Analysis of digital garbage classification of Hangzhou citizens

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Abstract

Garbage classification is a long-term and systematic project. Under the background that garbage classification policy is widely implemented in various places, the overall effect of garbage classification in China is not good, especially the stability of the effect needs to be improved. With the continuous improvement of Internet technology, people begin to digitize garbage classification and apply big data technology to garbage classification. In this study, by using the research methods of expert interview and questionnaire survey, the current situation of household waste classification in Hangzhou was investigated, and the existing problems were summarized. Finally, according to the survey results, some suggestions are put forward to enhance the willingness of Hangzhou residents to participate in garbage sorting.

Keywords

big data; garbage classification; digital classification.

1. Introduction

In recent years, more and more countries have begun to pay attention to garbage classification, and the government encourages residents to actively participate in garbage classification activities. In 2017, Chinese government departments issued the "Implementation Plan for the Household Waste Classification System", which provides an implementation plan for China's household waste classification system. At the same time, various provinces and cities have successively promulgated waste classification implementation plans, which has increased the enthusiasm of the whole people to participate in waste classification. Since then, various cities in China have begun to fully implement waste sorting plans. According to relevant statistics, in 2022, the daily volume of China's waste sorting market will reach 550,000 tons. Driven by the government, the market demand for garbage sorting is increasing. In recent years, the Chinese government has vigorously promoted waste disposal policies, and took Shanghai as the first pilot city, but the effect of waste classification has not met people's expectations.

Garbage classification is one of the important links to achieve carbon neutrality. Waste sorting relies on recycling methods to reduce the use of materials and reduce the amount of new raw

materials produced, thereby reducing carbon dioxide emissions. Zhejiang Province comprehensively promotes digital reform, develops and rationally utilizes public data resources, continues to optimize digital services for the benefit of the people, and actively encourages all walks of life to move towards digital transformation. Today, digital garbage sorting has spread to every city in Zhejiang Province. For example: In Zhongdi Street, Pinghu City, Jiaxing, Zhejiang, 20 "barrel-for-barrel" collection vehicles, 18 street sorting collection vehicles, and 7 compression collection vehicles have been installed with chips, and have received their own "ID cards" ", the staff can visually see the situation of garbage removal and transportation on the back-end platform; Shaoxing City has also launched the "Shaoxing Municipal Household Waste Classification Comprehensive Management Platform", which realizes a comprehensive understanding of residents' daily garbage production, Various data such as renewable resource recovery, garbage collection and transportation, and garbage disposal volume; Nanhu District, Jiaxing City focuses on the field of rural household garbage classification, and is the first to create a full-process digital supervision system to realize precise intelligent control of rural household garbage big data.

Based on the above status quo, the research team went to Banshan Village, Baizhang Town, the only "zero-carbon emission village" in Zhejiang Province in June 2022 to conduct field research. From the survey results, it can be seen that the core link for Banshan Village to achieve the goal of "zero carbon" is to realize digital garbage classification. Garbage sorting has become a part of every villager's daily life. According to the experience shared by local residents, it can be seen that garbage classification plays a very significant role in reducing carbon emissions and optimizing the natural environment.

2. Research Design

2.1. Method

This research mainly adopts the research method combining qualitative research and quantitative research. By reading a large number of papers, the existing research on digital garbage classification is sorted out. Based on the existing research results, in the study the questionnaire survey method was used to investigate the status quo of Hangzhou residents' waste classification and residents' willingness to participate in digital waste classification. The advantage of the questionnaire method is that it is simple and easy to operate, saving manpower, material resources and time costs. At the same time, the data recovered from the questionnaire are all real first-hand information, directly expressing the true wishes of the respondents, and the survey results have certain reliability and value.

2.2. Questionnaire design

The research team distributed a total of 250 questionnaires, and the interviewees were all Hangzhou residents. A total of 245 questionnaires were actually recovered, of which 240 were valid questionnaires. The content of the questionnaire is mainly divided into two parts: "personal information" and "survey on waste classification". In the questionnaire, logical jumps between questions are set to ensure the scientificity of the answer sheet data.

2.3. Behavioral characteristics

After stepping into the old age stage, the aging of the body is expected to impose a direct

impact on one's behavior characteristics. With prominent dull actions with a slow reaction speed, the elderly witness weaker coordination ability of the movement in comparison with before. In addition, the elderly are prone to get exhausted and generate the feeling of fatigue. Last but not least, given the sharp decline in the physical function of the elderly, their resistance will also gradually weaken. In such case, they have to attach great importance to seasonal changes and diseases brought by climate change, where the elderly will cast their eyes on and fully leverage preventive measures in advance.

