Harmony, Risk, and Trust: Public Acceptance of CCUS Projects in Guizhou Province, China from a Daoist Ecological Perspective

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Abstract: In the context of China's dual-carbon goals, carbon capture, utilization, and storage (CCUS) has emerged as a critical technological pathway for reducing emissions in coal-dependent regions. Yet the implementation of CCUS projects depends not only on technical feasibility and policy support, but also on public acceptance. This study examines public acceptance of CCUS projects in Guizhou Province, a region of ecological sensitivity, strong policy relevance, and rich cultural traditions that invite reflection on the relationship between human activity, technological intervention, and the natural world. Drawing on a perspective informed by Daoist ecological thought, especially the concern for harmony between humans and nature. This study investigates how public cognition, fairness, legal protection, environmentalism, perceived usefulness, perceived risk, and trust shape acceptance of CCUS projects. Using questionnaire data collected from college students, institutional employees, and enterprise-related personnel in Guizhou, the study applies structural equation modeling to test the proposed relationships. Exploratory factor analysis shows that the cumulative explained variance reaches 66.61%. The results indicate that environmentalism has a significant positive effect on public acceptance of CCUS projects. Fairness and legal protection significantly influence public acceptance through trust. Public cognition affects public acceptance through perceived benefits and perceived risks. Distinct from some previous studies, however, the findings reveal that perceived risk exerts a stronger influence on public acceptance than perceived benefit. Without altering the empirical structure of technology-acceptance research, this study places CCUS acceptance within a broader ethical and cultural conversation about ecological governance in contemporary China. It suggests that public responses to low-carbon technologies are shaped not only by instrumental evaluations, but also by deeper concerns about balance, responsibility, and the legitimacy of intervening in nature..

Keywords: CCUS; public acceptance; public cognition; fair; trust.

Introduction

Climate change has become one of the most pressing challenges of the contemporary world, demanding not only technological innovation and policy coordination, but also deeper reflection on the relationship between human beings and the natural environment. In the Chinese context, ecological transition is often discussed in terms of harmony between humans and nature, a concept that also resonates strongly with Daoist thought. Rather than viewing nature as merely an object of unlimited

intervention, Daoist ecological sensibilities emphasize balance, restraint, and respect for the larger order of the natural world. Such a perspective is especially relevant when examining public responses to emerging carbon-reduction technologies whose legitimacy depends not only on their technical performance but also on how they are socially and ethically understood..

CCUS technology refers to a series of technologies that separate CO_2 from industrial process, energy utilization or atmosphere, and directly utilize it or inject it into the stratum to realize CO_2 permanent emission reduction(Mon et al., 2024). Since the industrial revolution, human activities, such as the emission of a large number of greenhouse gases and aerosols from fossil fuels, the emission of various chemicals from production and life, and the change of land use and cover, have caused changes in the climate system consisting of the atmosphere, hydrosphere, cryosphere, biosphere and lithosphere, that is, the greenhouse gases have greatly increased and the temperature has risen, resulting in extremely bad weather, which has adversely affected the world ecological environment and human physical and mental health.

In order to solve the problem of greenhouse effect, all countries in the world are working hard to effectively reduce greenhouse gases. In response, in 2016, more than 170 national leaders gathered at United Nations Headquarters to jointly sign the Paris Agreement. At present, more than 140 countries and regions around the world have put forward "zero carbon" or "carbon neutral" climate goals. China, as a responsible country, China's carbon dioxide emissions would peak before 2030, and strive to achieve carbon neutrality before 2060 (Luo et al., 2023).

With the gradual clarification of the carbon-neutral goal in China and other countries and the acceleration of carbon emission reduction, a technology called CCUS (Carbon Capture, Utilization and Storage) came into being (Figure 1.1). CCUS is a series of technologies (IPCC, 2004) that capture and purify the carbon dioxide emitted in the production process, and then put it into a new production process for reuse and storage. Therefore, based on the negative carbon characteristics of CCUS, its role in helping to achieve carbon neutrality is more prominent. This is because CCUS is the only technical choice to realize low-carbon utilization of fossil energy, the main technical means to maintain the flexibility of power system under the goal of carbon neutrality, and the feasible technical choice for low-carbon transformation of industries that are difficult to reduce emissions such as steel and cement. In addition, the negative emission technology coupled with CCUS and new energy is an important technical guarantee to achieve the goal of carbon neutrality(IEA, 2017).

