



Factors Influencing the Willingness of Beijing Residents to Sort Waste: An Empirical Analysis Based on the Logistic Regression Model

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Abstract. The ongoing acceleration of urbanization in our nation has given rise to the prevalent issue of domestic waste, which has stimulated heightened focus from governmental authorities and the general populace alike. This study selected residents from six districts within Beijing as questionnaire survey participants to analyze the factors affecting their participation in domestic waste sorting. The results show that factors such as education level, environmental values, standard cognition, clarity of signs, convenience of facilities, level of infrastructure, government publicity and regulation significantly impact the willingness of residents to sort waste.

Keywords: Waste Sorting, Sorting Willingness, Influencing Factors, Logistic Regression Model

1 Introduction

The standard of waste sorting governance represents a city's stage of development and degree of civilization, and it is an important factor in promoting high-quality urban development [1]. In recent years, the pace of urban construction in our country has been accelerating, and the amount of urban domestic waste is also expanding. Proper resource treatment is not just a fundamental prerequisite to achieving high-quality development, but also serves as an imperative pivot for effective resource recycling [2]. Our country has devoted substantial endeavors towards waste sorting management and has also issued many policies. In March 2017, the National Development and Reform Commission and the Ministry of Housing and Urban-Rural Development issued the *Implementation Plan for the Domestic Waste Sorting System*. In 2000, eight cities including Beijing, Shanghai, Guangzhou, and Shenzhen were listed as the first batch of pilot cities for domestic waste sorting nationwide. So far, 237 prefecture-level and above cities in our country have initiated waste sorting. After many years of practical exploration, our country has made notable strides in advancing waste sorting, however, certain challenges persist. Scholars have found through research that factors such as insufficient environmental awareness among residents, poor environmental con-

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A. Rauf et al. (eds.), *Proceedings of the 3rd International Conference on Management Science and Software Engineering (ICMSSE 2023)*, Atlantis Highlights in Engineering 20,
https://doi.org/10.2991/978-94-6463-262-0_51

sciousness, and an incomplete waste sorting system are important reasons hindering the smooth progress of waste sorting [3][4].

As the political and cultural center of our country, Beijing produces a huge amount of domestic waste every year, and how to handle the waste is a huge challenge. On May 1, 2020, the Beijing Municipal Domestic Waste Management Regulations officially came into effect, with ongoing efforts citywide to enhance waste sorting. The awareness and regard for waste sorting among residents have progressively improved. However, insufficient waste sorting practices still persist in residential communities across Beijing. This issue not only affects the city's appearance to a certain extent, but also poses a significant obstacle to the high-quality development of the city. The aim of this paper is to review the literature, consolidate domestic and foreign research on domestic waste sorting, sort out the factors influencing the willingness of Beijing residents to sort waste, and propose strategic suggestions on how to promote residents' waste sorting behavior.

2 Data Selection and Research Methods

2.1 Data Sourced from Sample Statistics

Based on an established survey questionnaire about factors influencing waste sorting, and incorporating theoretical knowledge related to waste sorting behavior, an initial survey questionnaire was developed for this study. Through a combination of online questionnaire surveys and offline interviews, we conducted a survey on the waste sorting intentions of residents in six urban districts of Beijing, including Dongcheng, Xicheng, and Haidian. The aim was to explore the factors influencing residents' participation in domestic waste sorting. A total of 400 questionnaires were distributed, with 365 successfully retrieved, representing a recovery rate of 91.25%. Out of the collected questionnaires, 336 were deemed valid, marking a validity rate of 92.05%. (see Table 1)

Table 1. Basic Statistics of Samples

Sample Name	Sample Option	Frequency / Person	Percentage %
Sex	Male	166	49.40
	Female	170	50.60
Age	Under 30	49	14.58
	31-40	89	26.49
	41-50	76	22.61
	51-60	69	20.54
	Over 61	53	15.77
Area	Dongcheng District	51	15.17
	Xicheng District	55	16.36
	Chaoyang District	64	19.04
	Haidian District	65	19.34
	Fengtai District	59	17.56
	Shijingshan District	42	12.50

2.2 Model Building

The binary logistic regression model is a probabilistic nonlinear equation model obtained through multiple transformations of the logistic function. Logistic regression is a generalized linear model that is equivalent to performing linear regression on the log odds ratio, typically used as a statistical method to explore the relationship between a binary dependent variable and multiple categorical or ordinal independent variables. Binary logistic regression is often used as a regression algorithm, but can also serve as a classification algorithm for predictive classification, capable of solving binary classification problems [5]. Given that the response variable is a binary variable, logistic regression is used for conditional probability modeling. The probability of y belonging to the first category is as follows [6]:

$$P(y_i = 1 | x_i) = \frac{1}{1 + e^{-(w^T x_i + b)}} = \frac{e^{w^T x_i + b}}{e^{w^T x_i + b} + 1}$$

