

Research on Cognition and Behavior Choice of Haze Control based on Questionnaire

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Abstract

The problem of haze control is a complex system problem, which requires a lot of human, material and capital investment from all walks of life, and improving the broad participation of the public is an important entry point for haze pollution control. Through questionnaire survey, chi square test and other research methods, this study carried out research on Residents' cognition and behavior choice of haze governance, explored its relevance, emphasized the necessity of multi-body participation in haze governance, and improved the public's awareness of the importance of participation in haze governance.

Keywords

Haze Control; Governance Cognition; Behavior Choice.

1. Introduction

The causes of haze pollution are complex, often caused by multi factor coupling, which is difficult to control, and consumes a lot of human, material and financial resources from all walks of life. In recent years, haze control has achieved remarkable results, behind which is the huge investment of the government in haze control, and the participation of the public has a significant role in curbing haze pollution and promoting environmental protection. However, there is still room for greater improvement in public haze control cognition and behavior choices.

Urban Haze control is a complex system problem, which requires the cooperation of multiple subjects such as the government, enterprises, social organizations and the public. Public participation in haze control is one of the most important links, which plays a crucial role in effectively preventing and controlling haze pollution. Tu Zhengge et al. believe that public participation can significantly improve the efficiency of environmental governance [1]. Wang Zebo and Wang Hongyan proposed a "four center" regional environmental collaborative governance model of "government enterprise people non-governmental environmental protection organizations" based on the current situation of environmental governance in Beijing Tianjin Hebei region [2]. Zhang Yanchun and Chen Anqi found that public participation can improve environmental quality, but the force on government environmental regulation is not strong, and its effect has regional differences [3]. Widening the ways of expression of social participation is one of the fundamental ways to solve China's environmental governance. The expansion of citizens' right to know and supervision can further improve citizens' enthusiasm and initiative to participate in environmental protection, and can effectively curb the occurrence of air pollution events under the supervision of the general trend of the public.

2. Data Sources and Research Methods

2.1. Overview of the Study Area

The primary pollutant of ambient air quality in Henan Province is PM_{2.5}. Since 2012, the comprehensive risk index of Urban Haze risk in Henan Province has shown a sharp upward trend, reaching its peak in 2015, and then decreased and leveled off [4]. As the capital city of Henan Province, Zhengzhou is the core city of the Central Plains Economic Zone and a megacity with a population of more than 10 million. In 2018, it withdrew from the sequence of moderate air quality pollution; Jiaozuo, as a non-capital city in the northwest of Henan Province, is the first coal resource city developed in Henan Province. In 2019, the air quality was reduced from moderate pollution to mild pollution. Zhengzhou and Jiaozuo are both cities with serious persistent haze pollution, which are representative of haze pollution in provincial capital cities and non-provincial capital cities. Therefore, this paper selects Zhengzhou and Jiaozuo as the research object to carry out the research on haze governance cognition and behavior choice.

The questionnaire was investigated online or offline in Zhengzhou and Jiaozuo, Henan Province in 2014, 2018 and 2021, and 138, 233 and 232 valid questionnaires were collected in Zhengzhou respectively; 437, 125 and 604 valid questionnaires were collected in Jiaozuo City, including basic information of residents such as gender and age, and residents' awareness, satisfaction and behavior choice of smog control.

2.2. Research Methods

Chi square test is a hypothetical test method that reflects the deviation between the actual observation value and the theoretical inference value of the sample. this paper analyzes the significant relationship between different demographic characteristics and haze cognition by comparing the differences between the actual observation frequency and the expected frequency to construct chi square statistics.

$$X^2 = \sum_{i=1}^k \frac{(f_i - np_i)^2}{np_i} \quad (1)$$

In formula (1), "fi" is the actual observation frequency, "n" is the survey sample size, "pi" is the expected frequency of the sample, "npi" is the expected frequency, and "k" is the number of samples. The inspection level is $\alpha = 0.05$.

