Inertia and Rationality: Behavioral Confusion and Optimization Paths of Urban Garbage Classification in the Perspective of Accessibility

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Abstract. Garbage classification is in line with China's carbon peaking and carbon neutrality goals and ecological advancement, but during its implementation, it faces the dilemma of a mismatch between supply and demand. Based on the theoretical framework of public service accessibility, this paper uses the scale definition method and SPSS software to empirically study the accessibility of scope, cognitive accessibility, and content of garbage classification in the city of Z as a case study. The results show that the affordability of garbage classification is better than the accessibility of geographic distance and time, and the affordability is significantly and positively correlated with residents' income; the cognitive accessibility is good overall, and the willingness and habit of sorting are average; the accessibility of facilities is better than the accessibility of service items. Given the problems of accessibility of garbage classification in Z city, relevant countermeasures are suggested.

Keywords: Garbage classification; Accessibility; Governance practice.

1. Introduction

With the accelerated urbanization process, massive people are gathering in cities. According to the National Bureau of Statistics of China, by 2021, 64.72% of China's population lives in cities and towns, and the urban population is huge. At the same time, the limited amount of infrastructure in cities, and its carrying capacity is difficult to meet the industrial development and the needs of a large number of residents; a large amount of garbage is generated and directly discharged, causing irreversible harm to the environment and ecology. Only in 2020, China's urban domestic waste removal volume is up to 235 million tons. Garbage seems to have become the inevitable result of urban development.

Since the implementation of the garbage classification policy, only some pilot cities have achieved some results, and the promotion of the nationwide still has many problems. For example, the policy and regulations of garbage classification are not sound, the standard of garbage classification is not uniform and the habit of residents' active participation in garbage classification has yet to be developed, which restricts the high-quality development of China's urbanization and the realization of China's carbon peaking and carbon neutrality goals, and is not conducive to the implementation of the concept of green development. Driven by national policies and realistic demands, it has become an important issue to analyze the multidimensional implementation dilemma of garbage classification and promote the accessibility of garbage classification. Based on the accessibility of public services, this paper defines "accessibility of urban garbage classification" as the convenience of urban residents in accessing and using garbage classification facilities and services, and whether they can separate waste within their ability to pay and understand. Based on this, a theoretical model is constructed to establish a system of indicators in terms of accessibility of scope, cognitive accessibility, and content accessibility; after that, the urban garbage classification policy is evaluated and its problems are analyzed based on the survey data of city Z. Finally, paths to optimize garbage classification are proposed.

2. Theoretical Framework

2.1 Theoretical Model

In this paper, we construct a model of urban waste separation accessibility from both supply and demand sides. The main goal of the supply side is to provide waste sorting services to residents within an effective range, i.e. within an acceptable distance, time, and money for the residents, to ensure the accessibility and affordability of supply; the demand side is that residents who need to put out waste, and the main goal is to obtain waste separation services to meet their physical and psychological needs; the key factor connecting the supply and demand sides is the habit of waste sorting. In this research, the accessibility of waste separation is divided into the accessibility of scope, accessibility of cognition, and accessibility of content. The logical relationship is shown in Figure 1.

