Individual, household and institutional level predictors of waste sorting: Evidence for Ecuador

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Abstract

The rapid increase in waste generation in developing countries presents significant challenges, necessitating effective waste management strategies. This study examines the influence of individual, household, and institutional factors on waste sorting behaviours in Ecuador, employing an ordered logistic regression model. Data were sourced from the 2019 National Multipurpose Household Survey (ENMH) and the Census of Economic Environmental Information in Decentralised Autonomous Governments (CIAEGAD). The ENMH uses a two-stage probabilistic sampling methodology, with census sectors as the primary sampling units and households as the secondary units. After excluding outliers and selecting individuals aged 15 to 65 years, the final sample consisted of 8,601 households, including 26,175 individuals. The findings reveal that personal attributes such as gender, ethnicity, age, marital status, and environmental concern significantly influence waste sorting behaviours. Household characteristics, including urban or rural location, are also critical. Institutional factors, such as municipal regulations, waste collection fees, and waste separation at source, play essential roles in promoting waste separation. The study highlights the necessity for targeted governmental policies. Recommendations include improving environmental education, increasing sorting infrastructure in urban areas, and ensuring waste collection systems maintain the separation of waste streams.

Keywords: waste sorting behaviour; waste management; households; institutional factors; ordered logistic regression; Ecuador.

Introduction

The global increase in population, combined with changes in lifestyle and consumption patterns, has led to a substantial rise in solid waste production. Current estimates suggest that approximately 2.01 trillion tonnes of municipal solid waste are generated annually, with projections indicating an increase to 3.4 trillion tonnes by 2050 (Kaza et al., 2018). This growing volume of waste presents significant environmental challenges, particularly for developing countries and urban areas (Alhassan et al., 2020; Padilla and Trujillo, 2018; Vassanadumrongdee and Kittipongvises, 2018). Middle-income countries currently contribute 29% of global waste, while low-income countries account for 5%. However, factors such as population growth, urbanisation, and increased reliance on packaging materials are expected to

triple waste generation in low-income countries by 2050. This anticipated increase underscores the urgent need for sustainable waste management strategies to mitigate the environmental impacts associated with rising solid waste levels (Ghani et al., 2013; Gundupalli et al., 2017).

In Ecuador, a South American nation known for its rich biodiversity, the challenge of managing municipal solid waste mirrors those faced by other developing countries. The country's per capita daily waste generation stands at 0.89 kg, closely aligning with the Latin American average of 0.99 kg (INEC, 2023). Factors such as rapid urbanisation and increased commercial and industrial activities have contributed to a rise in waste production. Notably, Ecuador's population growth rate of 1.5% exceeds the Latin American average of 0.9% (World Bank, 2015), leading to higher population density and, consequently, increased solid waste generation. This situation poses a threat to Ecuador's renowned biodiversity (Soliz Torres, 2014), highlighting the need for effective waste management strategies to protect the country's environmental assets amidst demographic and economic changes.

The management of municipal solid waste presents considerable challenges for governmental authorities. Historically, the focus has predominantly been on waste produced by enterprises rather than household waste, largely due to perceptions regarding the scale and complexity of monitoring and regulating household waste generation (OECD, 2019). However, households contribute a substantial proportion of total municipal solid waste, necessitating the development of comprehensive public policies for efficient waste management from generation to disposal, to mitigate environmental repercussions (Alhassan et al., 2018, 2020; Padilla and Trujillo, 2018; Suthar and Singh, 2015).

Recycling rates in Latin America and the Caribbean remain low, ranging from 1% to 20%, with approximately 90% of municipal solid waste ending up in landfills (UNEP, 2018). Specifically, in Ecuador, only 12.9% of solid waste is recycled, while the majority, 53.22%, is disposed of in landfills. According to the National Institute of Statistics and Censuses (INEC, 2019b), only 44.3% of Ecuadorian households engage in waste sorting at the source, separating materials such as organic waste, plastics, paper, and glass. This low rate of sorting is attributed to a lack of a sorting and recycling culture, inadequate infrastructure, and insufficient services. Furthermore, the implementation of these infrastructures and services plays a critical role in shaping household waste sorting behaviours (Khajuria et al., 2010; Rousta, 2018; Tonglet et al., 2004).

