (2016) statement that climate awareness promotes the innate personal responsibility to take protective action towards the climate.

It was suggested from the current study results that three beliefs (ecological worldview, awareness of consequences, and ascription of responsibility) accounted for approximately 50% of the variance in the personal norms. The conclusion of this study was in line with Ünal et al.'s (2019) statement that the ecological worldview, awareness of consequences, and ascription of responsibility contributed to ecological behaviors.

It was suggested that personal and social norms promoted participation in solid waste management practices among the Malaysian respondents. This result was in line with Trautwein et al. (2021) that the individual norms strengthened the intention to participate in environment-friendly practices to reduce the climate problems. Finally, the desire to participate in solid waste management techniques led to conservational behavior such as participation in solid waste management. This result was in agreement with the work by Landon et al. (2018), which stated that the intention to engage in sustainable actions encourages the actual adoption of sustainable practices.

## Implications

The current study's findings increased the VBN framework's utility and predictive ability in estimating solid waste management's pro-environmental behavior. Personal values were shown to be in line with ideas that foster personal and social norms to engage in climate-friendly actions in the current study (Trautwein et al., 2021).

These results presented three appropriate and practical implications. First, given that all parties are responsible for producing solid waste, taking collective responsibility is necessary to overcome the challenge of solid waste management. Considering that solid waste is produced daily, changing lifestyle and consumption patterns is vital for all people. Furthermore, the education system should develop biospheric and altruistic values to protect the environment and make efforts to reduce the global climate system footprint (UNESCO, 2022). As noted by Reid (2019), the education system needs to incorporate prevention, mitigation, and adaptation strategies to promote environmental sustainability. The education system emphasizes the importance of climate in human life and the collective action required to sustain life, and therefore, the number of universities adopting and promoting carbon neutral goals and practices is on the rise (Leal et al. (2021). To lessen the environmental impact of solid waste, the school system must create the required values that help reduce waste generation and dispose of solid trash appropriately. To reduce solid waste output, producers of goods and services must adapt their production techniques and packaging. Policymakers should provide the right policies to kickstart solid waste reduction efforts and improve solid waste management operations. However, in order to reduce environmental concerns, policymakers must take into account public opinion and develop a sense of community responsibility. Financial and social incentives could persuade the general people to minimize solid waste output and adopt a more environmentally conscious mindset. Moreover, solid waste management policies should be openly debated and formulated with the public's consent given that mass implementation is not possible without the acceptance of the policies by the general public. Solid waste management must be a priority for all urban and rural residents; thus, civic authorities and city administrations should levy reasonable surcharges to instill civic responsibility in urban residents.

Several limitations were present in this study. To illustrate, solid waste management in the personal setting was the only subject emphasized in this study. More research into solid waste management practices in personal and social settings would be beneficial. Individuals' social and personal behaviors toward adopting solid waste management practices may be described by descriptive and injunctive social norms. Furthermore, the present study thoroughly applied the VBN framework to determine the environmentally friendly behavior of solid waste management and connect it with personal values, beliefs, and norms. General and specific environmental knowledge significantly harnessed the attitude towards the environment. Accordingly, future work is required to incorporate environmental knowledge factors and identify how these factors impact beliefs and norms towards climatic issues.

As a result, future research should include personality variables (mindfulness, hope, indigenous wisdom orientation, and the Big Five) that influence solid waste management methods (Gkargkavouzi et al., 2019). Finally, the current study relied on cross-sectional data collection and a quantitative research approach, resulting in limited generalization for comprehending the phenomenon under study. As a result, future studies should use a mixed-method study design and a longitudinal data collection strategy to fully understand the respondents' solid waste management practices.

# CONCLUSIONS

Climate issues are becoming more prevalent, posing greater threats to human life around the world. The majority of climate problems are created by irresponsible human behavior, whereas climate-friendly behavior has the potential to reduce the challenges that humans confront. Solid waste management is a climatic concern that requires appropriate measures. The current study used the VBN model to assess the intention

and behavior of Malaysian adults to engage in solid waste management techniques. According to the findings, pro-climatic actions and solid waste management practices are linked to Malaysian adults' beliefs and standards. The intention and behavior to engage in solid waste management methods that contribute in the mitigation of global climate concerns are heavily influenced by social and personal standards. As a response, concerted steps should be taken to limit solid waste generation and process solid waste in a climate-friendly manner.

## DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author.

## ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

NH, MM, ZM, and MS—conceptualization, instrument, data collection, writing—original draft. AM and TJ—methodology, formal analysis, writing—revisions.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fenvs.2022.906002/full#supplementary-material

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# APPENDIX

**APPENDIX 1 |** Survey Questionnaire.

| Code | Items | Source |
|---|---|---|
| Biospheric values – Please indicate to what extent the following are important as a guiding principle in your life | | |
| BOV1 | Unity with nature | Ünal, Steg and Granskaya, (2019); Han et al. (2016) |
| BOV2 | Respecting the earth | |
| BOV3 | Protecting the environment | |
| BOV4 | Preventing pollution | |
| BOV5 | Protecting natural resources | |
| Altruistic values | | |
| ALV1 | I respect equal opportunity for all | Kim et al. (2016) |
| ALV2 | I value a world free of war and conflict | |
| ALV3 | I like to correct injustice | |
| ALV4 | I care for others who are weak and older | |
| Ecological worldview | | |
| EWV1 | When humans interfere with nature, the consequences can be disastrous | López-Mosquera and Sánchez (2012); Han et al. (2016) |
| EWV2 | Plants and animals have as much right to live as humans | |
| EWV3 | Humans are seriously abusing the environment | |
| EWV4 | The balance of nature is very delicate and easily upset | |
| EWV5 | Human is responsible for the long-life of nature sustainability | |
| Awareness of consequences | | |
| AOC1 | Global warming is a problem for society | López-Mosquera and Sánchez (2012); Choi, Jang and Kandampully (2015) |
| AOC2 | Recycling and composting help reduce global warming | |
| AOC3 | Environmental quality will improve if we practice recycling and composting | |
| AOC4 | Protection of the environment benefits us all | |
| AOC5 | Environmental protection is beneficial for our health | |
| AOC6 | Environmental protection improves our quality of life | |
| Ascription of responsibility | | |
| AOR1 | We are jointly responsible for global warming | López-Mosquera and Sánchez (2012); Ünal, Steg and Granskaya, (2019) |
| AOR2 | We are jointly responsible for the environmental problems caused by lack of recycling and composting | |
| AOR3 | We are jointly responsible for the environmental problems caused by energy industry | |
| AOR4 | We are jointly responsible for the environmental deterioration caused by our activities | |
| AOR5 | We are jointly responsible for the ecological deterioration caused by our activities | |
| Personal norms | | |
| PNS1 | I feel morally obliged to consume eco-friendly products | Choi, Jang & Kandampully (2015); Ünal, Steg and Granskaya, (2019) |
| PNS2 | People like me should do everything they can to save the environment | |
| PNS3 | I feel obliged to bear the environment and nature in mind | |
| PNS4 | I feel morally obliged to use green products, regardless of what others do | |
| PNS5 | I feel personally obliged to save as much energy as possible | |
| Social norms | | |
| SON1 | Family members whose opinion I value would approve of my engagement in pro-environmental behavior | Kim et al. (2016) |
| SON2 | Family members whose opinion I value would approve of my engagement in recycling and composting | |
| SON3 | Most people who are important to me think I should do whatever I can to prevent climate change | |
| SON4 | Most people who are important to me would want me to take action to stop the disposal of toxic substances in the air, water, and soil | |
| SON5 | People whose opinions I value would prefer that I do whatever I can to prevent the loss of tropical forests | |
| Solid waste management intention | | |
| WMI1 | I am willing to pay for the recycling and composting equipment's | Chen and Deng (2016); Maichum, Parichatnon and Peng (2016) |
| WMI2 | I am willing to accept inconvenience for recycling and composting household wastes | |
| WMI3 | I am willing to recycle and/or compost household wastes | |
| WMI4 | I am willing to adopt recycling and composting practices in an energy efficient way | |
| WMI5 | I am willing to pay premium price for recycling and composting equipment's manufactured in an energy efficient environment | |
| WMI6 | I will encourage my friends and relatives to practice recycling and composting | |

(Continued on following page)