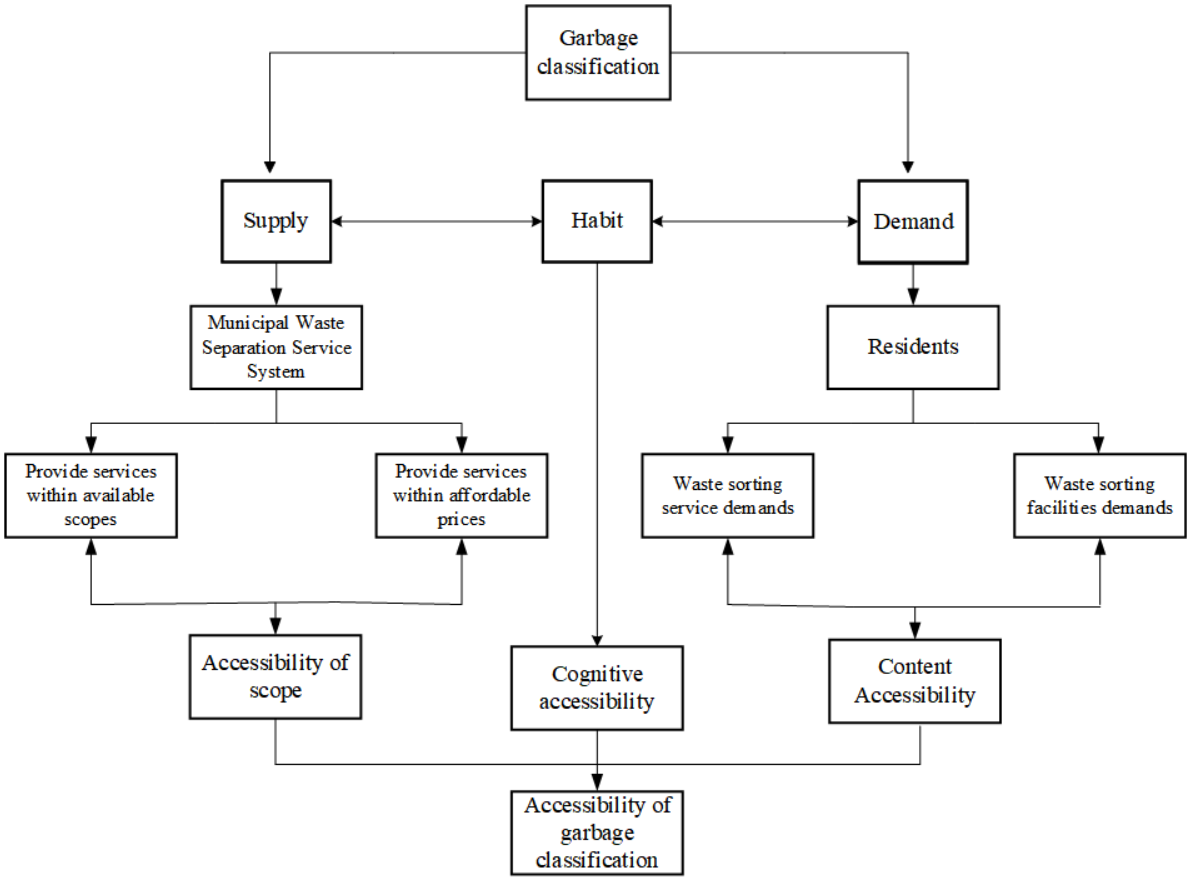


Figure 1. Analysis framework of urban garbage classification accessibility

2.2 Construction of evaluation indicators

2.2.1 Accessibility of scope

Accessibility of scope is the degree of matching between the actual and expected geographic range, time, and money of residents' access to waste separation services, which is measured by whether residents can enjoy waste separation services within the reachable geographic range, the time consumed, and the money paid. Among them, geographic range refers to the distance between residents' residence and the waste sorting location; the time consumed by residents to reach the waste sorting drop-off point refers to the time consumed by residents to reach the centralized waste sorting drop-off point assuming the same distance and the same speed from residents to the waste sorting drop-off; and the range of money that residents can pay refers to the money spent by residents to sort their waste assuming the same price per household for the service.

2.2.2 Cognitive accessibility

Cognitive accessibility refers to the extent to which residents' willingness, knowledge, and habits to separate garbage match the existing standards, and is measured by the extent to which residents can fully understand the current garbage separation rules with their existing willingness, knowledge, and habits. From this, it is clear that the accessibility of waste sorting perceptions is influenced by residents' willingness, habits, and knowledge of sorting as well as the habits of the government system. Among them, residents' sorting habit refers to their subconscious recognition of waste sorting; residents' knowledge of waste sorting refers to their acceptance of waste sorting rules with their current knowledge level; residents' willingness to sort refers to their support for waste sorting; and government institutional habit refers to the extent to which the government attaches importance to waste sorting in terms of institutional settings, which is influenced by multiple factors such as China's traditional culture. It is influenced by many factors such as the traditional culture of China.

2.2.3 Accessibility of content

Accessibility of content refers to the degree of matching the supply of community service facilities and programs with the quantity and type of residents' demand, which measures whether waste separation services can meet the needs of residents. According to Clayton. Alderfer's E.R.G. theory, human needs are divided into Existence, Relatedness, and Growth. Among them, the development needs of residents in waste separation mainly include intelligent equipment for waste separation, knowledge and education, time and space constraints, and incentive programs.

Table 1. Residents' needs and corresponding services

Human needs	Residents' needs	Corresponding Services
Existence needs	Survival needs of residents: putting out the garbage, clean living environment, odor-free roads, etc., mainly refers to the residents' needs for putting out garbage in various aspects such as food, housing, and transportation.	Separate garbage collection Garbage classification and Transportation Garbage cleaning and disposal
Relatedness needs	Residents' interrelationship needs the sharing of responsibility for garbage disposal in the household, residents' desire to integrate into the community, make social connections, and gain a sense of belonging and identity in the organization.	Garbage sorting guidance
Growth needs	Residents' development needs: residents' willingness to learn about sorting; residents don't want to spend their time on waste sorting; residents' increased sense of gain and accomplishment after sorting correctly.	Garbage classification intelligent equipment Garbage sorting knowledge education Waste sorting time and space restrictions Waste sorting incentive program

In summary, the indicators to measure the accessibility of waste sorting in this paper are listed in Table 2 below.

