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Driving factors of residents' participation in air pollution prevention and control under air quality improvement policies

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Abstract: The effectiveness of air quality improvement policies is influenced by residents' willingness to participate. Therefore, this study collected 322 valid samples using a questionnaire survey. Through empirical analysis, it explores how residents' psychological perceptions regarding the detrimental effects of air pollution influence their readiness to engage in pollution prevention and control efforts. The findings demonstrate that the influence coefficients of probabilistic distance (0.583), spatial distance (0.461), social distance (0.327), and temporal distance (0.094) are significant. The findings demonstrate that all factors related to psychological distance significantly and positively influence residents' willingness to participate, with probabilistic distance having the strongest effect and temporal distance the weakest. This study confirms that psychological distance is an important factor driving residents' participation in air pollution prevention and control, thus providing a reference for public communication strategies in environmental policy formulation.

Keywords: air quality improvement policies; pollution prevention and control; social psychology; willingness to participate

INTRODUCTION

In recent times, air pollution (AP) has emerged as a critical environmental issue that hinders the sustainable development of Chinese cities and the improvement of residents' quality of life. In response to the AP situation, the State Council Executive Meeting in 2023 reviewed and approved the "Action Plan for Continuous Improvement of Air Quality". The document proposed that in the action to improve air quality, it is necessary to "promote in-depth treatment of pollution in key industries" and "strengthen the treatment of non-point source pollution and improve the level of refined management". It can be seen that the action to prevent and control urban AP not only depends on the supervision and guidance of the government and the transformation and governance of industries, but is also closely related to the lives of the masses [1]. In the current research field of AP prevention and control (P&C), Yang X et al. employed a dynamic spatial Durbin model with economic and geographic weight matrices to examine the direct regulatory influences of fiscal decentralization and urban sprawl on AP. Their findings revealed that AP exhibits notable time-lag and spatial spillover effects, with both fiscal decentralization and urban expansion significantly affecting AP levels [2]. Kumar K et al. analyzed AP data from 23 Indian cities over the last six years to assess and forecast air quality. Exploratory data analysis was conducted to gain a deeper understanding of the various hidden patterns in the dataset and to identify the pollutants that directly affect the air quality index [3]. It can be seen that although there are many research results on air quality improvement in the current academic research field, the existing research is mostly focused on the analysis of pollution sources and the level of governance technology. There is a relative lack of research on the participation behavior of AP P&C from the perspective of residents' psychological perception. Therefore, the innovative contribution of this study is to explore the psychological

driving factors of residents' participation in AP P&C under the air quality improvement policy from the psychological distance theory in social psychology. The study aims to obtain the psychological reaction of residents to the air quality improvement policy by analyzing the factors that affect residents' willingness to participate in P&C, so as to provide scientific guidance for adjusting the policy.

1. Theoretical basis and hypothesis

In recent years, the Chinese government has introduced a series of air quality improvement policies. The "Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution" was revised in 2015, the "Opinions of the CPC Central Committee and the State Council on Deepening the Battle Against Pollution" was issued in 2021, and the "Action Plan for Continuous Improvement of Air Quality" was issued in 2023. The above policy documents have clarified specific pollutant emission reduction targets and air quality compliance requirements, which not only involve the production activities of industrial enterprises, but also are closely related to residents' daily heating, transportation use, environmental consumption and other behaviors [4]. Under the above policy background, residents' willingness to participate in AP P&C can be mainly quantified as their willingness to pay policy costs and their preference for policy attributes.

From a social psychology perspective, residents' willingness to participate in AP P&C is influenced by their policy psychological distance. Residents' subjective perception of the distance between themselves and other objects, events or others is psychological distance, which is based on their own direct experience at this time and place. Generally speaking, the closer residents are to air quality improvement policies, the more specific their understanding of the policies and the stronger their willingness to respond to the policies and participate in AP P&C [5]. Similarly, the closer residents are to the harm of AP, the higher their willingness to participate in AP P&C. Among psychological distances, time distance, spatial distance, social distance and probability distance are the main factors [6]. Specifically, residents' time distance perception is used to measure the time urgency of the harm of AP from themselves; spatial distance perception measures the distance of the harm of AP from their location. Social distance measures the closeness of the harm of AP from their social group, while probability distance measures the possibility of the harm of AP occurring to them.

Therefore, the study proposes the following hypothesis:

Hypothesis 1: Residents' perception of the temporal and distance-based hazards of pollution increases their willingness to participate in AP P&C.

Hypothesis 2: Residents' perception of the spatial distance of pollution hazards increases their willingness to participate in AP P&C.

Hypothesis 3: Residents' social distance perception of the harm caused by pollution increases their willingness to participate in AP P&C.

Hypothesis 4: Residents' probabilistic perception of the harm caused by pollution increases their willingness to participate in AP P&C.