3. Analysis on the Current Situation of Air Quality in Zhengzhou and Jiaozuo

It can be seen from table 1 that the AQI index and the concentrations of PM_{2.5}, PM₁₀, SO₂, NO₂, CO and other five pollutants in Zhengzhou and Jiaozuo showed a significant downward trend as a whole, the concentration of O₃ showed a trend of increasing first and then decreasing, and the number of days with good air quality continued to increase. The AQI index of both places has improved from mild pollution in 2014 to "good" air quality in 2021, and the concentrations of SO₂, NO₂, CO and O₃ have been lower than the secondary concentration standard limit of GB3095-2012. The concentrations of PM_{2.5} and PM₁₀ pollutants increased from 88.00 in Zhengzhou in 2014 $\mu\text{g}/\text{m}^3$, 158.00 $\mu\text{g}/\text{m}^3$ and Jiaozuo City 77.07 $\mu\text{g}/\text{m}^3$, 130.52 $\mu\text{g}/\text{m}^3$ decreased to 42.67 in 2021 $\mu\text{g}/\text{m}^3$, 77.50 $\mu\text{g}/\text{m}^3$ and 46.42 $\mu\text{g}/\text{m}^3$, 87.50 $\mu\text{g}/\text{m}^3$, but it still exceeds the secondary concentration standard limit of GB3095-2012. It can be seen that PM_{2.5} and PM₁₀ are the main pollutants in Zhengzhou and Jiaozuo, and their pollution hazards still exist. According to the air quality reports of 168 cities nationwide released by the Ministry of ecological environment, Zhengzhou ranked 20th among the cities with relatively poor air quality twice (in May and June) and Jiaozuo five times (in February, April, May, June and October) in 2021. It can be seen that the situation of haze control in the two places is still serious. Haze control is an

extremely complex systematic project, which requires the joint participation of all sectors of society, including the public.

Table 1. Current situation of air quality in Zhengzhou and Jiaozuo

City	Particular year	AQI	PM _{2.5}	PM ₁₀	SO ₂	NO ₂	CO	O ₃	Air quality Good days
Zhengzhou	2014	122.67	88.00	158.00	43.00	51.00	3.10	71.00	163
	2015	134.76	95.75	167.08	33.17	57.5	2.71	160.00	138
	2016	124.01	75.58	143.33	30.55	55.5	2.81	179.00	159
	2017	119.97	72.42	130.08	20.25	53.08	2.2	198.00	166
	2018	115.62	63.00	106.00	15.00	50.00	1.84	194.00	168
	2019	111.07	57.67	99.75	9.33	44.75	1.34	150.00	177
	2020	98.81	51.33	84.25	8.50	37.92	1.15	146.33	245
	2021	81.25	42.67	77.50	8.33	31.67	1.09	139.67	237
Jiaozuo	2014	111.88	77.07	130.52	63.86	45.00	—	96.00	182
	2015	121.79	85.76	148.30	47.87	51.00	3.96	150.00	173
	2016	118.68	84.68	141.09	39.89	48.00	3.91	169.00	175
	2017	111.04	74.31	128.73	23.05	44.00	3.06	208.00	171
	2018	101.19	63.67	116.23	14.31	40.00	2.50	190.00	168
	2019	94.04	63.33	110.50	13.42	37.50	1.54	150.08	164
	2020	87.16	56.92	97.83	11.00	32.83	1.35	148.58	210
	2021	85.54	46.42	87.50	9.83	25.92	1.23	142.58	228