On January 26th, 2022, the State Council, China issued "Opinions on Supporting Guizhou to Break New Trails in Western Development in the New Era", which proposed: exploring and implementing the demonstration project of carbon capture, utilization and storage (CCUS), and conducting the pilot projects of underground coal gasification, large-scale carbon capture and utilization and karst geological carbon capture and storage in an orderly manner. Promote the construction of a comprehensive utilization base for industrial resources, and promote the large-scale and high-value utilization of industrial solid waste and renewable resources. Steadily promote the construction of a "waste-free city". This document undoubtedly points out the direction for Guizhou, which has various high-emission enterprises, to carry out CCUS projects. However, due to various reasons, no CCUS project has been born in Guizhou so far (Council, 2022).

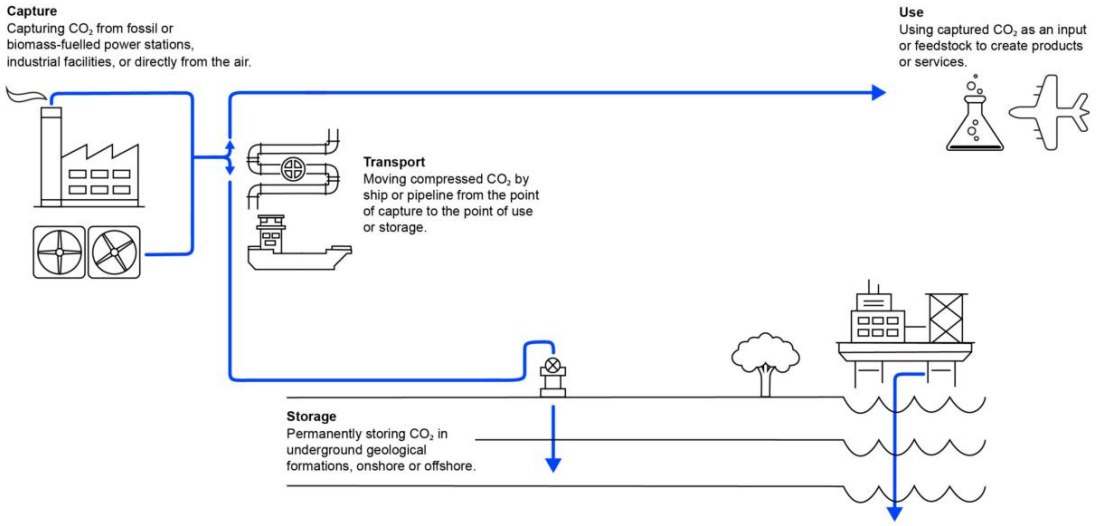

Figure 1.1 Schematic Diagram of CCUS(Carbon Capture, Utilization and Storage)

Guizhou has high coal reserves and large-scale coal-fired power plants, which are distributed in nine prefectures and cities, and make a lot of contributions to the power supply and coal supply and economic development of China every year. Although CCUS technology is currently in the demonstration stage, the technology needs to be mature and the cost needs to be reduced, and CCUS does not have the conditions for large-scale commercial application in peak carbon dioxide emissions stage, it is expected that the second generation technology of CCUS will be mature and the cost will be greatly reduced by the initial stage of carbon neutrality. One hour before the closing plenary session of the COP26 summit, the agreement was changed from "phasing out" to "gradually reducing" coal-fired power without emission reduction measures(Gough & Mander, 2022). This makes CCU or CCS very important for these areas that still rely on coal in economic development and achieve climate goals. Therefore, 2030-2035 is the best period for the transformation of "coal-electricity +CCUS" in China. Relevant calculations show that under the development mode of "coal-electricity +CCUS", the time when "coal-electricity +CCUS" is economical will be advanced by one year for every 20% increase in power generation hours of coal-fired generating units(Xiang et al., 2023).

The purpose of this study is to investigate the influencing factors of public acceptance of CCUS project which is of great significance for carbon reduction under the background of carbon neutrality. The research model of this study examines the direct influence of environmentalism, perceived benefits, perceived risks and trust on CCUS public acceptance. In addition to the direct influence, this study also takes perceived interest and perceived risk as intermediary factors to explore the indirect influence of public cognition on CCUS public acceptance; Trust is also used as an intermediary factor to explore the indirect influence of fairness and legal protection on CCUS public acceptance. Thus expanding the academic discourse around this topic.