In the "Personal Information" part, we collect personal information such as the age of residents, number of family members, gender, current industry they are engaged in, and the community they currently live in in the form of filling in the blanks and selection. In the "Investigation on Garbage Sorting" part, the investigation is carried out in four main dimensions. They are: residents' habits of garbage sorting, residents' mastery of garbage sorting knowledge, the status quo of garbage sorting in the community where residents live, and residents' opinions and suggestions on garbage sorting.

3. Data analysis and results

3.1. Descriptive statistical analysis

First, according to the statistical results of the questionnaire, the following are the descriptive statistics of each factor.

Table 1 Descriptive statistics results

	Min.	Max.	Ave.	SD	MED
age	22.000	65.000	46.195	9.418	44.000
number of family members	2.000	6.000	4.186	1.153	4.000
sex	1.000	2.000	1.362	0.483	1.000
region	1.000	7.000	5.851	1.808	7.000
occupation	1.000	15.000	7.021	4.308	4.000
frequency	1.000	4.000	3.468	0.851	4.000
categories	1.000	3.000	2.340	0.756	3.000
understanding of garbage sorting	1.000	4.000	2.702	1.153	3.000
number of facilities	1.000	4.000	2.809	0.820	3.000
Relevant Policies	1.000	2.000	1.957	0.203	2.000
Promotion frequency	1.000	5.000	2.383	0.917	2.000

According to the statistical results, the average age of the interviewees is 46.20 years old, the oldest interviewee is 65 years old, and the youngest interviewee is 22 years old, including three ages: youth, middle age and old age part. Among them, male respondents accounted for 36.17%, and female respondents accounted for 63.83%. In terms of waste sorting survey, the results show that the proportion of respondents who will actively carry out waste sorting is as high as 71.28%. Respondents generally sort garbage multiple times, and more people sort garbage every day. In addition, the research team investigated residents' mastery of garbage classification knowledge through specific cases. 91.49% of the respondents answered correctly, and a small number of residents could not accurately grasp the relevant knowledge. At present, sorting trash cans are set up in the communities of all interviewees. Among them, 95.74% of the interviewees ' communities have set up garbage sorting supervisors, and 93.62% of the respondents said that many garbage sorting education activities have been carried out in the communities, which fully shows that the government attaches great importance to garbage sorting.

3.2. Chi-square test

This study will conduct a chi-square test on the waste classification in different regions to explore whether the waste classification in different regions is the same. First, establish the following two assumptions.

H0=Waste classification in different areas is the same

H1=Waste classification is different in different regions

a=0.05

Table 2 Garbage classification in different communities

	Name	frequency of weekly garbage sorting (%)				$\chi 2$	p
		1-2	3-4	5-6	Over 7		
community	A	0(0.00)	0(0.00)	0(0.00)	10(3.23)	27.928	0.063
	B	10(50.00)	0(0.00)	0(0.00)	20(6.45)		
	C	0(0.00)	10(20.00)	10(11.11)	20(6.45)		
	D	0(0.00)	10(20.00)	0(0.00)	10(3.23)		
	E	0(0.00)	10(20.00)	2(11.11)	30(9.68)		
	F	0(0.00)	0(0.00)	0(0.00)	10(3.23)		
	G	10(50.00)	20(40.00)	70(77.78)	210(67.74)		

According to the standard of a=0.05, if P>0.05, H1 is rejected and H0 is accepted, that is, there is no significant difference in the classification of garbage in different regions.

Then, a multiple linear regression model was established according to the influencing factors of garbage classification. According to the surveyed information, we explore the impact of the following factors on the waste classification situation. These factors are regional policies, establishment of facilities, education and publicity, etc. Among them, the garbage classification is the dependent variable, and the influencing factors are the independent variables. The gender, age, etc. of the respondents will be set as dummy variables, and the number of garbage sorting per week will be the actual variable. According to the principle of dummy

variable setting, if a regression model has an intercept item and has m features, it is necessary to introduce m-1 virtual variables. First, set the virtual variables as follows:

X1={1, male; 0, female}

X3={1, occupation related to environmental protection; 0, occupation not related to environmental protection}

X4={1, target area; 0, other areas}

G is the number of family members, the respondent's gender X1, age X2, occupation X3, area X4. G may have an impact on the weekly frequency of garbage classifications Y, resulting in a multiple linear regression model:

Y =b0+b1X1+b2X2+b3X3+b4X4+b5G+e (e is the random variable coefficient)

3.3. Model validation

3.3.1 Significance Test

The options of the virtual variables are selected according to the above principle of value selection, and the actual variable G is the median value of each group. Select stepwise regression for multiple linear regression model fitting. The following table is the regression result and significance test, P<0.01, indicating that the linear relationship between age, gender, occupation, area and garbage classification is significant.