3.1. Chi Square Test of Haze Control Awareness and Satisfaction

In 2018 and 2021, SPSS statistics 25 software was used to assign the demographic characteristic variables of Zhengzhou and Jiaozuo residents' survey results, haze control awareness and satisfaction data in groups, and chi square test was performed. Among them, the demographic characteristic variables in 2018 include gender, age, education background, occupation and monthly income, and haze governance awareness and satisfaction include haze awareness, laws and regulations and governance measures awareness and haze governance satisfaction. The results showed that: (1) the haze awareness of Zhengzhou residents was significantly correlated with their academic qualifications ($p < 0.05$), indicating that the higher their academic qualifications, the higher their personal cultural level, and the higher their awareness of haze pollution; (2) The recognition of laws and regulations and control measures in Zhengzhou is significantly correlated with age and Education ($p < 0.05$), and the satisfaction of haze control is significantly correlated with Education ($p < 0.05$), indicating that the increase of age and education is conducive to improving residents' awareness of haze control measures; (3) The haze awareness of Jiaozuo residents is significantly correlated with age, education, occupation and monthly income ($p < 0.05$), indicating that with the increase of age, education level and income level, the cognitive level of Jiaozuo residents on haze pollution is also significantly improved. In addition, the changes in the employment structure of the respondents also significantly affect the cognitive level of haze among urban residents in Jiaozuo.

Table 2. Chi square test of haze control awareness and satisfaction of respondents with different demographic characteristics in 2018

Demographic characteristics	Haze awareness				Awareness of laws and regulations and governance measures				Satisfaction with haze control			
	Zhengzhou		Jiaozuo		Zhengzhou		Jiaozuo		Zhengzhou		Jiaozuo	
	X2	P	X2	P	X2	P	X2	P	X2	P	X2	P
Gender	2.975	0.560	2.649	0.449	7.399	0.060	3.896	0.273	0.816	0.846	1.550	0.671
Age	21.099	0.175	36.364	0.000	29.166	0.004	17.499	0.132	16.056	0.189	18.388	0.104
Education	26.950	0.042	17.571	0.040	29.682	0.003	10.787	0.291	23.250	0.026	7.373	0.598
Occupation	15.351	0.223	26.621	0.002	13.635	0.136	13.998	0.122	9.890	0.359	12.994	0.163
Monthly income	31.422	0.299	29.202	0.046	13.965	0.871	16.842	0.534	18.987	0.586	14.411	0.702

Compared with 2018, the demographic characteristic variables of the two cities in 2021 increased factors such as marital status, number of children, travel mode, working environment and living environment, and divided the awareness of laws and regulations and governance measures in haze governance awareness and satisfaction into two survey contents: awareness of laws and regulations and awareness of governance measures. Chi square test results show that: (1) the haze awareness of Zhengzhou residents is significantly related to education, occupation, travel mode, working environment and monthly income ($p < 0.05$), and the haze awareness of Jiaozuo residents is significantly related to education, occupation and travel mode ($p < 0.05$), indicating that the improvement of education level, the change of employment structure and the change of travel mode are conducive to significantly improving the cognitive level of haze pollution of residents in the two cities, The improvement of working environment and monthly income level may also improve urban residents' awareness of smog; (2) Zhengzhou's awareness of laws and regulations is significantly correlated with education, occupation, travel mode and monthly income ($p < 0.05$), and Jiaozuo's awareness of laws and regulations is significantly correlated with age, education, marital status, travel mode, working environment and monthly income ($p < 0.05$), indicating that education level, travel mode and monthly income level all significantly affect urban residents' awareness of laws and regulations, while age, employment structure Marital status and working environment also have a certain impact on urban residents' awareness of laws and regulations on haze control; (3) The awareness of governance measures in Zhengzhou is significantly related to gender, education background, travel mode and monthly income ($p < 0.05$), and the awareness of governance measures in Jiaozuo is significantly related to age, education background, marital status and travel mode ($p < 0.05$), indicating that the awareness of urban residents' haze governance measures is significantly related to travel mode, while age, gender, education background Factors such as marital status and monthly income level also have an impact on urban residents' cognition of haze control measures; (4) The satisfaction of smog control in Zhengzhou is significantly correlated with travel mode ($p < 0.05$), and the satisfaction of smog control in 2021 is significantly correlated with gender, age, education, travel mode, living environment and monthly income ($p < 0.05$). It shows that there is a significant correlation between Zhengzhou urban residents' satisfaction with haze control and their travel mode, and gender, educational level, living environment and monthly income level also have a certain impact on urban residents' satisfaction with haze control.