Where $w \in \mathbb{R}^p$, $x_i = (x_{i1}, x_{i2}, \dots, x_{ip})$. The probability of y belonging to another category is as follows:

$$P(y_i = 0 | x_i) = 1 - \frac{1}{1 + e^{-(w^T x_i + b)}} = 1 - \frac{e^{w^T x_i + b}}{e^{w^T x_i + b} + 1} = \frac{1}{e^{w^T x_i + b} + 1}$$

Assuming that the probability of residents willing to sort waste is P , the regression model is generally as follows:

$$\text{Logit}(p) = \ln\left(\frac{p(y=1)}{1-p(y=1)}\right) = w_1 x_1 + w_2 x_2 + \dots + w_p x_p + b$$

Where $\text{Logit}(P)$ is a transformation of the log odds ratio. In this equation, P represents the probability of residents willing to sort waste, $1-P$ represents the probability of residents not willing to sort waste, and X_i is the i th explanatory variable that influences residents' participation in waste sorting. b is the constant term, and w_i is the regression coefficient of the i th explanatory variable, indicating the direction and extent of the impact of this independent variable on residents' willingness to sort waste.

2.3 Variable Selection

In the model, Y is the dependent variable, that is, the variable to be explained. The questionnaire is designed with the item "Are you willing to sort waste?". If residents choose "yes", it is represented by "1"; if they choose "no", it is represented by "0". (see Table 2)

Table 2. Dependent Variable Data Statistics

Statistical items	Are you willing to sort waste?		Total
	Yes (=1)	No (=0)	
Number of people	175	151	336
Percentage %	52.08	47.92	100

X is the independent variable, i.e., the explanatory variable, denoted as X_i ($i=1,2, \dots$). The main explanatory variables in this study include the following five categories [7][8]: (1) Individual factors. These include sex, age, occupation, level of education, and monthly family income. (2) Subjective attitudes. These include the sense of achievement in waste sorting, environmental values, and benefits to future generations. (3) Behavioral control. This includes standard cognition, waste sorting frequency, willingness to pay, and source of information. (4) Situational factors. These include the influence of people around, moral norms, clarity of signs, and convenience of facilities. (5) Government governance. This includes the level of attention to laws and regulations, influence of government publicity, level of infrastructure construction, and community supervision. (see Table 3)

Table 3. Independent variables and descriptions

Statistical variables	Variable name	Code	Description
Individual factors	Sex	X1	Female=0 Male=1
	Age	X2	Under 30 years old=1, 31-40 years old=2, 41-50 years old=3, 51-60 years old=4, Over 61 years old=5
	Occupation	X3	Student=1, Teacher=2, Civil servant and public institution=3, Enterprise=4, Other=5
	Education level	X4	Below junior high school=1, High school and technical secondary school=2, Junior college=3, Undergraduate=4, Master and above=5
	Monthly family income	X5	Below 3000 yuan=1, 3000-5000 yuan=2, 5000-10000 yuan=3, 10000-20000 yuan=4, above 20000 yuan=5
Subjective attitudes	Sense of achievement in waste sorting	X6	Strongly disagree=1, Disagree=2, Neutral=3, Somewhat agree=4, Strongly agree=5
	Environmental values	X7	Very unimportant=1, Unimportant=2, Neutral=3, Somewhat important=4, Very Important=5
	Benefits to future generations	X8	Strongly disagree=1, Disagree=2, Neutral=3, Somewhat agree=4, Strongly agree=5
Behavioral control	Standard cognition	X9	Very unfamiliar=1, Familiar=2, Uncertain=3, Somewhat familiar=4, Very familiar=5
	Waste sorting frequency	X10	No sorting=1, Occasional sorting=2, Sorting 1-2 times per week=3, Sorting 3-4 times per week=4, Sorting every day=5