Table 3 Multiple linear regression analysis table

	Min.	Max.	Ave.	SD	p
Age	22.000	65.000	46.195	9.418	0.000**
Sex	1.000	2.000	1.362	0.483	0.000**
occupation	1.000	15.000	7.021	4.308	0.000**
region	1.000	7.000	5.851	1.808	0.000**
number of family members	2.000	6.000	4.186	1.153	0.000**

This study will conduct a chi-square test on the waste classification in different regions to explore whether the waste classification in different regions is the same. First, establish the following two assumptions.

3.3.2 Regression coefficient test

According to the results of the regression coefficient test, it can be seen that the P value corresponding to the model variable and the observed value of the respective regression coefficient significance test, if p<0.05, means that their linear relationship with Y is significant.

Table 4 Linear regression analysis results

	Non-standardization		standardizatioon	t	VIF	R2	Adjusted R2	F
	B	s.e.	Beta					
C	2.867	0.659	-	4.352	-	0.153	0.096	F (5,74)=2.673, p=0.028
Age	0.6	0.009	0.078	0.718	1.039			
Sex	-1.07	0.191	-0.065	-0.558	1.171			

occupation	-0.2	0.020	-0.010	-0.090	1.110			
region	0.146	0.049	0.324	2.999	1.020			
number of family members	-1.84	0.077	-0.124	-1.085	1.141			

Through the above analysis results, the following equations are obtained:

Y1=2.867-1.84G

Y2=2.867-1.84G+0.6X1

Y3=2.867-1.84G+0.146X4-0.2X3-1.07X2+0.06X1

Equation 1 reflects that residents with more family members will relatively reduce the number of garbage sorting times per week, and the number of garbage sorting times will decrease by 1.84 times for each additional family member.

Equation 2 reflects that older residents have more garbage sorting times per week than younger residents, and the number of garbage sorting increases by 0.6 for every ten years of age.

Equation 3 reflects that male average 1.07 times less garbage sorting per week than female residents, and residents of other occupations average 0.2 times less garbage sorting per week than residents of occupations related to environmental protection. The model conforms to the actual situation and passed the test of economic theory criteria.

3.4. Regression analysis

3.4.1 Modeling

Factors such as regional policies, establishment of facilities, education and publicity will all have an impact on waste classification. At the same time, there will be a certain correlation between the influencing factors. Therefore, the following regression model is established to explore how factors such as regional policies, facility establishment, and education and publicity affect the frequency of garbage classification.

Table 5 Linear regression analysis results

	Non-standardizatioon		standardizatioon	t	VIF	R2	Adjusted R2	F
	B	s.e.	Beta					
C	2.613	0.955	-	2.735	-	0.025	-0.007	F =7.8
Number of Facilities	-0.67	0.111	-0.064	-0.603	1.050			
related policy	0.48	0.439	0.107	1.021	1.009			
Promotion frequency	0.70	0.099	0.075	0.703	1.056			

T1 represents the number of waste sorting facilities, T2 represents the number of related policies, and T3 represents the frequency of waste sorting education activities. The multiple linear regression equation can be obtained as:

$Y=a+bT1+cT2+dT3+\varepsilon$

Among them, T is an explanatory variable, Y is an explained variable, a, b, c, d are regression coefficients, and ε is a random error item. Regression calculations were performed on relevant data using SPSS software.

3.4.2 Result Analysis

3.4.2.1 Economic Significance Test

According to the estimation results of SPSS, a=2.613, b=-0.67, c=0.48, d=0.70, ε=0, it can get:

$Y=2.613-0.67T1+0.48T2+0.70T3$

Explanatory variable coefficients -0.67 and -0.48 are less than 0, in line with the negative correlation between the explained variable and the explanatory variable, in line with the fact that the growth of the explanatory variable inhibits the growth of the explained variable, the model passed the practical significance test.

3.4.2.2 Practical significance test

$\beta 1$^=-0.67, which means that when the relevant policies or regulations and garbage sorting education remain unchanged, the number of garbage sorting facilities changes by 1 unit, and the number of garbage sorting times per week changes by 0.67 units.