**APPENDIX 1 |** (*Continued*) Survey Questionnaire.

| Code | Items | Source |
|---|---|---|
| Solid waste management behavior | | |
| WMB1 | I purchased all equipment's needed for recycling and composting solid household wastes | Walton and Austin (2011); Sánchez, López-Mosquera and Lera-López (2015) |
| WMB2 | I intentionally purchase products used recycled materials or green composts | |
| WMB3 | I separate all recyclable materials for re-use and/or industrial recycling | |
| WMB4 | I separate solid food waste for composting | |
| WMB5 | I intentionally purchase green composts for household plants and/or garden | |

*BOV, biospheric values; ALV, altruistic values; EWV, ecological worldview; AOC, awareness of consequences; AOR, ascription of responsibility; SON, social norms; PNS, personal norms; WMI, solid waste management intention; WMB, solid waste management behavior.*

**APPENDIX 2: Loadings and Cross-Loadings.**

| | VIB | ALV | EWV | AOC | AOR | PNS | SON | WMI | WMB |
|---|---|---|---|---|---|---|---|---|---|
| VOB1 | 0.752 | 0.445 | 0.457 | 0.392 | 0.392 | 0.487 | 0.434 | 0.405 | 0.353 |
| VOB2 | 0.847 | 0.550 | 0.541 | 0.538 | 0.504 | 0.528 | 0.443 | 0.419 | 0.289 |
| VOB3 | 0.863 | 0.541 | 0.535 | 0.554 | 0.492 | 0.530 | 0.443 | 0.420 | 0.286 |
| VOB4 | 0.850 | 0.568 | 0.550 | 0.588 | 0.523 | 0.489 | 0.429 | 0.399 | 0.243 |
| VOB5 | 0.820 | 0.540 | 0.539 | 0.546 | 0.524 | 0.499 | 0.442 | 0.421 | 0.299 |
| ALV1 | 0.543 | 0.791 | 0.560 | 0.578 | 0.491 | 0.431 | 0.350 | 0.342 | 0.172 |
| ALV2 | 0.499 | 0.772 | 0.564 | 0.596 | 0.508 | 0.387 | 0.324 | 0.291 | 0.109 |
| ALV3 | 0.436 | 0.728 | 0.473 | 0.462 | 0.430 | 0.457 | 0.446 | 0.415 | 0.304 |
| ALV4 | 0.487 | 0.782 | 0.545 | 0.522 | 0.470 | 0.468 | 0.407 | 0.397 | 0.291 |
| EWV1 | 0.483 | 0.552 | 0.750 | 0.550 | 0.532 | 0.440 | 0.379 | 0.344 | 0.229 |
| EWV2 | 0.506 | 0.520 | 0.737 | 0.544 | 0.530 | 0.504 | 0.429 | 0.422 | 0.301 |
| EWV3 | 0.430 | 0.484 | 0.750 | 0.536 | 0.535 | 0.445 | 0.373 | 0.371 | 0.216 |
| EWV4 | 0.457 | 0.521 | 0.769 | 0.551 | 0.528 | 0.488 | 0.455 | 0.401 | 0.306 |
| EWV5 | 0.529 | 0.573 | 0.791 | 0.660 | 0.605 | 0.490 | 0.431 | 0.390 | 0.207 |
| AOC1 | 0.481 | 0.551 | 0.632 | 0.768 | 0.597 | 0.456 | 0.379 | 0.363 | 0.176 |
| AOC2 | 0.484 | 0.533 | 0.561 | 0.757 | 0.586 | 0.518 | 0.476 | 0.444 | 0.281 |
| AOC3 | 0.501 | 0.546 | 0.588 | 0.794 | 0.609 | 0.522 | 0.466 | 0.423 | 0.247 |
| AOC4 | 0.540 | 0.591 | 0.612 | 0.829 | 0.626 | 0.491 | 0.404 | 0.384 | 0.176 |