By comparing and analyzing the results of the chi square test of the smog control cognition of residents in Zhengzhou and Jiaozuo in 2018 and 2021, it is found that education, occupation, travel mode and monthly income significantly affect the smog control cognition and satisfaction

of Zhengzhou and Jiaozuo, and there are obvious temporal and spatial differences in the significant impact of residents' demographic characteristics on the smog control cognition and satisfaction. In terms of time scale, residents' awareness of haze is deepening, and the factors affecting haze governance awareness and satisfaction are gradually increasing, showing a multi factor coupling effect. On the spatial scale, the influencing factors of smog control awareness and satisfaction in Zhengzhou are more stable. In 2018, there was a significant relationship between Zhengzhou's academic qualifications and haze awareness and satisfaction. In Jiaozuo City, only haze awareness was significantly related to age, education, occupation and monthly income. There was no significant correlation between laws and regulations and governance measures, governance satisfaction and demographic statistical characteristics of residents; In the 2021 survey, education, monthly income and travel mode have the most significant impact on Residents' awareness and satisfaction of haze control in the two places, which has a certain relationship with the change of residents' travel mode and income in recent years.

Table 3. Chi square test of smog control cognition of respondents with different demographic characteristics in 2021

Demographic characteristics	Haze awareness				Awareness of laws and regulations				Awareness of governance measures				Satisfaction with haze control			
	Zhengzhou		Jiaozuo		Zhengzhou		Jiaozuo		Zhengzhou		Jiaozuo		Zhengzhou		Jiaozuo	
	X ²	P	X ²	P	X ²	P	X ²	P	X ²	P	X ²	P	X ²	P	X ²	P
Gender	6.222	0.101	2.054	0.561	2.617	0.455	0.996	0.802	8.091	0.044	7.352	0.196	2.257	0.521	9.545	0.023
Age	19.979	0.067	20.171	0.064	19.940	0.068	21.007	0.050	20.171	0.064	40.006	0.005	14.171	0.290	39.636	0.000
Education	41.384	0.000	43.477	0.000	25.833	0.011	27.922	0.006	23.349	0.025	46.27	0.001	8.693	0.729	34.315	0.001
Occupation	19.175	0.024	23.697	0.022	21.242	0.012	12.873	0.378	15.608	0.076	27.848	0.113	10.436	0.316	15.157	0.233
Marital status	5.358	0.802	12.926	0.166	8.548	0.480	22.921	0.006	8.220	0.512	27.409	0.026	12.824	0.171	15.907	0.069
Number of children	11.337	0.079	5.799	0.760	5.762	0.450	6.813	0.657	6.851	0.335	11.526	0.715	11.831	0.066	14.397	0.109
Travel mode	35.155	0.000	31.630	0.000	28.244	0.001	22.594	0.007	30.451	0.000	29.603	0.013	38.201	0.000	23.809	0.005
Work environment	14.042	0.029	14.732	0.099	5.021	0.541	20.345	0.016	0.460	0.998	17.181	0.308	4.942	0.551	15.469	0.079
Living environment	6.695	0.350	15.568	0.076	7.806	0.253	11.963	0.215	11.155	0.084	22.851	0.087	3.654	0.723	19.498	0.021
Monthly income	31.451	0.002	20.224	0.063	35.242	0.000	32.997	0.001	41.382	0.000	22.285	0.325	17.971	0.117	27.446	0.007