In this context, the development of programmes and public policies aimed at environmental stewardship becomes imperative. In its pursuit of sustainability, Ecuador enacted the Organic Law of the Inclusive

Circular Economy in 2021. This legislation aims to define the roles and responsibilities of public sector entities, organisations, and agencies within the circular economy framework. It sets forth criteria and mechanisms for adopting eco-design principles, promoting sustainable production and consumption practices, reducing waste generation, and fostering comprehensive and inclusive waste management. Additionally, the law emphasises the importance of public policy and financing in supporting the inclusive circular economy, aiming to achieve economic well-being, job creation, sustainable development, and a reduction in the consumption of non-renewable resources. However, the implementation of this law faces challenges that necessitate strategic measures to ensure the enduring success of the Circular Economy in Ecuador. In this sense, understanding the factors that influence household waste sorting practices is crucial for fostering greater environmental responsibility among citizens.

Recent research has explored household waste sorting behaviour (Alhassan et al., 2020; Knickmeyer, 2020; Rousta, 2018; Rousta et al., 2020). This body of literature identifies various determinants influencing waste sorting practices, which can be categorised into three main groups: external variables (demographic and socio-economic factors), internal or micro variables (individual attitudes, behaviours, and environmental perceptions), and institutional, political, or macro variables (legislative frameworks, regulatory measures, and incentive systems) (Macklin et al., 2023; Mintz et al., 2019; Saphores and Nixon, 2014; Tabernero et al., 2015; Zhang, 2023). This classification provides a comprehensive understanding of the multifaceted influences on waste sorting behaviour, highlighting the importance of integrating approaches across these dimensions for effective waste management strategies.

Among socio-economic and demographic characteristics, variables such as gender, age, education, income level, household size, homeownership, and geographical location have been prominently featured (Rousta et al., 2020). However, findings regarding their impact on waste sorting behaviour vary by region and methodology. For instance, while some studies indicate gender as a significant factor (Alhassan et al., 2020; Escario et al., 2020; Luo et al., 2020), others, such as those conducted in Lithuania and Sweden (Miliute-Plepiene et al., 2016) and Hong Kong (Yau, 2010), found no significant correlation between gender and recycling practices. Similarly, the impact of education on waste sorting has yielded mixed results, with some studies highlighting a positive effect (Luo et al., 2020; Padilla and Trujillo, 2018; Zand et al., 2020) and others reporting no significant impact (Ekere et al., 2009; Meneses and Palacio, 2005).

Age and household size have also been identified as variables with varying degrees of influence on waste sorting behaviour (Abebaw, 2008; Akil et al., 2015; Binyaruka, 2015; Pakpour et al., 2014).

Psychological factors have been posited as critical determinants of waste sorting behaviour, examined through various theoretical lenses including the Theory of Planned Behaviour, the Norm Activation Model, the Attitude-Behaviour-Context Model, and the Value-Belief-Norm Framework (Razali et al., 2020; Vassanadumrongdee and Kittipongvises, 2018; Wang et al., 2021; Zhang et al., 2021). In particular environmental concern, defined as an attitude towards environmental protection and problem-solving willingness (Aprile and Fiorillo, 2019), has been extensively studied for its correlation with recycling participation (Botetzagias et al., 2015; Cudjoe et al., 2022; Gamba and Oskamp, 1994; Liu et al., 2023; Zhang et al., 2021)

Institutional factors, including local government support, public policies, and infrastructure availability, have been identified as influential in facilitating waste sorting and recycling (Kalyanasundaram et al., 2021; Nguyen and Watanabe, 2019; Xu et al., 2018). Various studies have highlighted the effectiveness of social pressure, monetary incentives, and regulatory measures in promoting waste management practices (Ferrara and Missios, 2005; Viscusi et al., 2013; Xu et al., 2018; Yang and Innes, 2007).

This study aims to integrate individual, household, and institutional variables to comprehensively understand the waste sorting behaviours of Ecuadorian households. Using an ordered logistic regression model, the study evaluates the impact of key variables on enhancing waste sorting. The analysis includes individual factors (gender, ethnicity, age, marital status, education, environmental concern, environmental cost perception, and environmental responsibility), household characteristics (size, homeownership, area of residence), and institutional aspects (municipal waste collection services, belonging to a community, municipal regulations, waste collection fees, waste separation at the source). The next section describes the study area, the data, and the methodology employed.