The structure of the rest of this paper is as follows. Section 2 introduces the literature, research model and related assumptions related to CCUS public acceptance in detail. Section 3 explains the method. See section 4 for data analysis and results. Section 5 discusses the analysis and research meaning related to this study, the limitations related to this study and the future research direction.

2. Literature review

Acceptance, mainly including narrow understanding and broad understanding. From a narrow

point of view, it is considered that acceptance refers to the consensus among established groups, and high acceptance is manifested in the absence of open and visible resistance. For example, when the investigation found that someone was willing to sign a petition against the proposed carbon dioxide sequestration project, it was regarded as a sign that the community did not accept the deployment of CCUS (Terwel & Daamen, 2012). Broadly speaking, acceptance includes the integration of social politics, market and community acceptance. Social and political acceptance refers to the acceptance or rejection of technology and policies by social actors such as policy makers and the general public (van Os et al., 2014). Market acceptance considers the interaction between consumers and technology investors under the background of competition and cooperation. Community acceptance refers to the recognition of the project by local stakeholders (including residents and local authorities). In this way, the three acceptance levels are interrelated and affect the results of CCUS project (Jones et al., 2017).

Public acceptance, there is corresponding policy support in China, and the Environmental Impact Assessment Law stipulates that the public has the right to participate in the assessment. As the core group of society, the public bears not only basic obligations, but also legal obligations. Public participation belongs to the supervision, examination and supervision of society in the face of environmental impact, which has universal characteristics. Its main body includes four types of groups, one is the groups affected or suspected to be affected by the project; Second, organizations that are mainly people's congresses, trade unions and women's federations and are easily affected by the project; Third, media news organizations at the social level; The fourth is a technical team with experts in environmental science, social economics and related disciplines as the main body(Swerdfager, 1988).

Although CCUS plays an increasingly prominent role in mitigating the urgent threat of climate change, its deployment also faces a series of challenges from cost, technology to social acceptance. The public's acceptance of technology, trust in key stakeholders, perceived security risks, transparency and fairness of project implementation will all determine the feasibility of CCUS. Lack of public acceptance has become an obstacle to the smooth implementation of CCUS projects, and examples have occurred from time to time in the history of various countries. The reasons for the public's rejection of CCUS generally include: long-term security concerns about CCS storage and transportation, health risks of CCU carbon conversion products, the tendency of "not in my backyard" or lack of relevant technical knowledge(Storrs et al., 2023).

Theories or models that affect CCUS public acceptance include: ABC (Emotion, Behavior and Cognition) attitude model(Liu et al., 2021), cumulative pyramid model based on social permission(Hall et al., 2015), stakeholder theory(Wang et al., 2022) and so on. In the past research, it mainly focused on the public in the places where CCUS projects have been built, and the research on public acceptance in the places where CCUS projects need to be implemented urgently has not been reported. Based on previous theories or models, this study established a CCUS public behavior model. Taking public cognition, fairness, legal protection and environmentalism as independent variables, perceived interests, perceived risks and trust as intermediary variables, public acceptance as dependent variables, and gender, age, education level and income as control variables. Then, we conducted a questionnaire survey on a large sample of the public in Guizhou Province (N=415). Finally, we use structural equation model (SEM) to test the established model, and discuss how various factors affect public acceptance. The research results provide theoretical support for decision makers to convey decisions that meet public acceptance.

Under the goal of "3060", peak carbon dioxide emissions's idea of carbon neutrality has penetrated into various industries, and the improvement of environmental awareness has also affected

the public's acceptance of CCUS projects. The research of (Wallquist et al., 2009) shows that there is a big gap in the public's understanding of carbon emissions, which further affects the public's acceptance of mitigation technologies such as CCUS. Therefore, this study believes that environmentalism can positively affect the public's acceptance of CCUS projects in Guizhou.

Hypothesis 1: Environmentalism positively affects the public's acceptance of CCUS in Guizhou.

