Factors influencing residents' behavior of domestic solid waste classification in Hanoi city

Trang Bui Thi Thu[1], Hanh Nguyen Thi Hong[1*]

Abstract: This study investigates residents' awareness, attitudes, and behaviors concerning domestic solid waste management in Hanoi. Statistical analysis identifies "knowledge of domestic solid waste management" as the primary determinant of household waste segregation behavior. Consequently, it is recommended that the Hanoi municipal government implement targeted educational interventions to enhance environmental knowledge. Such measures are essential for promoting waste classification at the source, thereby minimizing environmental discharge and alleviating the operational burden on waste management authorities

Keywords: Domestic solid waste, knowledge of domestic solid waste management, residents' behavior of domestic solid waste classification.

1. Introduction

Vietnam has experienced substantial economic expansion in recent decades; however, this trajectory - compounded by demographic growth and rising per capita income-has intensified pressure on natural resources and environmental systems, with domestic solid waste emerging as a critical concern. Reconciling economic objectives with environmental preservation remains a complex global challenge, persisting even within nations that have implemented robust sustainable development frameworks. Distinctly, the processes of industrialization and modernization have catalyzed technological advancements in production, particularly regarding the ubiquity of polymer and composite packaging materials. While these innovations offer logistical convenience and have shifted consumption patterns across rural and urban demographics, they significantly contribute to waste volume.

Furthermore, the proliferation of digital infrastructure and e-commerce has accelerated consumption rates, creating a marked correlation between modernized delivery mechanisms and the escalation of household waste generation in densely populated regions. Despite rising waste generation, Vietnam's waste management infrastructure faces significant limitations, characterized by a national recycling rate of approximately 10% and substantial marine discharge estimated at 13 million tons annually. According to the Ministry of Natural Resources and Environment (MONRE, 2021), while reported collection rates reach 85% in urban areas and 40% in rural areas, actual coverage may be lower; of the collected volume, 63% is landfilled while only 22% undergoes treatment (14% incineration, 10% recycling, and 4% composting). Currently, treatment relies predominantly on conventional landfilling and basic incineration, though select major urban centers have begun implementing specialized technologies such as electrocoagulation (MONRE, 2019).

Hanoi city is a large city, with the mission of being the heart of the country, so to solve the problem of environmental sanitation and social security here is of special concern. However, in the process of collecting and treating domestic solid waste in the Capital area, there are still many difficulties and inadequacies, requiring synchronous and comprehensive solutions to manage natural resources and the environment efficient and ensures sustainable development in this area.

2. Research methods

2.1. Data collection method

Research has selective inheritance of secondary documents is the process of using published information, figures, and data from scientific research works and documents from relevant competent authorities as Hanoi Department of Natural Resources and Environment, Statistical Yearbook characteristics, information from current legal documents related to MSW management, previous research projects related to research on household waste.

2.2. Sociological investigation methods

Implement sociological survey methods using questionnaires combined with field surveys to collect information related to the current status of household waste collection and recycling and awareness, attitudes, and behaviors of local residents. After piloting 20 households, the official survey was conducted with 200 households.

Questionnaire structure:

- Part 1: This section includes the questions about prevailing status of the waste management lifecycle, specifically examining generation, source separation, collection logistics, transportation, and treatment protocols.

- Part 2: This section includes the questions about the cognitive and behavioral dimensions of local residents regarding household solid waste

[1]Hanoi University of Natural Resources and Environment
[*] Corresponding author
Received 24th Sep. 2025
Accepted 4th Dec. 2025
Publication date 31st Dec. 2025

management, focusing on their awareness, attitudes, and practices

- Part 3: This section includes the questions about the socio-demographic profiles of respondents, capturing variables such as age, gender, residential location, educational attainment, average income, and household composition

The sample characteristics is summarized in Table 1.