Materials and methods

Study Area

This study focuses on Ecuador, located in the north-western region of South America. The country's political and administrative structure is organised into three hierarchical levels: 24 provinces, 221 municipalities, and 1,499 parishes, as depicted in Figure 1. The Organic Code of Territorial Organisation, Autonomy, and Decentralisation (COOTAD) assigns the responsibility for comprehensive solid waste

management to municipalities, which is executed via Decentralised Autonomous Governments (GADs). Among the 221 GADs in Ecuador, 172 GADs (78.2%) manage solid waste directly through their internal departments, 13 GADs (5.9%) utilise public companies, 25 GADs (11.4%) partner with associations, and 10 GADs (4.5%) adopt a hybrid approach, typically segregating the collection and final disposal stages under different management systems. Figure 1 delineates the geographical context of the case study, excluding the Galapagos Islands due to the unavailability of pertinent data.

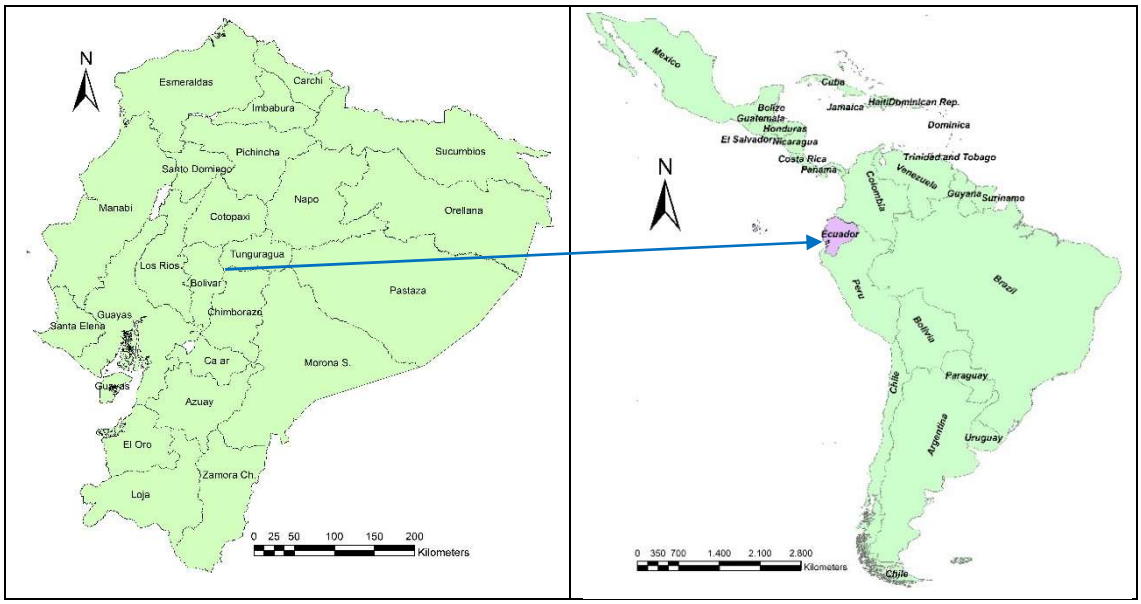

Figure 1. Location of the study area.

Within the context of source-separated waste collection, 34.5% of Decentralized Autonomous Governments (GADs) have either initiated or are currently implementing this process. Regarding the disposal of final waste, 54.5% of the GADs manage municipal solid waste via landfill sites, 28.2% utilise emerging cells, and 17.3% employ controlled landfills (INEC, 2019a). However, many landfills lack essential infrastructure such as leachate systems and gas ventilation, leading to significant soil, air, and water contamination that pose risks to public health. This indicates a notable variance in the adoption of waste disposal methods across different GADs.

The insufficient implementation of effective solid waste sorting processes is mirrored in household waste management behaviour. Data from the National Institute of Statistics and Censuses (INEC, 2019b) reveal that in 2019, 44.03% of Ecuadorian households engaged in waste sorting. Analysis by waste type shows that plastic is the most frequently sorted material (45.52%), followed by organic waste (44.03%), paper and cardboard (37.98%), glass (21.24%), metal (21.23%), and tetra pack packaging (11.67%). This distribution

highlights a discernible preference in sorting practices among households, emphasising the need for enhanced waste management strategies.

Data

Previous research has seldom adopted a multilevel perspective on the various determinants influencing pro-environmental behaviour (Boulet et al., 2021; Pan et al., 2022; Rousta et al., 2020). This study addresses this gap by identifying drivers of waste sorting behaviour across three distinct levels. The first level pertains to individual characteristics, encompassing personal attributes and environmental concerns and perceptions. The second level focuses on household-related features, such as size and location. The third level relates to institutional factors, including collection fees or the existence of differentiated waste management systems.