2. Research design

2.1 Questionnaire design

To determine the impact of residents' perceived psychological distance on their willingness to participate in AP P&C, this study designed a questionnaire to measure the psychological distance of AP hazards, referencing the research findings of McDonald et al. [7]. Meanwhile, a supplementary questionnaire on residents' willingness to participate was used to analyze residents' willingness to

participate in AP P&C. The specific questionnaire information is presented in Table 1.

Table 1. Psychological distance measurement questionnaire for AP hazards and willingness to participate in AP P&C at the questionnaire level

Questionnaire	Dimension	Serial number	T itle	Option				
				1	2	3	4	5
Psychological distance measurement questionnaire on the hazards of AP	Time distance (T)	T1	When do you think AP started to have a significant impact on your life?	50 years later	25 years later	10 years later	Now	Has already had a serious impact
	Spatial distance (S)	S1	The area where I live is severely affected by AP.	Strongly Disagree	Disagree	General	Agree	Strongly Agree
		S2	AP mainly affects other developing countries and has little impact on China.	Strongly Agree	Agree	General	Disagree	Strongly Disagree
	Social distance (C)	C1	I am very worried that AP will pose a great threat to my physical health.	Strongly Disagree	Disagree	General	Agree	Strongly Agree
		C2	I am very concerned that AP will pose a great threat to my family and friends.	Strongly Disagree	Disagree	General	Agree	Strongly Agree
		C3	I believe that AP has	Strongly	Disagree	General	Agree	Strongly

			a serious impact on the health of the entire society.	Disagree				Agree
	Probability distance (H)	H1	I am confident that the current AP problem is already very serious.	Strongly Disagree	Disagree	General	Agree	Strongly Agree
		H2	I think the severity of AP has been exaggerated by the media.	Strongly Agree	Agree	General	Disagree	Strongly Disagree
		H3	I think the impact of AP on health is highly uncertain.	Strongly Agree	Agree	General	Disagree	Strongly Disagree
Resident participation intention survey form	Willingness to participate (I)	I1	I think paying a certain fee to improve air quality is a responsible behavior.	Strongly Disagree	Disagree	General	Agree	Strongly Agree
		I2	I am willing to practice environmental protection in my daily life.	Strongly Disagree	Disagree	General	Agree	Strongly Agree
		I3	If the	Strongl	Disagr	Gener	Agree	Strongl

	policy is reasonable, I am willing to actively cooperate with the government's AP control measures.	y Disagree	ee	al	y Agree

All items in Table 1 were quantified using the Likert five-point rating scale. In the questionnaire measuring the psychological distance of AP hazards, items S2 (spatial distance) and H2 and H3 (probabilistic distance) were both negative items; therefore, the ratings for options 1-5 were replaced.

2.2 Study area and research methods

The study selected Jinan City, Shandong Province as the experimental area to conduct empirical investigation. Jinan City is located in the hinterland of the North China Plain. Due to the influence of topography and meteorological conditions, the atmospheric pollutant diffusion conditions are poor. Jinan City frequently experiences heavy pollution weather in autumn and winter. The annual average concentration of PM2.5 has been higher than the national secondary standard for a long time, making it one of the provincial capital cities with more serious AP in China. Therefore, taking Jinan City as the research object can better represent the typical situation of AP threat faced by urban residents in northern China [8].

The study employed structural equation modeling (SEM) for regression analysis. SEM can test the goodness of fit of the overall model. The study designed the survey results of time distance, spatial distance, social distance, and probabilistic distance in residents' psychological distance as dependent variables, and residents' willingness to participate as independent variables. The relationship between the two is expressed as shown equation (1).

$$X = \Lambda_1 Y_1 + \Lambda_2 Y_2 + \Lambda_3 Y_3 + \Lambda_4 Y_4 + \delta \quad (1)$$

In equation (1), X represents the independent variable, Y_1 - Y_4 represent the dependent variables in four dimensions, Λ_1 - Λ_4 represent the factor loading matrices in different dimensions, and δ represents the measurement error. The study uses the maximum likelihood estimation (ML) method to estimate the model parameters. This method has asymptotic unbiasedness and consistency when the sample size is moderate and the data satisfies the assumption of multivariate normal distribution.

2.3 Questionnaire survey and data processing methods

The study selected six main urban districts of Jinan City as the survey area. From September 10th to 15th, 2025, 60 questionnaires were distributed in each district. The questionnaires were distributed offline, with a total of 360 questionnaires distributed and 334 returned. Manual checks were conducted to identify questionnaires with patterns of answering correctly, omissions exceeding 10%, and contradictory options.