	Willingness to pay	X11	Very unwilling=1, Unwilling=2, Neutral=3, Somewhat willing=4, Very willing=5
	Source of information	X12	TV=1, Newspaper=2, Social network=3, Community poster=4, Others=5
Situational factors	Influence of people around	X13	None at all=1, Very little=2, Rarely=3, A fair amount=4, A lot=5
	Moral norms	X14	Never=1, Rarely=2, Occasionally=3, Frequently=4, Always=5
	Clarity of signs	X15	Never=1, Rarely=2, Occasionally=3, Frequently=4, Always=5
	Convenience of facilities	X16	Never=1, Rarely=2, Occasionally=3, Frequently=4, Always=5
Government governance	Level of attention to laws and regulations	X17	Very unfamiliar=1, Familiar=2, Neutral=3, Somewhat familiar=4, Very familiar=5
	Government publicity intensity	X18	Strongly disagree=1, Disagree=2, Neutral=3, Somewhat agree=4, Strongly agree=5
	Level of infrastructure	X19	Very incomplete=1, Not so complete=2, Neutral=3, Fairly complete=4, Very complete=5
	Community supervision	X20	Very lax=1, Not so strict=2, Neutral=3, Fairly strict=4, Very strict=5

3 Regression Results and Analysis of the Model

Before performing a binary logistic regression analysis, a correlation analysis is conducted on the explanatory variables X to select the X variables that are correlated with the dependent variable Y. The chi-square test can identify whether there is a significant correlation between two variables. A chi-square test was performed separately for each explanatory variable and the dependent variable. According to the chi-square test results, the P values of X1, X2, X3, X5, X8, and X11 are all greater than 0.05, indicating that these variables do not significantly affect the willingness of Beijing residents to sort waste. The P values of the remaining X variables are all less than 0.05, indicating that the remaining explanatory variables have a significant effect on the willingness of Beijing residents to sort waste. The remaining explanatory variables X, which passed the significance test, and the dependent variable Y are used to construct a binary logistic regression model. By using SPSS software, Y and X are subjected to logistic regression analysis, and the following results can be obtained:

Table 4. Model Results

Variable name	B	S.E.	Wals	df	sig.	Exp(B)
X4 Education level	.603	.156	19.38	1	0.000	1.827
X7 Environmental values	.542	.256	3.214	1	0.026	1.719
X9 Standard cognition	.956	.651	10.47	1	0.031	2.601
X15 Clarity of	.316	.162	6.325	1	0.001	1.372

signs						
X16 Convenience of facilities	.659	.349	7.264	1	0.001	1.933
X18 Government publicity	.358	.128	6.259	1	0.015	1.430
X19 Infrastructure	.511	.263	8.185	1	0.023	1.667
X20 Community Supervision	.852	.541	4.236	1	0.034	2.344
Constant term	3.219	1.062	5.268	1	0.003	25.01

The P value of the chi-square test of the regression model is 0.000, which is less than 0.05. Therefore, at a significance level of 5%, it can be considered that there is a significant linear relationship between the explanatory variables and $\text{Logit}(P)$, and the binary logistic regression model as a whole is significant. According to the model results in Table 4: there is a significant correlation between whether Beijing residents are willing to sort waste and their education level, environmental value, standard cognition, clarity of signs, convenience of facilities, government publicity, infrastructure, and supervision intensity. The P values of these explanatory variables are all less than 0.05, while there is no significant correlation with other explanatory variables. According to the regression coefficient analysis, the coefficient of educational level is 0.603, which indicates that residents with higher education levels are more willing to sort waste. The coefficient of environmental values is 0.542, indicating that residents with stronger environmental awareness are more willing to sort waste. The coefficient of standard cognition is 0.956, indicating that residents who understand how to sort waste are more willing to do so. The clarity of signs has a coefficient of 0.316, indicating that the clearer the waste bin classification signs, the higher the willingness of residents to sort waste. The convenience of facilities has a coefficient of 0.659, indicating that the more convenient the waste bin is to use, the higher the willingness of residents to sort waste. The government publicity coefficient is 0.511, indicating that the stronger the government publicity, the higher the residents' willingness to sort waste. The infrastructure coefficient is 0.511, indicating that the more comprehensive the community's waste sorting facilities, the higher the willingness of residents to sort waste. The coefficient of supervision intensity is 0.852, indicating that the stricter the government and society are in supervising waste sorting, and the higher the willingness of residents to sort waste.

4 Relevant Suggestions

(1) Carry out waste sorting education to improve residents' environmental awareness

Given the impact of education level and environmental values on the willingness of Beijing residents to sort household waste, it is necessary to enhance the willingness of residents to sort household waste in the following three aspects. The first is to strengthen waste sorting education among students. Beijing has placed a considerable emphasis on waste sorting education for school children in recent years. However, there isn't a standardized teaching system in place yet [9]. It is suggested that relevant national departments integrate waste sorting education into compulsory education,

formulate comprehensive curricula, and arrange dedicated practical courses. These efforts would teach students how to properly sort waste and dispose of it in the corresponding bins within the school grounds, fostering a strong habit of waste sorting from a young age. The second is to carry out diversified and normalized waste sorting education. The correct knowledge of waste sorting is an important prerequisite for the successful implementation of waste sorting. The government, society, and other stakeholders can guide the public to learn the standards and methods of waste sorting by organizing lectures and public welfare lectures, stimulate the public's recognition of waste sorting, and thus promote public participation. The third is to strengthen residents' environmental protection awareness education. Relevant departments, by carrying out activities with environmental protection as the theme in crowded places such as shopping malls, parks, and museums, and organizing waste sorting practical activities, can strengthen the public's environmental protection awareness, enhance residents' concepts of environmental protection and sustainable social development, and thus enhance citizens' sense of social responsibility.