This study utilises data from the 2019 National Multipurpose Household Survey (ENMH) and the Census of Economic Environmental Information in Decentralised Autonomous Governments (CIAEGAD), specifically the Solid Waste Integral Management (GIRS) module. The ENMH facilitates the collection of data on household environmental practices, including waste sorting and disposal, conservation of water and energy, transportation and mobility, consumption patterns, and environmental awareness (INEC, 2019b). The ENMH's sampling methodology, as described by the National Institute of Statistics and Censuses (INEC, 2018), follows a two-stage probabilistic design. In the initial stage, the census sector serves as the primary sampling unit, with households as the second-stage unit. The 2019 sample included 11,528 households nationwide, encompassing 40,814 individuals aged five years and older. To gather institutional variables, we incorporated data from the CIAEGAD, specifically the GIRS module (INEC, 2019a). The INEC released its data in separate modules, each marked with a unique identifier (ID) that facilitates the merging of these distinct modules into a unified database. In this study, we merged the module on environmental practices at the household level and the household information module of the ENMH with the GIRS module of the CIAEGAD. After excluding outliers and selecting individuals aged 15 to 65 years, the study's final sample consisted of 8,601 households, including 26,175 individuals.

To integrate the results from individual, household, and institutional levels, a comprehensive approach was employed. The integration process involved the following steps:

- Data Cleaning: Each dataset was cleaned to remove inconsistencies and ensure compatibility. This included standardising variable names and formats and addressing missing values.
- Data Alignment: Unique identifiers (IDs) were used to align records across different modules.

- Data Merging: the datasets were merged, ensuring that each household and individual record was accurately associated with its corresponding GAD data.
- Validation and Verification: Post-merging, validation checks were conducted to verify the accuracy and completeness of the integrated database.

The operational definitions and measurement of the selected variables, as well as their descriptive statistics, are presented in Table 1.

Table 1. Variables and descriptive statistics.

Variable	Description	Mean	Std. Dev.	Min	Max
Dependent variable					
Waste sorting behaviour	0 = The household did not sort any type of waste	0.368	0.482	0	1
	1 = The household sorted 1 type of waste	0.193	0.394	0	1
	2 = The household sorted 2 types of waste	0.116	0.320	0	1
	3 = The household sorted 3 types of waste	0.098	0.297	0	1
	4 = The household sorted 4 types of waste	0.066	0.249	0	1
	5 = The household sorted 5 types of waste	0.068	0.251	0	1
	6 = The household sorted all types of waste	0.089	0.285	0	1
Independent variables					
Individual variables					
Gender	1 = Female, 0 = Male	0.264	0.441	0	1
Ethnicity	1 = Respondent belongs to a minority or ethnic group (indigenous, montuvio), 0 = Otherwise	0.178	0.382	0	1
Age	Age in years	46.02	11.45	16	65
Marital status	1 = Married, 0 = Other	0.407	0.491	0	1
Education level	Number of years of schooling (0-10)	4.721	1.676	0	10
Environmental concern	Concern about the state of the environment: 0 = No concern to 4 = Very high concern	2.361	1.012	0	4
Environmental cost perception	Perception that environmental protection increases cost of living: 1 = Totally agree to 5 = Totally disagree)	2.906	1.575	1	5
Environmental responsibility	Belief that individuals are responsible for the protection of the environment: 1 = Totally agree to 5 = Totally disagree	4.411	0.961	1	5
Household variables					
Household size	Number of members in the household	3.795	1.860	1	20
Home ownership	1 = The household owns its home, 0 = Otherwise	0.583	0.492	0	1
Area of residence	1 = Urban area, 0 = Rural area	0.646	0.478	0	1
Institutional variables					
Municipal service	1 = There is a municipal waste collection service, 0 = Otherwise	0.845	0.361	0	1

Community	1 = The GAD belongs to a community, 0 = Otherwise	0.050	0.219	0	1
Municipal regulation	1 = There is a municipal regulation on solid waste management, 0 = Otherwise	0.796	0.402	0	1
Collection fee	1 = The GAD has a fee on waste collection, 0 = Otherwise	0.954	0.209	0	1
Separation at source	1 = The GAD has a waste separation at source, 0 = Otherwise	0.377	0.484	0	1

On average, 36.8% of households do not sort any type of waste, 19.3% sort one type, and 11.6% sort two types. This trend suggests that the likelihood of sorting decreases as the number of waste types to be sorted increases. This can be attributed, among other factors, to the limited availability of differentiated waste sorting systems implemented by GADs.

Regarding individual variables, 26.4% of respondents are women, and 17.8% of respondents belong to a minority or ethnic group. The mean age of respondents is 46 years, and more than 40% are married. The average education level is 4.72 years, with a range from no formal education to a maximum of 10 years.