After completing the questionnaire survey, SEM analysis was performed using AMOS 26.0 or Mplus 8.3 software, along with SPSS 26.0 for data preprocessing, reliability and validity testing, and descriptive statistical analysis. $p < 0.05$ was set as the significance of the structural model.

3. Empirical analysis results

3.1 Dependability and validity testing

The dependability and validity of the scale were tested employing SPSS 26.0 and AMOS 26.0. The Cronbach's α coefficient, composite reliability (CR), and average variance extracted (AVE) for each variable are presented in Table 2.

Table 2 Outcomes of scale dependability and convergence validity test

Questionnaire	Dimension	Serial number	Factor loading	Cronbach's α	CR	AVE
Psychological distance measurement questionnaire on the hazards of AP	Time distance	T1	0.82	0.814	0.815	0.688
	Spatial distance	S1	0.73	0.752	0.754	0.486
		S2	0.68			
	Social distance	C1	0.82	0.861	0.863	0.678
		C2	0.85			
		C3	0.79			
	Probability distance	H1	0.71	0.793	0.795	0.564
		H2	0.78			
		H3	0.76			
Resident participation intention survey form	Willingness to participate	I1	0.80	0.825	0.828	0.617
		I2	0.83			
		I3	0.86			

As presented in Table 2, the Cronbach's α values for all latent variables were greater than 0.7, and the combined reliability was also greater than 0.7, demonstrating that the scale had good internal consistency reliability. Except for spatial distance, whose AVE value was 0.486 (slightly below 0.5), the AVE values for the other latent variables were all greater than 0.5, falling within an acceptable threshold given the intricate nature of measuring psychological distance. The standardized factor loadings for all variables ranged from 0.62 to 0.92, indicating that the scale had good convergent validity. Furthermore, the study tested the discriminant validity (DV); the specific outcomes are presented in Figure 1.

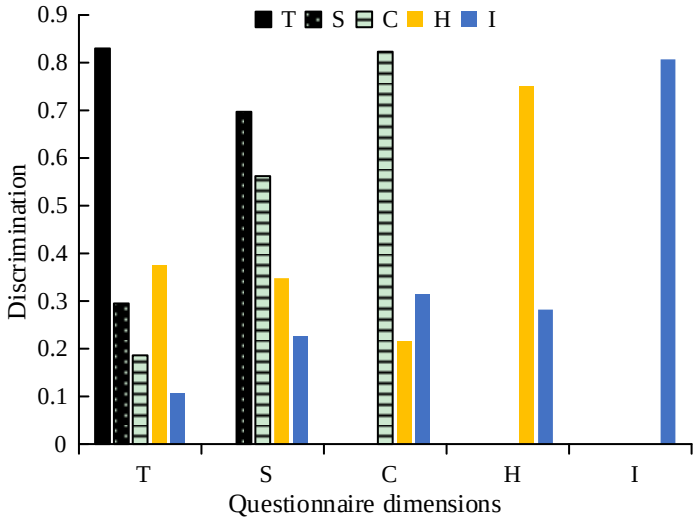

Figure 1. Results of DV test

In Figure 1, the AVE square root (SR) of the time distance dimension variable was 0.83, the AVE SR of the spatial distance dimension variable was 0.697, the AVE SR of the social distance dimension variable was 0.823, and the AVE SR of the probability dimension variable was 0.751. All of these AVE SRs were greater than the absolute values of the correlation coefficients of their respective rows and columns, demonstrating that the scale had good DV.

3.2 Descriptive statistical results

The study used SPSS 26.0 for data processing and descriptive statistical analysis. The specific outcomes are presented in Table 3.

Table 3 Descriptive statistics of mean values and item ratings for each dimension

Questionnaire	D imension	Dimension mean	Serial number	Topic rating
Psychological distance measurement questionnaire on the hazards of AP	Time distance	2.85	T1	2.85
	Spatial distance	3.86	S1	4.14
			S2	3.58
	Social distance	4.19	C1	4.05
			C2	4.36
			C3	4.17
	Probability distance	3.08	H1	3.15
			H2	2.76
			H3	3.34
Resident participation intention survey form	Willingness to participate	3.83	I1	3.57
			I2	3.86
			I3	4.07