| AOC5 | 0.522 | 0.596 | 0.602 | 0.828 | 0.633 | 0.495 | 0.379 | 0.383 | 0.168 |
| AOC6 | 0.520 | 0.558 | 0.599 | 0.810 | 0.651 | 0.508 | 0.416 | 0.408 | 0.228 |
| AOR1 | 0.473 | 0.521 | 0.600 | 0.690 | 0.804 | 0.519 | 0.437 | 0.448 | 0.226 |
| AOR2 | 0.501 | 0.539 | 0.603 | 0.672 | 0.829 | 0.568 | 0.501 | 0.483 | 0.319 |
| AOR3 | 0.447 | 0.462 | 0.542 | 0.571 | 0.798 | 0.540 | 0.495 | 0.462 | 0.345 |
| AOR4 | 0.518 | 0.531 | 0.625 | 0.649 | 0.851 | 0.580 | 0.480 | 0.495 | 0.274 |
| AOR5 | 0.496 | 0.498 | 0.599 | 0.607 | 0.845 | 0.594 | 0.504 | 0.511 | 0.307 |
| PNS1 | 0.487 | 0.421 | 0.503 | 0.502 | 0.555 | 0.812 | 0.571 | 0.584 | 0.463 |
| PNS2 | 0.525 | 0.515 | 0.540 | 0.555 | 0.606 | 0.797 | 0.616 | 0.568 | 0.434 |
| PNS3 | 0.510 | 0.481 | 0.510 | 0.505 | 0.552 | 0.831 | 0.574 | 0.558 | 0.440 |
| PNS4 | 0.487 | 0.417 | 0.479 | 0.470 | 0.530 | 0.837 | 0.627 | 0.611 | 0.531 |
| PNS5 | 0.476 | 0.461 | 0.503 | 0.504 | 0.514 | 0.789 | 0.602 | 0.581 | 0.446 |
| SON1 | 0.475 | 0.456 | 0.503 | 0.501 | 0.528 | 0.648 | 0.823 | 0.596 | 0.462 |
| SON2 | 0.464 | 0.429 | 0.480 | 0.491 | 0.523 | 0.624 | 0.815 | 0.598 | 0.450 |
| SON3 | 0.385 | 0.361 | 0.400 | 0.379 | 0.450 | 0.597 | 0.847 | 0.594 | 0.528 |
| SON4 | 0.424 | 0.393 | 0.423 | 0.398 | 0.450 | 0.587 | 0.842 | 0.582 | 0.547 |
| SON5 | 0.460 | 0.416 | 0.468 | 0.428 | 0.492 | 0.616 | 0.850 | 0.609 | 0.554 |
| WMI1 | 0.329 | 0.303 | 0.355 | 0.304 | 0.407 | 0.544 | 0.528 | 0.791 | 0.652 |
| WMI2 | 0.402 | 0.393 | 0.419 | 0.404 | 0.472 | 0.572 | 0.580 | 0.832 | 0.602 |
| WMI3 | 0.433 | 0.419 | 0.437 | 0.474 | 0.489 | 0.551 | 0.548 | 0.772 | 0.492 |
| WMI4 | 0.460 | 0.439 | 0.475 | 0.499 | 0.547 | 0.595 | 0.577 | 0.793 | 0.531 |
| WMI5 | 0.285 | 0.239 | 0.281 | 0.240 | 0.347 | 0.504 | 0.526 | 0.770 | 0.675 |
| WMI6 | 0.450 | 0.414 | 0.436 | 0.462 | 0.486 | 0.600 | 0.606 | 0.755 | 0.550 |
| WMB1 | 0.274 | 0.222 | 0.271 | 0.187 | 0.282 | 0.462 | 0.518 | 0.652 | 0.825 |
| WMB2 | 0.311 | 0.237 | 0.297 | 0.258 | 0.318 | 0.510 | 0.515 | 0.615 | 0.799 |
| WMB3 | 0.308 | 0.262 | 0.296 | 0.261 | 0.326 | 0.470 | 0.495 | 0.589 | 0.805 |
| WMB4 | 0.280 | 0.238 | 0.249 | 0.215 | 0.288 | 0.414 | 0.453 | 0.571 | 0.791 |
| WMB5 | 0.242 | 0.163 | 0.214 | 0.149 | 0.211 | 0.429 | 0.461 | 0.568 | 0.803 |

*BOV, biospheric values; ALV, altruistic values; EWV, ecological worldview; AOC, awareness of consequences; AOR, ascription of responsibility; SON, social norms; PNS, personal norms; WMI, solid waste management intention; WMB, solid waste management behavior.*