Concern about the state of the environment has an average score of 2.36 on a scale from 0 to 4, while perceptions regarding the impact of environmental protection on increasing the cost of living average at 2.9 on a 1 to 5 scale. The average score for individual environmental responsibility, measured on a 0 to 5 scale, is 4.41.

Regarding household characteristics, the average household size is 3.79 members. Most households (58.3%) ar1e homeowners and live in urban areas (64.6%).

In terms of institutional variables, most GADs provide a waste collection service (84.5%), have municipal regulations on solid waste management (79.6%), and impose a fee on waste collection (95.4%). However, the percentage of GADs belonging to a community is very low (5%), and only 37.7% of GADs have differentiated systems for waste separation at the source.

Methodology

To examine the influence of individual, household, and institutional variables on waste sorting behaviour, we utilised an ordered logit model. This model predicts ordered levels of a dependent variable based on multiple independent variables, including both continuous and categorical variables (Wooldridge, 2010). In this study, the dependent variable represents the number of different types of waste sorted, ranging from 0 (not sorting any type of waste) to 6 (sorting all types of waste), and the independent variables are those described in Table 1.

Following Cameron and Trivedi (2005), the starting point is an index model with a single latent variable:

$$y_i^* = x_i'\beta + u_i \tag{1}$$

In this context, we define:

$$y_i = j \quad if \quad \alpha_{j-1} < y_i^* \leq \alpha_j \tag{2}$$

where $\alpha_0 = -\infty$ and $\alpha_6 = \infty$.

Then:

$$\Pr[y_i = j] = F(\alpha_j - x_i'\beta) - F(\alpha_{j-1} - x_i'\beta) \tag{3}$$

where F is the cumulative distribution function of u_i. In this case, u is assumed to be logistically distributed with $F(z) = e^z/(1+e^z)$. The sign of the regression parameters β indicates whether the latent variable y_i^* increases or decreases with the regressor.

To measure the magnitude of the influence of the independent variables, marginal effects on the probabilities can be obtained as follows:

$$\frac{\partial \Pr[y_i = j]}{\partial x_i} = \{F'(\alpha_j - x_i'\beta) - F'(\alpha_{j-1} - x_i'\beta)\}\beta \tag{4}$$

Where F' is the derivative of F.

The results obtained are discussed in the following section.

Results and discussion

Prior to estimating a model, it is essential to examine the independent variables. To this end, the Pearson correlation matrix for the independent variables was computed, as provided in Appendix A. The matrix indicates no significant correlation issues among the explanatory variables, as the correlation coefficients do not exceed 0.70. Additionally, Appendix B presents the results of a formal collinearity assessment among the explanatory variables. The results show that the Variance Inflation Factor (VIF) for all variables remains below the threshold of 5, confirming the absence of collinearity problems.

Table 2 reports the results from the ordered logistic regression. An underlying score is estimated as a linear function of the independent variables and a set of cutpoints. In addition to this score, the marginal effects are shown.

Most individual variables are statistically significant, with the notable exception of education level, which does not show a significant effect on waste sorting. In Ecuador, although education can provide knowledge about the importance of waste separation and its benefits for the environment, if environmental awareness

is not ingrained in society, people may not act accordingly. In line with previous studies for Uganda (Ekere et al., 2009) and Hong Kong (Yau, 2010), the results found no relationship between education and waste separation. This suggests that Ecuador's educational system may not adequately address environmental issues.

The gender variable has a positive relationship with the number of types of waste sorted. The results indicate that women are more likely to sort solid waste than men. This could be explained by the fact that within households, women often manage waste and decide what is useful and what constitutes waste (Ekere et al., 2009; Luo et al., 2020).

Ethnicity emerges as a statistically significant variable in waste sorting. Self-identification as indigenous is associated with a higher likelihood of sorting two, three, four, or five types of waste. Indigenous communities often possess a profound connection to the environment, fostering a culture of respect for nature and recognising the importance of sustainable waste management to conserve biodiversity. Additionally, the communal structure prevalent in these societies promotes shared responsibilities and cooperative endeavours, potentially enhancing waste management practices at a community level (Siragusa and Arzyutov, 2020).

There is a negative relationship between age and the likelihood of not sorting any type or only one type of waste. However, the likelihood of sorting two to six types of waste increases with age. Older individuals often have more free time than younger individuals, allowing them to engage more in activities such as sorting waste (Akil et al., 2015; Binyaruka, 2015).