3.2. Choice of Haze Control Behavior

In the three surveys on the choice of haze control behavior, the proportion of Zhengzhou residents who "use electric vehicles or minimize the use of private cars" showed a "V" change trend, "water and electricity conservation", "planting trees and grass" and "payment fees" showed an increasing trend, while the highest proportion of "payment fees" was only 20.30% in 2021;The proportion of "payment expenses" in Jiaozuo City shows a downward trend, and the indirect payment willingness of residents to "use electric vehicles or minimize the use of private cars", "save water and electricity" and "plant trees and grass" shows a "V" trend. From the survey data, it can be seen that the indirect willingness to pay such as "using electric vehicles or minimizing the use of private cars", "saving water and electricity" and "planting trees and grass" accounts for a relatively high proportion of residents in Zhengzhou and Jiaozuo, while the direct willingness to pay such as "payment fees" accounts for a relatively low proportion. Combined with the above, the improvement of air quality in the two places and the low reliability of residents to the government are the important reasons for the low willingness to pay directly, indicating that the government should pay more attention to the publicity, guidance and training of residents' environmental protection behavior, strive to improve

residents' reliability to the government, encourage the practice of energy-saving and environmental protection behavior, and actively advocate the participation of the whole people in the prevention and control of smog.

Table 4. Descriptive statistics of haze control behavior selection

Haze control behavior selection variables	2014				2018				2021			
	Zhengzhou		Jiaozuo		Zhengzhou		Jiaozuo		Zhengzhou		Jiaozuo	
	Number of samples	Proportion	Number of samples	Proportion	Number of samples	Proportion	Number of samples	Proportion	Number of samples	Proportion	Number of samples	Proportion
Using electric vehicles	88	63.77%	272	62.20%	173	74.25%	63	50.40%	203	87.50%	441	73.01%
Water and electricity saving	126	91.30%	286	65.40%	108	46.35%	37	29.60%	199	85.78%	397	65.73%
Planting trees and grass	130	94.20%	269	61.60%	158	67.81%	67	53.60%	192	82.76%	446	73.84%
Pay fees	28	9.38%	41	20.29%	27	11.59%	24	19.20%	33	20.30%	121	14.22%
Supervision and reporting	—	—	—	—	74	31.76%	31	24.80%	—	—	—	—
Eat less fried food	—	—	—	—	68	29.18%	17	13.60%	—	—	—	—
Cooperate with government governance	—	—	—	—	120	51.50%	60	48.00%	—	—	—	—
Other	15	10.87%	19	4.30%	5	2.15%	8	6.40%	21	9.05%	33	5.46%

The results showed that the willingness of residents to pay for smog in Zhengzhou did not increase significantly due to the depth of the COVID-19 and the severe rainstorm disaster; With the cumulative effect of hazards caused by continuous haze pollution and the continuous improvement of residents' living standards, the percentage of residents' willingness to pay for governance in Jiaozuo City shows a downward trend; Smog control continued to advance, the obvious harm of smog pollution was reduced, and the willingness to pay was relatively low in both places. The survey found that the main reasons why residents are unwilling to pay are as follows: (1) they do not believe in the use of funds and their governance effects; (2) Haze control has nothing to do with itself; (3) Haze control should be undertaken by the government or enterprises; (4) Their own economic capacity is insufficient.

4. Conclusion

(1) Residents' awareness and satisfaction of haze control are significantly related to their academic qualifications, and the significant influencing factors are spatio-temporal differences. in terms of time, the significant factors that affect residents' awareness and satisfaction of haze control show a multi factor coupling effect with time; Spatially, the influencing factors of awareness and satisfaction of smog control in Zhengzhou are more stable.

(2) The indirect willingness to pay, such as "using electric vehicles or minimizing the use of private cars", "saving water and electricity" and "planting trees and grass", accounts for a relatively high proportion in Zhengzhou and Jiaozuo, showing a "V" trend as a whole, while the direct willingness to pay, such as "payment fees", accounts for a relatively low proportion. Among them, the willingness to pay for smog in Zhengzhou does not increase significantly, and the percentage of willingness to pay for governance in Jiaozuo shows a downward trend.

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