Table 1. Characteristics of the interviewee

Variable	Quantity (person)	Rate (%)
Gender		
Female	59	29.5
Male	141	70.5
Total	200	100
Ages		
Under 25	36	18.0
From 25 - 45	161	80.5
Over 45	3	1.5
Total	200	100
Occupations		
Farmer	67	33.5
Worker	25	12.5
Office staff	42	21.0
Housewife	4	2.0
Teacher	4	2.0
Seller	32	16.0
Driver	10	5.0
Civil servants	2	1.0
Doctor	3	1.5
Accountant	3	1.5
Guard	5	2.5
Journalist	1	0.5
Policeman	2	1.0
Total	200	100
Members of household		
1 - 4	119	59.5
Over 4	81	40.5
Total	200	100
Educations		
High school degree	117	58.5
Intermediate degree	35	17.5
Bachelor College degree	21	10.5
Bachelor University degree	23	11.5
Postgraduate degree	4	2.0
Total	**200**	**100**

(Source: Compiled by the authors)

2.3. Structural equation modeling (SEM) method

Descriptive statistics were utilized to examine participants' awareness, attitudes, and behaviors regarding waste management across the designated study sites. The analysis encompassed measures of central tendency (mean, median), dispersion (standard deviation, range), and frequency distributions.

A 5-point Likert scale was employed to quantify participants' perceptions and behavioral responses. To interpret the resulting mean scores, a class interval of 0.8 was established based on the formula: (maximum-minimum)/n = (5-1)/5 = 0.8.

Consequently, the interpretation of average scores is stratified into five levels, as detailed in Table 2.

Table 2. Interpretation of Likert Scale Levels and Average Score Ranges

Likert Scale Score	Range of Average Scores	Agreement Level	Frequency Level
1	[1.00 – 1.80]	Strongly disagree	Never
2	[1.81 – 2.60]	Disagree	Rarely
3	[2.61 – 3.40]	Neutral	Occasionally
4	[3.41 – 4.20]	Agree	Frequently
5	[4.21 – 5.00]	Strongly agree	Always

Step 1: Data screening and cleaning

Prior to analysis, the raw dataset underwent a rigorous screening process. Questionnaires containing missing data, logical inconsistencies (absurdities), repetitive patterns, or evidence of unengaged responses (straight-lining) were excluded. This filtering process ensured that only high-quality data were retained for computational processing.

Step 2: Exploratory factor analysis (EFA)

EFA was employed to condense correlated variables into a manageable set while preserving the structural integrity of the original information (Hair J.R et al., 1998). The suitability of the data for EFA was evaluated based on three criteria:

Sampling Adequacy: Data appropriateness was verified using the Kaiser-Meyer-Olkin (KMO) measure (where $0.5 \leq KMO \leq 1$) and a significant Bartlett's Test of Sphericity ($p < 0.05$), indicating sufficient inter-variable correlation (Bagher A.N, 2018; Sharaf M.A, 2015).

Factor Extraction: Eigenvalues and cumulative variance percentages were analyzed to determine the explanatory power of the extracted factors.

Factor Loading Significance: Factor loadings quantified the correlation between variables and factors. Loadings exceeding \$0.5\$ were deemed practically significant for interpretation (Joseph F. et al., 2013).

Step 3: Reliability analysis and confirmatory factor assessment

To validate the measurement model, the internal consistency of scales measuring awareness, attitudes, and waste management behavior was assessed using Cronbach's alpha (α)

Thresholds: Acknowledging the exploratory nature of the study and potential sample size influences, a minimum threshold of $\alpha \geq 0.6$ was adopted (Raghu S.J et al., 2021; Peterson R.A, 1994).

Item Purification: Item-total correlations were calculated to refine the scales; items with coefficients below 0.3 were removed to enhance scale reliability (Raghu S.J et al., 2021).

Step 4: Multiple regression analysis

Multiple regression analysis was utilized to determine the impact of independent factors on waste management behavior across research locations. The analysis followed a two-phase approach:

Variable Selection: First, Pearson correlation analysis identified significant predictors. Variables demonstrating a statistically significant relationship ($p < 0.05$) with a correlation coefficient (R) exceeding 0.3 were selected for the model.

Model Evaluation: The Adjusted R^2 was used to assess the goodness of fit, correcting for the number of predictors. Analysis of Variance (ANOVA) verified the overall model compatibility. In the regression equation, the magnitude and sign of the standardized Beta (β) coefficients indicated the strength and direction of the impact on the dependent variable.