Table 2. Municipal waste sorting accessibility indicators

Level I Indicators	Level II Indicators	Level III Indicators	Measurable Indicators
Accessibility of urban garbage classification	Accessibility of scope	Distance between the place of residence and the place of waste separation	The actual distance between the place of residence and the drop-off point
			Desired distance between the place of residence and the drop-off point
		The time it takes for residents to reach the waste sorting location	The actual time taken to reach the drop-off point
			Expected time spent to reach the drop-off point
		The price paid by residents to separate their waste	Disposable income of residents
	Cognitive accessibility	The willingness of residents to separate garbage	Residents' willingness to buy
			Residents' willingness to sort
		Knowledge of waste separation for residents	Residents' knowledge of waste sorting
		Habits of residents in separating the garbage	
	Accessibility of content	Perfection of facilities for waste sorting	Number of sorting containers
			Quality of sorting containers
			Distribution of sorting containers
		Completeness of the garbage classification program	Number of garbage sorting items

3. Method and data

3.1 Survey design

This study takes Z city as the investigation area for the following reasons: (1) Z city is located in the Central Plains, has strong economic strength, and is one of the top 20 cities in the comprehensive national GDP ranking. In 2019, Z city fully implements the compulsory garbage classification policy and is one of the 46 key cities implementing the garbage classification policy which has a certain representative. (2) The urbanization level of City Z is the highest level of urbanization rate at the same administrative level. According to the Statistical Yearbook of City Z, at the end of 2022, the city's urban resident population reaches 12.828 million, with an urbanization rate of 79.40%, which is 0.3 percentage points higher than that at the end of 2021.

The questionnaire design consists of two parts. The first part is the basic information of residents, including gender, age, education level, income, etc. The second part is the measurement of accessibility of garbage sorting, mainly including the accessibility of scope, accessibility of cognition, and accessibility of content, and the options are set by the Likert scale, using 1-5 scores corresponding to different levels from "not at all" to "completely". The options were set using a Likert scale, using a scale of 1-5, corresponding to different levels of "not at all" to "fully". Before the formal research, 116 questionnaires were distributed for the previous survey in March 2023. In the previous survey, samples with appropriate proportions of gender, age, education, and income level were selected to initially determine the scientific validity of the scale selection, and the items that were difficult to understand were adjusted. After the pre-survey, 330 electronic questionnaires were distributed based on the questionnaire star platform, and the collected questionnaires were eliminated according to the

length of response time and whether they were filled out regularly, and finally 312 questionnaires were obtained, with an effective rate of 94.55%.

3.2 Survey data

Among the 312 samples formally researched, 47.1% were male and 52.9% were female, with a balanced gender ratio to reduce the influence of gender on the data results; 63.8% of the residents were aged 19-35 and 25.0% were aged 25-55, with a younger age group; 71.4% of the residents had undergraduate and postgraduate degrees or above in terms of education, which ensured that the number of respondents was 71.4%. In terms of education, 71.4% of the residents had bachelor's or postgraduate degrees, ensuring that the respondents could fully understand the content of the questions and make practical judgments; in terms of residential location, 68.6% of the residents lived in urban areas and 31.4% in suburban areas.

Table 3. Sample statistical information

Variables		Number of pre-study	Percent(%)	Number of formal studies	Percent(%)
Gender	Male	57	49.1	147	47.1
	Female	59	50.9	165	52.9
Age	Under 18	4	3.4	14	4.5
	19-35	81	69.8	199	63.8
	25-55	29	25.0	78	25.0
	Over 56	2	1.7	21	6.7
Edu	High school or technical secondary school or below	10	8.6	27	8.7
	College	14	12.1	62	19.9
	Bachelor	87	75.0	202	64.7
	Master's degree	5	4.3	21	6.7
Income per month(RMB)	Less than or equal 3000	36	31.0	108	22.4
	[3001,6000]	26	22.4	70	34.6
	[6001,10000]	31	26.7	84	26.9
	[10001,15000]	16	13.8	32	10.3
	More than 15000	7	6.0	18	5.8
City location	Downtown	77	66.4	214	68.6
	Suburb	39	33.6	98	31.4

Table 4. Table of demographic characteristics(N=312)

Variables	Description	Mean	sd	min	max
Gender	1=male,2=female	1.53	0.500	1	2
Age	1=under 18,2=19-35,3=25-55, 4=over 56	2.34	0.671	1	4
Edu	1=high school or technical secondary school or below,2=college,3=bachelor,4= master's degree	2.70	0.722	1	4
Income per month(RMB)	1=less than or equal 3000,2=[3001,6000],3=[6001,10000],4=[10001,15000],5=More than 15000	2.65	0.884	2	5
City location	1=downtown,2=suburb	1.31	0.465	1	2

4. Results and discussions

Table 5. Correlation coefficients of variables

	1	2	3	4	5	6	7	8
Gender	1							
Age	-0.010	1						
Edu	0.020	-0.191**	1					
Income per month	-0.035	0.078	0.219**	1				
City location								
Accessibility of	0.002	0.028	-0.107	-0.176**	1			
scope	0.100	0.109	0.028	0.157**	-.0249**	1		
Cognitive								
accessibility	0.143*	0.012	0.126*	0.045	-.0291**	0.778**	1	
Accessibility of								
content	0.124*	-0.002	0.062	0.117**	-.0235**	0.846**	0.828**	1

Note:* p < 0.1, ** p < 0.05, *** p < 0.01.