$\beta 2$^=0.48, which means that when the number of garbage sorting facilities and garbage sorting education remain unchanged, the number of garbage sorting changes per week by 0.48 units when relevant policies or regulations change.

$\beta 3$^=0.7, which means that when the number of garbage sorting facilities and relevant policies or regulations remain unchanged, for every unit change in garbage sorting promotion, the frequency of weekly garbage sorting changes by 0.7 units.

3.4.3 Correlation analysis

It is assumed that there is a certain correlation between various influencing factors, that is, when regional policies exist, the number of garbage sorting facilities and the number of publicity and promotion will be relatively large. From the correlation test results, it can be seen that:

Table 6 Results of correlation analysis results

results of correlation analysis				
		Number of Facilities	related policy	Promotion frequency
Number of Facilities	R	1	0.71	0.74
	p value		0.043	0.022
related policy	R	-0.9	1	0.701
	P value	0.036		0.037

Promotion frequency	R	-0.702*	0.89	1
	P value	0.037	0.396	
* p<0.05 ** p<0.01				

It can be seen from the table that the correlation coefficients of the number of waste sorting facilities, relevant policies or regulations, and waste sorting promotion are all above 0.7, indicating that the three selected independent variables have a high correlation with the situation of waste sorting. It is more appropriate to do multiple linear regression with the number of times and independent variables.

3.5. Reliability Analysis

Repeat the measurement on another part of the sample drawn out, and compare the consistency of the results, and use the half-reliability method to divide the survey data into two parts. Calculate the correlation coefficient of the numerical characteristics of the data, and then estimate the reliability of the whole regression equation. The reliability of the test regression function has reached 0.97, and the overall deviation is less than 0.05. When the value of Cronbach's coefficient is between 0.7-0.8, it is considered that the reliability of the questionnaire is good; between 0.8-0.9, the reliability of the questionnaire is very good; and above 0.9 indicates the internal consistency and reliability of the questionnaire is very good. Therefore, the reliability of the regression equation obtained in this experiment is relatively high.

4. Discussion

This study conducted an in-depth investigation on the garbage classification of Hangzhou residents, the existing garbage classification problems was found, and proposed a feasible solution to the problem to improve the governance level of garbage classification in Hangzhou. On the other hand, in the process of questionnaire survey and expert interviews, the research team turned into a garbage sorting " propagandist ", shuttled through the streets of Hangzhou, explained the relevant knowledge of garbage sorting to the residents, and enhanced residents' knowledge about garbage sorting. It can deepen residents' understanding of garbage classification, stimulate residents' sense of responsibility, and more fully aware of the importance of garbage classification, improve their awareness of green environmental protection, and have more senses of social responsibility. Finally, the focus of this study is to combine digitization with waste sorting. Based on the existing waste classification-related infrastructure, publicity methods and management measures, digitalization and waste classification actions are effectively combined, through digital technology is applied to household waste classification system, and a scientific long-term mechanism is formed.

5. Conclusion

According to the findings of this study, it is shown that: firstly, the waste sorting facilities in each community are not complete. Infrastructure is the foundation of garbage classification. Without complete facilities, garbage cannot be classified correctly. At the same time, it is not

conducive to cultivating the enthusiasm of residents to participate in garbage classification. Second, relevant management policies are lacking, and waste classification is neglected. Although 95.74% of the interviewees have waste sorting supervisors in their communities, residents' waste sorting behavior is still not standardized enough. The enthusiasm of residents to participate in garbage sorting is not too high, and some incentives and punishments need to be added to encourage residents to actively participate in garbage sorting. Third, the garbage classification supervision mechanism is relatively mechanized. According to the survey results, 70.45% of the respondents reflected that most of the garbage sorting supervisors had a single job content, and the supervisory work could not reflect the real work situation. Although 93.62% of the respondents indicated that garbage sorting education has been carried out in the community, the effect of publicizing garbage sorting knowledge is not satisfactory. Finally, residents' household waste sorting knowledge is generally low. Only 36% of the respondents said they understand the standard principles of household waste classification. 71.28% of the respondents can easily carry out dry and wet classification of household waste. Among them, only 65.96% performed dry and wet classification 7 times or more per week. Nearly half of the residents who were interviewed indicated that they did not understand the knowledge of garbage sorting or that their understanding was average. This deeply reflects that residents have not yet realized the importance of garbage classification.

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