2.4. Data analysis method

The collected data were processed through a rigorous procedure aligned with the study's objectives and content. This included data cleaning, classification, coding, and grouping to perform statistical analysis and visualization. Data processing was carried out using Microsoft Excel and SPSS software.

3. Results

3.1. Assessing the scale's reliability and refinement

Structural Equation Modeling (SEM) is a well-established methodology that plays a pivotal role in both academic research and practical management across various organizational contexts. In this study, the authors employ SPSS software to conduct SEM analysis for the validation of the proposed research model. The model to test the level of impact includes 05 factors: the subjective norms; the knowledge of domestic solid waste management; the environmental concerns; the attitudes towards domestic solid waste management; Behavior on classify and collection domestic solid waste.

In particular, all variables have a proportional influence on each other: knowledge affects the behavior, attitudes, standards and concerns of the interviewee in particular, and of each person in general. From there, it is possible to come up with the most general criteria to propose to managers about people's standards, attitudes, and behaviors toward domestic solid waste collection.

Table 3. Results of Cronbach's Alpha consistency reliability test

	Scale Mean	Scale Variance	Corrected Item-Total Correlation	Cronbach's Alpha
SN	13.5834	7.588	0.852	0.940
KN	13.7260	7.155	0.866	0.936
EN	13.7739	6.815	0.898	0.931
AT	13.6778	7.145	0.922	0.927
Be	13.7194	6.976	0.791	0.952

(Source: Results of data processing using SPSS 20)

From the results of Cronbach's alpha reliability analysis above, it shows that the Cronbach's alpha coefficient of each concept and the correlation coefficient - the total variable of the observed variables in each concept all satisfy the condition, that is, the concepts All concepts achieve reliability and are used for subsequent analysis. There is no Cronbach's alpha coefficient < 0.5, so the indicators of each concept are reliable.

3.2. Analyzing factors affecting household solid waste management behaviors

Exploratory factor analysis (EFA) is a quantitative analysis method used to reduce a set of many interdependent measurement variables into a smaller set of variables (called factors) so that they are meaningful. but still contains most of the information content of the original variable set (Hair et al. 2013).

In Exploratory Factor Analysis (EFA), each observed variable is modeled as a linear combination of latent factors. Consequently, the total variance of these variables is partitioned into two components: that which is explained by a limited set of common factors, and that which is attributable to unique factors specific to each variable.

Table 4. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.862
Bartlett's Test of Sphericity	Approx. Chi-Square	10857.230
	df	435
	Sig.	0.000

(Source: Results of data processing using SPSS 20)

To use EFA, KMO must be greater than 0.50. According to data collected and processed by the author, the table above has determined that KMO satisfies the conditions. Kaiser (1974) suggested:

KMO >= 0.90: Very good;

0.80 <= KMO < 0.90: Good;

0.70 <= KMO <0. 80: Acceptable.

0.60 <= KMO <0. 70: Temporary Acceptable.

0.50 <= KMO <0. 60: Bad;

KMO <0. 50: Not acceptable.

EFA results show that the model achieves high compatibility with real data with the indicators:

(1): Environmental concerns (EN);

(2): the subjective norms (SN);

(3): Knowledge of domestic solid waste management (KN);

(4): Attitudes attitudes towards domestic solid waste management (AT);

(5): Behavior in domestic solid waste classification (Be).

The resullt of the CFA confirmatory factor and specific variables shows that the relationships in the research model, through the unstandardized regression coefficient, all results are acceptable. The relationships are tested and the hypotheses obtained and tested on AMOS are accepted, the weights have been standardized to show the relationship between the variables KN<>SN, KN<>Be, KN<>EN, KN<>AT, SN<>EN, SN<>AT, SN<>Be, Be<>EN, Be<>AT ... This confirms that if people have enough legal knowledge, knowledge of domestic solid waste management will have positive changes in that person's attitude, behavior, and concern for environmental protection in general, and classification and management of domestic solid waste in particular. In addition, domestic solid waste supply and transportation services need a long-term strategy to classify domestic solid waste and hazardous domestic solid waste right at the source to ensure that each citizen can use it easily and access it. In the analysis of interview data, there are some quite positive suggestions from people such as placing trash cans with clearly marked categories or placing plastic bags with specified colors to classify domestic solid waste.