Marital status positively affects the sorting of two to six types of waste, possibly because married individuals spend more time at home, thereby fostering environmental awareness. This finding is consistent with the research of Knickmeyer (2020) and López-Mosquera et al. (2015).

Environmental concern is positively associated with the decision to sort waste, indicating that achieving a cleaner living environment, which contributes to health and well-being, motivates more comprehensive waste sorting practices.

Table 2. Ordered logit model

Variables	Global	Not sort any type of waste	One type	Two types	Three types	Four types	Five types	Six types
	Coefficients	Marginal Effects	Marginal Effects	Marginal Effects	Marginal Effects	Marginal Effects	Marginal Effects	Marginal Effects
Gender	0.120**	-0.027**	-0.001**	0.003**	0.005**	0.005**	0.006**	0.009**
	(2.39)	(-1.72)	(-2.00)	(2.49)	(2.41)	(2.37)	(2.35)	(2.33)
Ethnicity	0.091*	-0.021*	-0.001	0.002*	0.004*	0.003*	0.004*	0.007
	(1.70)	(-1.72)	(-1.44)	(1.79)	(1.72)	(1.69)	(1.67)	(1.66)
Age	0.004***	-0.001***	-0.0006**	0.0001**	0.0002**	0.0002**	0.0002**	0.0003**
	(2.69)	(-2.69)	(-2.51)	(2.66)	(2.67)	(2.67)	(2.67)	(2.68)
Marital status	0.246***	-0.056***	-0.003***	0.007***	0.011***	0.010***	0.012***	0.019***
	(5.32)	(-5.36)	(-4.11)	(5.32)	(5.28)	(5.21)	(5.18)	(5.17)
Education level	0.015	-0.003	-0.0002	0.0004	0.0007	0.0006	0.0007	0.001
	(1.30)	(-1.30)	(-1.28)	(1.29)	(1.30)	(1.30)	(1.30)	(1.30)
Environmental concern	0.037*	-0-008*	-0.0005*	0.001*	0.001*	0.001*	0.001*	0.002*
	(1.92)	(-1.92)	(-1.84)	(1.91)	(1.91)	(1.91)	(1.91)	(1.91)
Environmental cost perception	-0.042***	0.009***	0.0005***	-0.001***	-0.001***	-0.001***	-0.002***	-0.003***
	(-3.33)	(3.33)	(3.00)	(-3.28)	(-3.30)	(-3.30)	(-3.30)	(-3.32)
Environmental responsibility	0.092***	-0.021***	-0.001***	0.002***	0.004***	0.003***	0.004***	0.007***
	(4.34)	(-4.34)	(-3.70)	(4.23)	(4.28)	(4.27)	(4.28)	(4.31)
Household size	0.040***	-0.009***	-0.0005***	0.001***	0.001***	0.001***	0.002***	0.003***
	(3.68)	(-3.67)	(-3.26)	(3.61)	(3.64)	(3.64)	(3.64)	(3.66)
Home ownership	-0.031	0.007	0.0004	-0.0009	-0.001	-0.001	-0.001	-0.002
	(-0.73)	(0.73)	(0.71)	(-0.73)	(-0.73)	(-0.73)	(-0.72)	(-0.72)
Area of residence	-0.430***	0.097***	0.008***	-0.011***	-0.019***	-0.018***	-0.022***	-0.035***
	(-9.10)	(9.32)	(5.86)	(-9.20)	(-8.98)	(-8.55)	(-8.42)	(-8.37)
Municipal service	0.044	-0.010	-0.0005	0.001	0.002	0.001	0.002	0.003
	(0.74)	(-0.73)	(-0.83)	(0.72)	(0.73)	(0.74)	(0.74)	(0.75)

Community	-0.105	0.024	0.0009*	-0.003	-0.004	-0.004	-0.005	-0.007
	(-1.09)	(1.07)	(1.93)	(-1.02)	(-1.07)	(-1.10)	(-1.11)	(-1.13)
Municipal regulation	0.319***	-0.075***	-0.001**	0.010***	0.015***	0.013***	0.015***	0.022***
	(5.86)	(-5.77)	(-2.34)	(5.18)	(5.65)	(5.84)	(6.01)	(6.25)
Collection fee	0.200*	-0-047*	-0.001*	0.006*	0.009*	0.008*	0.009**	0.014**
	(1.92)	(-1.88)	(-1.87)	(1.72)	(1.88)	(1.96)	(2.01)	(2.07)
Separation at source	0.555***	-0.125***	-0.010***	0.014***	0.024***	0.023***	0.028***	0.045***
	(11.87)	(-12.20)	(-6.88)	(11.14)	(11.33)	(10.74)	(10.64)	(10.75)
/cut1	0.817***							
	(4.35)							
/cut2	1.633***							
	(8.65)							
/cut3	2.147***							
	(11.34)							
/cut4	2.659***							
	(14.00)							
/cut5	3.104***							
	(16.27)							
/cut6	3.759***							
	(19.53)							
Observations	8,601							
Log likelihood	-14364.287							
LR chi2(16)	441.84***							
Prob > chi2	0.0000							
Pseudo R2	0.0151							