From Table 3, the mean of the time distance dimension was 2.85, which was lower than the other three dimensions, indicating that Jinan residents generally believes that the harm of AP has not yet had a significant impact at present. Meanwhile, the mean of the spatial distance dimension was 3.86, which was at a medium-high level, indicating that residents generally recognize the problem of AP in the region. The mean of the social distance dimension was 4.19, which was the highest score among all dimensions, indicating that residents have a high degree of recognition of the social relevance of the harm of AP. The mean of the probability distance dimension was 3.08,

indicating that there is some disagreement among residents regarding the certainty of the consequences of AP. Finally, the mean of the willingness to participate dimension was 3.83, which was at a high level, indicating that Jinan residents are generally willing to participate in AP P&C actions. It can be inferred that the achievements Jinan has made in environmental governance in recent years have enhanced residents' trust in air quality improvement policies, thereby increasing their willingness to cooperate [9]. Meanwhile, residents may be more willing to accept daily environmental protection behaviors due to their lower costs (I2 = 3.86); while monetary payments involve actual economic benefits and have a higher acceptance threshold (I1 = 3.57). In addition, the information that residents obtain from different self-media channels may be contradictory, leading to a divergence in the perception of the probability of pollution. Residents' concerns about the health of their relatives and friends have become an important emotional basis for their participation in AP P&C (C2 = 4.36). Finally, the harm that AP actually causes to residents may have a cumulative effect and may be difficult for individuals to perceive directly in the short term, resulting in a certain degree of delayed cognition in the time dimension (T1 = 2.85) [10].

3.3 SEM fitting results

Finally, the study analyzed the impact of different psychological distance factors on residents' willingness to participate in AP P&C grounded in the SEM model. The specific outcomes are presented in Table 4.

Table 4 Path coefficients and hypothesis testing outcomes of SEM

Hypothesis	Path relationship	Standardization coefficient β	Standard error	CR	*p*	Test results
/	Spatial distance → Social distance	0.582	0.068	8.56	***	/
/	Time distance → Probability distance	0.403	0.071	5.68	***	/
Hypothesis 1	Time distance → willingness to participate	0.094	0.043	2.19	0.029	support
Hypothesis 2	Space distance → willingness to participate	0.461	0.062	7.44	***	support
Hypothesis 3	Social distance → willingness to participate	0.327	0.055	5.95	***	support
Hypothesis 4	Probability distance → willingness to participate	0.583	0.074	7.88	***	support

Note: In Table 4, *** indicates $p < 0.001$.

The data in the table showed that the influence coefficient of temporal distance on participation intention was 0.094 ($p = 0.029$), which was relatively weak among all factors. Spatial distance had a stronger influence on participation intention, with an influence coefficient of 0.461 ($p < 0.001$). Social distance also had a strong influence on residents' participation intention, with an influence

coefficient of 0.327 ($p < 0.001$). Finally, probabilistic distance had the greatest influence on residents' participation intention, with an influence coefficient of 0.583 ($p < 0.001$).

Individuals tend to discount future gains, and the greater the time distance, the weaker the incentive effect of behavior. Therefore, it can be inferred that current residents may regard pollution hazards as future problems, which weakens the sense of urgency to take action now. At the same time, the disclosure of air quality information on social media has brought residents closer to the spatial distance of AP. Therefore, many residents believe that AP is more directly accessible in space. In addition, concern for the social group within an individual is often more likely to stimulate environmental protection behavior than self-interest [11]. In Chinese families, health issues are often closely related to environmental pollution issues, so social distance has also become an important path to improve residents' willingness to participate. Finally, probabilistic distance is the strongest psychological factor driving residents to participate in AP P&C. Although there is a differentiation in residents' perception of probabilistic distance, due to the certainty of AP hazards caused by high probability distance perception, residents are more likely to take specific measures to participate in AP P&C [12]. Overall, all the hypotheses proposed in the study are valid, and the influence mechanism of probabilistic distance > spatial distance > social distance > time distance is shown. Therefore, the improvement of current air quality improvement policies should emphasize the immediate benefits of policy effectiveness, showcasing the short-term benefits of public participation in AP P&C. Simultaneously, precise interventions should be implemented for groups with different levels of pollution exposure. For example, residents living near highly polluted industrial areas, whose spatial distance perception is already relatively close, can have their intervention focus on narrowing probabilistic and temporal distances; while residents living in relatively clean areas need their spatial distance perception narrowed.

4. Conclusion

Based on survey data from Jinan City, this study empirically tested an integrated model of residents' psychological distance and willingness to participate in AP P&C using SEM. The results showed that residents' perception of social distance in relation to AP was the strongest, with a mean dimension of 4.19, while their perception of temporal distance was the weakest, with a mean dimension of 2.85. Meanwhile, probabilistic distance (β=0.583), spatial distance (β=0.461), social distance (β=0.327), and temporal distance (β=0.094) all had significant positive impacts on residents' willingness to participate, with probabilistic distance having the strongest effect and temporal distance the weakest. The study indicated that psychological distance plays a multi-layered role in driving residents' participation in AP P&C. However, the study has limitations in its data survey design, as it collected data on residents' perceived psychological distance and willingness to participate at the same time point. Residents' perceived psychological distance may change with policy developments, seasonal variations, and other factors. Therefore, future research will examine residents' psychological distance under different information frames to comprehensively analyze the impact mechanism of psychological factors on residents' environmental protection participation.

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