Through research and analysis of influencing factors, as well as using the SEM linear regression method, we found that there are 5 main factors affecting domestic solid waste management in Hanoi city, those factors are: (1): Environmental concerns (EN); (2) Subjective norms (SN); (3) Knowledge of domestic solid waste management (KN); (4) Attitudes attitudes towards domestic solid waste management (AT); (5) Residents' behavior of domestic solid waste classification (Be). In particular, specifically as follows:

- The factor "Environmental concerns" is measured by 6 observed variables, showing concern for the environment such as treating domestic solid waste, classifying MSW at source before collection, transportation, and treatment to protect the environment. It can be said that the factor "Environmental concerns" has a certain influence on domestic solid waste management.

- The "The subjective norms" factor is measured by 6 observed variables, expressing people's willingness to change old waste management habits that are harmful to the environment by using reusable products, environmentally friendly products, limiting the use of plastic waste or classifying domestic solid waste at home.

- Factor "Knowledge of domestic solid waste management" includes 6 observed variables, this is the expression of people's knowledge of environmental protection, awareness of the importance of classifying domestic solid waste at source to does not affect the process of collecting, processing and recycling domestic solid waste.

- The factor "Attitudes towards domestic solid waste management" is measured by 6 observed variables, expressing people's attitudes on current and future domestic solid waste management. People willing to use environmentally friendly products, limiting the use of plastic, nylon bags and disposable food containers.

- The factor "Residents' behavior of domestic solid waste classification" is measured by 6 observed variables, representing positive behaviors affecting the environment of people such as classifying domestic solid waste at source; placing waste in the right place according to civilized regulations; use reusable waste such as plastic, packaging; use environmentally friendly products; pay full domestic solid waste collection fee.

3.3. Factors influencing household solid waste management behaviors

Using SPSS software for regression analysis, resulting in an adjusted R of 0.689, the authors conclude that the built linear regression model fits the

data to the extent of 72.8% of the variation in the variable, depends on the fluctuations of the 10 variables mentioned above. The remaining 27.2% is due to the influence of factors outside the model.

Table 5. Table for assessing the suitability of the regression model

R	R^2	R^2 adjustment	Estimated standard error
0,849	0,720	0,689	0,4108

(Source: Results of data processing using SPSS 20)

Table 6. Multivariate regression analysis

Factors	Unstandardized Regression coefficients		Standardized Regression coefficients	T	Sig
	β	**Std. Error**			
Constant	0,537	0,767		6,598	0,000
Gender	0,420	0,090	0,286	4,642	0,000
Age	0,157	0,040	0,301	3,881	0,000
Education	0,144	0,040	0,282	3,590	0,001
Occupation	0,154	0,078	0,378	1,463	0,124
Members of household	0,234	0,034	0,419	6,926	0,000
Income	0,130	0,046	0,171	2,801	0,006
Posision	0,156	0,394	0,154	1,368	0,075
Total amount of domestic solid waste	0,267	0,045	0,250	0,463	0,045
KN	0,501	0,092	0,448	5,472	0,000
AT	0,090	0,098	0,363	0,921	0,036
Af	0,390	0,115	0,240	3,403	0,001

(Source: Results of data processing using SPSS 20)

The unstandardized regression coefficient (β) is primarily used to formulate the regression equation. In this study, however, the authors do not rely on unstandardized coefficients to rank the influence of independent variables on the dependent variable, as these variables differ in measurement units and standard deviations. Instead, standardized regression coefficients (Beta) are employed to assess the relative impact of the predictors, as they normalize the units and variances across the regression model.

Linear regression results show that the significance level of the criterion "the knowledge of waste management" is 0.000 (<0.05) and is correlated with the variable "Residents' behavior of domestic solid waste classification" at the 95% significance level. The criterion "Income" has a significance level of Sig. is 0.006 (<0.05), that means the variable "Income" in this study has a linear correlation with the variable "Residents' behavior of domestic solid waste classification". The criterion "Occupation" has a significance level of Sig. is 0.124 (>0.1), that means the variable "Occupation" in this study does not have a linear correlation with the variable "Residents' behavior of domestic solid waste classification". Similar explanation for the other remaining factors.