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

However, the perception that environmental protection increases the cost of living reduces the likelihood of sorting waste, reflecting varying attitudes towards waste sorting. The results confirm that high individual environmental responsibility is positively associated with waste sorting (Goh et al., 2022; Rousta et al., 2020). This is consistent with findings that those most concerned about the environment often prioritise the classification of the amount of waste produced (Alhassan et al., 2020; Cudjoe et al., 2022).

Household size significantly influences waste sorting behaviour, with larger households increasing the likelihood of sorting various types of waste. Larger households generate more waste, necessitating greater involvement in sorting activities. Consistent with previous studies (Knickmeyer, 2020), the area of residence also plays a role, with the likelihood of sorting waste decreasing in urban areas, possibly due to lifestyle factors, lack of space for temporary storage, or consumption patterns that prioritise convenience over environmental considerations.

One of the key novelties of this study is to examine the influence of institutional variables on the probability of sorting different types of waste. The existence of municipal regulations, collection fees, and separation at source increases the likelihood of sorting waste. These results show the importance of having regulations that govern the management of solid household waste. Xu et al. (2018) and Viscusi et al. (2013) have also found that regulations effectively encourage, and in some cases compel, sorting activities at the source and recycling. Additionally, these findings underscore the critical role of government institutions in regulating household waste sorting, as regulations commonly increase the pressure to sort effectively (Tian et al., 2022). The positive impact on waste sorting of the existence of a differentiated system with separation at source aligns with research that emphasises the necessity of proper resources and infrastructure for waste management (Alhassan et al., 2020; Fan et al., 2019; López-Mosquera et al., 2015; Zhang et al., 2019).

Conclusions

Preventing household waste generation and promoting recycling and reuse are fundamental strategies for advancing environmental sustainability globally. As municipal solid waste continues to accumulate, the urgency for effective recycling and reuse measures becomes increasingly apparent. Achieving higher recycling and reuse rates requires active participation from households, particularly in the critical initial step of waste sorting at home. The requirement to separate various waste types, such as plastics, glass, and paper, is a cornerstone of an efficient recycling system. Proper sorting at the source enables specialised treatment processes for each waste stream, thereby enhancing the quality and value of recycled materials.

Moreover, conscientious waste sorting can lead to broader environmental awareness and more sustainable consumption patterns among citizens, further supporting the overarching goal of minimising the ecological footprint associated with waste management.

This study employs an ordered logit model to explore the main factors influencing household waste sorting behaviour in Ecuador, a country celebrated for its rich biodiversity and diverse ecological landscapes. By integrating a range of individual, household, and institutional variables, this research offers a comprehensive analysis of waste sorting behaviours. The findings provide critical insights into the factors affecting households' engagement in waste sorting, highlighting the roles of variables such as gender, ethnicity, age, marital status, household size, and area of residence.

One significant observation from the study is that Ecuadorian households in urban areas are less inclined to sort waste. This underscores the need for targeted interventions in densely populated cities, where space constraints can limit the availability of storage for sorted waste. Authorities should consider these unique urban challenges when designing and implementing waste management policies.

Interestingly, the study did not find a significant impact of education level on waste sorting. However, variables related to environmental concern and environmental responsibility had a positive effect on waste sorting. This suggests that knowledge about waste sorting, including the proper methods and the negative consequences of improper sorting, may not be sufficiently addressed in educational curricula. This gap points to a critical area for intervention. The Ecuadorian government should prioritise enhancing environmental education, perhaps by increasing the hours dedicated to this topic in school curricula or by launching targeted public awareness campaigns. These campaigns could emphasise the importance of waste sorting, not just for environmental benefits but also for community well-being and economic efficiency. Developing a "sorting culture" could create a more informed and engaged citizenry, ready to participate in sustainable waste management practices.