(2) Improve infrastructure construction and scientifically arrange sorting facilities

Given the impact of the clarity of signs, the convenience of facilities, and the level of infrastructure on the willingness of Beijing residents to sort household waste, it is necessary to enhance the willingness of residents to sort household waste in the following three aspects. The first is to set up clear waste sorting signs. The waste sorting signs should be strictly in accordance with the Signs for Classification of Municipal Solid Waste standard issued by the Ministry of Housing and Urban-Rural Development, and the signs and symbols should meet the standard requirements for color, text, and size. The signs should be easy for residents, especially the elderly, to recognize. The second is to improve supporting facilities. Government departments should improve the basic facilities in the community, provide convenient hardware facilities for residents to sort waste, improve the accessibility of waste sorting facilities, ensure that there is a complete waste drop-off point in front of each residential building, and that each drop-off point has complete classification waste bins[10]. The third is to make rational and scientific arrangement. Waste sorting is a systematic project, and everything from the provision of waste bins and waste trucks to the setting up of transfer stations needs to be planned scientifically and systematically. In addition, scientific planning and design are also required for the selection of waste sorting points, facility placement, classification instructions, recycling time, and the subsequent maintenance and management of sorting facilities. Relevant departments should consider characteristics such as the number of people in the community, the composition of the population, and the distribution of residences, and rationally arrange the waste sorting facilities in the residential area.

(3) Broaden communication channels to improve residents' enthusiasm for waste sorting

Given the impact of standard recognition and government publicity on the willingness of Beijing residents to sort household waste, it is necessary to enhance the willingness of residents to sort household waste in the following three aspects. The first is to diversify communication modes. Resident committees and property management companies should play a proactive role in promotion and guidance. By distributing

flyers, posting promotional booklets, public service advertisements, and more within residential communities, they should disseminate the importance of waste sorting and standard practices to all residents, ensuring comprehensive coverage within each community. The second is to innovate communication methods. With the help of internet technology and various new media channels, including Beijing WeChat Official Account and waste sorting mini-programs, it's possible to increase awareness and acceptance of waste sorting work among residents. In addition, periodic online live broadcasts, reward-based quizzes, and reward points can be used as community activities to enhance residents' acceptance and recognition of waste sorting. The third is to establish advanced role models. Individuals who demonstrate exemplary behavior in waste sorting should be recognized and their actions promoted. By doing so, we can utilize their influence as role models, encouraging others to follow in their footsteps. Meanwhile, inappropriate behaviors, such as not sorting waste or sorting waste improperly, should be appropriately highlighted. By celebrating positive role models and highlighting negative examples, the concept of waste sorting can gradually penetrate into residents' daily lives, promoting the formation of waste sorting habits and effectively enhancing residents' willingness to sort waste [11].

(4) Improve supervisory mechanisms and enhance the effectiveness of waste sorting

Given the impact of community supervision on the willingness of Beijing residents to sort household waste, it is necessary to enhance the willingness of residents to sort household waste in the following three aspects. The first is to provide financial support. The government can establish a certain amount of financial reward funds to give appropriate financial support to communities that effectively carry out waste sorting work, promoting effective advancement of waste sorting among residents [12]. The second is to strengthen supervision and management. Neighborhood offices can hire proactive community members as waste sorting supervisors in their residential communities, responsible for overseeing the daily waste handling and sorting in their assigned areas, guiding residents to correctly sort their waste. In addition, a community waste sorting law enforcement team should be established to effectively supervise all stages of waste management from the source sorting of the waste, through its transportation, to its final processing. The third is to establish a long-term mechanism. Create a comprehensive coordination mechanism for waste sorting management, clarify the responsibilities of departments, neighborhood offices, communities, and individuals, and unify responsibilities in various stages such as waste sorting, collection, and processing. This creates a favorable atmosphere for shared management and participation by all sectors of society and all citizens. At the same time, strengthen the evaluation of the waste sorting management department, establish an evaluation mechanism, formulate evaluation methods, and promote refined and scientific management of household waste sorting.

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