High cognition can help us understand CCUS more completely and deeply. Some studies show that participants' initial reaction changes from negative to contradictory, and then they become positive after they get some information about CCUS, which in turn affects their acceptance. Therefore, assumptions 2 and 3, 6 and 7 are proposed.

Hypothesis 2: Public cognition positively affects Guizhou public's perceived interest in CCUS.

Hypothesis 3: Public cognition negatively affects Guizhou public's perceived risk of CCUS.

Hypothesis 6: Perceived benefits positively affect the public's acceptance of CCUS in Guizhou.

Hypothesis 7: Perceived risk negatively affects the public's acceptance of CCUS in Guizhou.

Fairness and legal protection are conducive to establishing public trust in public facilities projects, and then improving the acceptance of CCUS projects. Therefore, this study puts forward hypothesis 4, hypothesis 5 and hypothesis 8.

Hypothesis 4: Fairness positively affects the public's trust in the government and enterprises carrying out CCUS projects in Guizhou.

Hypothesis 5: Legal protection positively affects the public's trust in the government and enterprises carrying out CCUS projects in Guizhou.

Hypothesis 8: Trust positively affects the public's acceptance of the government and enterprises that carry out CCUS projects in Guizhou.

In addition, the following intermediate variable assumptions are proposed

Hypothesis 9: In the upcoming CCUS project, perceived interest has an intermediary role between Guizhou public's cognition of CCUS and Guizhou public's acceptance of CCUS.

Hypothesis 10: Perceived risk plays an intermediary role between Guizhou public's cognition of CCUS and Guizhou public's acceptance of CCUS.

Hypothesis 11: Trust mediates the fairness of the government and CCUS project enterprises to the public in Guizhou and the acceptance of CCUS projects by the public in Guizhou.

Hypothesis 12: Trust plays an intermediary role between the legal protection for the local public in the implementation of CCUS project and the acceptance of CCUS project by Guizhou public.

The research hypotheses are summarized in Table 1.

Table 1 Summary of Research Assumptions

Number	Hypothetical content
H1	Environmentalism is positively affecting the public's acceptance of CCUS.
H2	Public cognition positively affects the public's perceived interests in CCUS.
H3	Public cognition positively affects the public's perceived risk of CCUS.
H4	Fairness positively affects trust.
H5	Legal protection has a positive impact on trust.
H6	Perceived benefits positively affect acceptance.
H7	Perceived risk positively affects acceptance.
H8	Trust positively affects acceptance.
H9	Perceived interests play an intermediary role between public cognition and acceptance.
H10	Perceived risk plays an intermediary role between public perception and acceptance.
H11	Trust plays an intermediary role between fairness and acceptance.
H12	Trust plays an intermediary role between legal protection and acceptance.

The theoretical model is illustrated in Fig. 2.