The regression model shows the relationship between household solid waste management behavior of Hanoi residents with factors such as age, gender, education level, average income, demographics, and knowledge. Environmental awareness and behavior of classifying, collecting, transporting, treating and recycling household solid waste are shown as follows:

Domestic solid waste management behavior = f (Gender, age, education (Edu), members of household (H), income, attitudes towards domestic solid waste management (AT), knowledge about environmental (KN), total amount of domestic solid waste (TDSW).

Domestic solid waste management behavior = 0,301 Age + 0,286 Gender + 0,282 Edu + 0,378 Occupation + 0,419 H + 0,171 income + 0,250 TDSW + 0,448 KN + 0,363 AT + 0,240 Af

Based on the regression model of factors affecting the classification index of domestic solid waste of domestic solid waste of people in Hanoi city, it can be seen that the factor "Knowledge of domestic solid waste management " has coefficient β = 0.448. This means that when the factor "knowledge of domestic solid waste management" changes by 1 unit while other factors do not change, it causes "Residents' behavior of domestic solid waste classification " to also fluctuate in the same direction by 0.754 units. Similar explanation for the other remaining factors. The research results show that the main factors influencing the behavior of classifying domestic solid waste are "Knowledge of domestic solid waste management" (β = 0.448), "Members of household" (β = 0.419),

"Occupation" (β = 0.378), "Attitudes towards domestic solid waste management" (β = 0.363). But the criterion "Occupation" does not have a linear correlation with the variable "Residents' behavior of domestic solid waste classification". Among the main factors influencing the behavior of classifying domestic solid waste, the factor of "Knowledge of domestic solid waste management" has the greatest influence, and the second influential factor is "Members of household".

4. Conclusions

Research results show that among the major factors (Knowledge of domestic solid waste management, Members of household, Attitudes towards domestic solid waste management) that are the primary driver of behavior towards domestic solid Waste classification in Hanoi City, the factor "knowledge of domestic solid waste management" has the greatest influence. So that, the city government Hanoi can choose solutions to improve the level of environmental knowledge to promote the behavior of classifying domestic waste to help reduce the amount of domestic waste discharged into the environment.

The authors declare that there is no conflict of interest regarding the publication of this article.

Acknowledgements

The authors would like to sincerely thank the scientific research thesis of Hanoi University of Natural Resources and Environment, code: HUNRE.2025.22.17. The results and the methodology are used in this paper is one of the main contents of this scientific research thesis.

References

Bagher A.N, Salati F., Ghaffari M. (2018) *Factors affecting intention to purchase organic food product among Iranan consumers*, Academy of Marketing Studies Journal, vol. 22, iss. 3, 1-23.

Hair J.R., Black J.F, Babin W.C, Anderson B.J (1998) *Multivariate data analysis (Eds)*, Prentice Hall, New Jersey, pp. 761.

Joseph F. Hair, William C. Black, Barry J. Babin, Rolph E. Anderson (2013) Multivariate data analysis, Pearson Education Limited, 734 pages.

Kaiser, Henry F. (1974) An Index of Factorial Simplicity, *Psychometrika* 39 (1): 31–36.

Ministry of Natural Resources and Environment (MONRE) (2021), *National Environmental Report 2016-2020,* 191pp.

Ministry of Natural Resources and Environment (MONRE) (2019), *National Environmental Report 2019*, 104pp.

Raghu S.J., Rodrigues L.L (2021) *Developing and Validating an instrument of antecedents of solid waste management behavior using mixed methods procedure*, Cogent Psychology, vol. 8, iss. 1, pp. 1886628.

Sharaf M.A, Md Isa, Filzah and Al-Qasa, Khalid (2015) *Factors affecting young Malaysians' intention to purchase green products, Merit research*, Journal of Business and Management, vol. 3, iss. 3, pp. 029-033.