4.1 Accessibility of scope

In terms of scope accessibility, the spatial and temporal accessibility of waste sorting in City Z is poor and affordability is average. For example, from the distance between the place of residence and the place of waste sorting, 63.78% of the residents think that the sorting facility points are too few and far from their homes; in terms of the time for residents to reach the place of waste sorting, 62.50% of them cannot put out the waste within the specified time; in terms of economic income and cost, 34.60% of the residents have an income of RMB 3001-6000, 44.87% of the residents think that the economic cost of waste The economic cost to be paid by individuals for sorting is high, but at the same time, 57.37% of the residents are willing to accept less than 25 yuan per year for unified garbage sorting and recycling.

From Table 6, it can be seen that the distance from the residence to the garbage classification drop-off site is strongly and positively correlated with the accessibility of the scope, indicating that residents attach great importance to the distance between the garbage sorting drop-off site and their own homes; monthly income also has a significant positive correlation with the accessibility of the range, indicating that residents' income plays a fundamental role in the price they are willing to pay for garbage sorting.

4.2 Cognitive accessibility

The perceived accessibility of waste sorting in Z is good. From the survey data, 32.05% of the residents lacked the habit of waste separation, more than 63% of the residents were satisfied with the "four division" standard of waste sorting, and more than 62% of the residents thought that it was not difficult to classify waste according to the existing classification standard, indicating that the residents had good knowledge of waste separation. As shown in Table 6, residents' willingness to sort and sorting habits have a significant impact on the accessibility of cognition, indicating that the focus of waste sorting is on the willingness and habits of waste sorting, which has a significant impact on the accessibility of cognition.

4.3 Accessibility of content

The accessibility of waste sorting service facilities is good. 39.74% of residents think the infrastructure of waste sorting is not sound, and only 9.30% of residents are dissatisfied with the quality of waste sorting facilities; the demand for service items is low in terms of supply and demand matching accessibility. For example, more than 71.40% of residents have a demand for intelligent garbage sorting equipment, and the demand is greater than the supply, showing low accessibility.

As shown in Table 6, the quantity and quality of facilities and the number of service items for waste separation are strongly correlated with content accessibility, indicating that the above three aspects have significant effects on content accessibility for residents.

Table 6. Scope, cognition, and content accessibility regression analysis

Dependent variable	Independent variable	beta	t	R2	F
Accessibility of scope	Casting distance	0.593	13.286***	0.396	51.869
	Time-consuming classification	0.034	0.683		
	Income per month				
	Costs of classification	0.150	3.239***		
	consumption	0.030	0.603		
Cognitive accessibility	Education level			0.514	110.802
	Willingness to classify	0.045	1.127		
	Classification habits	0.341	7.761***		
		0.496	11.231**		
Accessibility of content	Number of classification facilities	0.355	8.452***	0.637	182.844
	Quality of classification facilities	0.318	7.454***		
	Number of service items	0.311	7.718***		

5. Conclusion

This study constructed an evaluation model of urban waste sorting accessibility and empirically analyzed the accessibility of waste sorting services in Z city from three dimensions: range accessibility, cognitive accessibility, and content accessibility. It is found that: (1) the affordability of waste separation is better than the accessibility of geographical distance and drop-off time, and it is significantly and positively correlated with residents' income, which may be related to the higher income of residents in Z. (2) the cognitive accessibility of waste sorting in Z is good overall, and the level of classification intention and habit is average; (3) the accessibility of waste separation facilities is better than the accessibility of service items, and the accessibility of service items is strongly influenced by the interaction between supply and demand.

The following countermeasures are proposed to address the problems of waste sorting accessibility in city Z: (1) adjust the time and place of waste separation according to local conditions, adjust the drop-off site and time according to the living habits of residents; encourage door-to-door collection in areas where economic and manpower conditions allow; (2) pay attention to quality education, encourage schools at all levels to actively offer relevant courses and extracurricular practices, and promote residents' habits of garbage sorting through multiple means such as the media; (3) accurately identify residents' needs, improve garbage sorting services, and promote a balance between garbage classification supply and demand. For example, we should update the waste separation and recycling system to improve the efficiency of waste sorting by using identity authentication as the basis for intelligent detection and weighing of waste.

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