From an institutional standpoint, the role of municipalities in regulating waste sorting and developing the necessary infrastructure cannot be overstated. Ecuadorian municipalities possess the autonomy to enact environmental regulations that align with national policies, allowing for a decentralised approach to solid waste management that respects the country's cultural and ethnic diversity. In addition to the implementation of collection fees or regulation, municipalities should play a pivotal role in facilitating waste sorting by increasing the availability of sorting bins, enhancing the accessibility of recycling facilities, and providing households with the necessary equipment to sort waste effectively.

Beyond the sorting process, it is crucial to improve the methods of household waste collection for recycling. The positive effect of a differentiated system of waste collection must be emphasised. Once sorted, waste streams should not be mixed during collection, as this undermines the efforts of households and complicates the recycling process. Collection systems must ensure that different waste streams remain separate to enable specialised treatment, which is essential for maximising the recovery and reuse of materials.

In conclusion, the insights gained from this research provide a valuable foundation for developing targeted and effective waste management policies in Ecuador. By addressing the key factors identified in this study, policymakers can promote a more sustainable and environmentally responsible culture of waste sorting and recycling. This study highlights the need for a multifaceted approach that considers the interplay of individual, household, and institutional factors in shaping waste sorting behaviours. Future research should continue to explore these dynamics and seek to identify new strategies to further enhance the efficiency and effectiveness of waste management systems, both in Ecuador and in other contexts with similar environmental and socio-economic challenges. By fostering a collaborative approach that involves all stakeholders—government, community, and individuals—Ecuador can make significant strides towards achieving its environmental sustainability goals.

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Appendix A. Pearson correlation matrix

	Gender	Ethnicity	Age	Marital status	Education level	Env. concern	Env. cost perception	Env. responsibility	Household size	Home ownership	Area of residence	Municipal service	Community	Municipal regulation	Collection fee	Separation at source
Gender	1															
Ethnicity	-0.052	1														
Age	0.046	-0.018	1													
Marital status	-0.400	-0.005	0.134	1												
Education level	0.005	-0.169	-0.185	0.070	1											
Environmental concern	-0.001	-0.027	0.004	0.046	0.107	1										
Environmental cost perception	0.008	0.030	0.017	-0.034	-0.090	0.009	1									
Environmental responsibility	0.001	-0.045	-0.004	0.040	0.096	0.164	-0.026	1								
Household size	-0.140	0.063	-0.012	0.233	-0.127	0.005	0.030	0.012	1							
Home ownership	-0.006	0.073	0.324	0.091	-0.159	-0.009	0.052	-0.006	0.084	1						
Area of residence	0.091	-0.240	-0.019	-0.021	0.362	0.095	-0.044	0.049	-0.057	-0.184	1					
Municipal service	0.064	-0.183	-0.029	0.037	0.219	0.093	-0.039	0.075	-0.011	-0.067	0.408	1				
Community	-0.022	0.080	0.006	-0.067	-0.076	-0.042	0.026	-0.096	0.011	0.024	-0.084	-0.105	1			
Municipal regulation	0.005	0.048	0.002	-0.047	-0.118	-0.027	0.143	-0.046	0.043	0.113	-0.102	-0.014	0.061	1		
Collection fee	0.016	-0.109	-0.007	0.043	0.086	0.017	-0.053	0.028	-0.017	-0.069	0.175	0.205	-0.026	0.047	1	
Separation at source	0.012	-0.085	-0.019	0.149	0.115	0.024	-0.142	0.095	-0.038	-0.108	0.006	0.093	-0.180	-0.390	0.131	1

Appendix B. Collinearity diagnostics

Variable	VIF	SRQT VIF	Tolerance	R-Squared
Gender	1.24	1.11	0.808	0.191
Ethnicity	1.08	1.04	0.924	0.075
Age	1.16	1.07	0.865	0.134
Marital status	1.34	1.16	0.745	0.254
Education level	1.02	1.01	0.984	0.015
Environmental concern	1.04	1.02	0.961	0.038
Environmental cost perception	1.04	1.02	0.965	0.034
Environmental perception	1.04	1.02	0.957	0.042
Household size	1.08	1.04	0.922	0.077
Home ownership	1.19	1.09	0.839	0.160
Area of residence	1.32	1.15	0.757	0.242
Facilities	1.25	1.12	0.800	0.199
Community	1.05	1.03	0.950	0.050
Municipal laws	1.24	1.11	0.806	0.193
Collection fee	1.09	1.04	0.920	0.079
Differentiated system	1.33	1.15	0.754	0.245
Mean VIF	1.16			