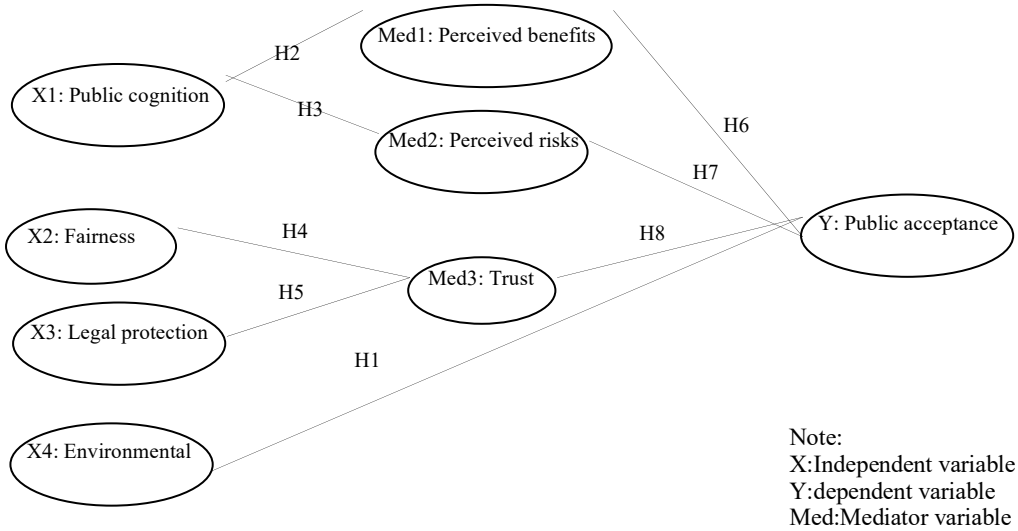

Figure 2 Research Model Based on Literature Review

Method

3.1 Questionnaire design

As a new technology, There are only a few demonstration projects or commercial projects in China(Mon et al., 2024), but it has not really landed in Guizhou Province. So, in general, the public in Guizhou has not really felt the CCUS project concretely. Therefore, the sample population we choose should try to choose senior intellectuals who can have a general understanding and form their own judgments on the quality of the project after seeing CCUS's introduction or the public who are engaged in relevant practical enterprise work. At the beginning of the questionnaire, we started with the schematic diagram of the standard CCUS project issued by the International Energy Agency, and translated the language into Chinese for a brief introduction. That is, CCUS project is a project based on carbon dioxide capture, utilization and storage, which is of great significance in environmental protection. The schematic diagram of this process is as follows (see Figure 1.1).

In the questionnaire, we collected the demographic and socio-economic information (gender, age and income) of the respondents. On the basis of existing research, 40 questions about perceived risk, perceived benefit, environmentalism, public cognition, trust, fairness, legal guarantee and public acceptance were developed to operate each structure in this study. A five-point Likert scale is put forward in the project, in which "1" means "strongly disagree", "2" means "disagree", "3" means "average", "4" means "agree" and "5" means "strongly agree". Table 2 shows the structure, measurement items and related articles.

Table 2 Operating variables and survey questionnaire

Construct	Measurement item
Perceived Risks (PR)	PR1: CCUS is an immature technology, and accidents may occur during implementation.
	PR2: The transport of CO_2 is dangerous, a leakage of CO_2 during transport is bad for the environment.
	PR3: The geological storage of CO_2 is hazardous, which may cause earthquakes.
	PR4: CO_2 products are harmful to human health.
	PR5: CCUS is harmful, which allowing the use of fossil fuels will further worsen the environment.
Perceived Benefits(PB)	PB1: CCUS is an environmentally-friendly technology that effectively alleviates climate change
	PB2: CCUS is a trustworthy technology that improves oil recovery rates and oil supply.
	PB3: CCUS is a sustainable technology that could reduce the dependence on fossil resources.
	PB4: CCUS is conducive to the development of a low-carbon economy.

	PB5: CCUS is a mature technology, which provides more employment opportunities for society.
Environmentalism(EN)	EN1: CCS technologies are an effective means of climate mitigation.
	EN2: CCS will improve our energy efficiency, reduce energy consumption.
	EN3: CCS can reduce CO_2 emissions.
	EN4: CCS technologies can benefit environmental protection.
	EN5: I think "Not reducing CO_2 emissions means that we just shift the responsibility onto the next generation."
Public Cognition(PC)	PC1: I have heard about CCUS.
	PC2: I have an understanding of CO_2 capture processes.
	PC3: I have an understanding of CO_2 transportation processes.
	PC4: I have an understanding of CO_2 utilization.
	PC5: I have an understanding of CO_2 storage.
Trust(TR)	TR1: I believe that CCUS stakeholders can judge risks and forecast returns.
	TR2: I believe that the information about the risks and benefits provided by CCUS stakeholders is objective.
	TR3: I believe that CCUS stakeholders would inform the public of the risks and benefits in a timely manner.
	TR4: If there is an accident in CCUS project, I believe the project implementer has the ability to protect the interests of citizens.
	TR5: I believe that CCUS stakeholders are environmentalists.
Fairness(FR)	FR1: I believe that the decision-making process of CCUS projects is open and transparent.
	FR2: The financial compensations (e.g., tax payments of the operators) counterbalance the disadvantages (e.g., accident risks and construction annoyance).
	FR3: Before the implementation of a CCUS project, there is sufficient publicity and notice.
	FR4: I have a say in the decision-making process of CCUS project.
	FR5: When I question the implementation results of a CCUS project, I can get a good response.
Legal protection(LP)	LP1: The legal system prevents us from suffering losses.

	LP2: Existing environmental laws and regulations can restrain CCUS project from affecting the surrounding public.
	LP3: The environmental impact assessment law stipulates that the public can participate in environmental impact assessment in an appropriate way.
	LP4: I think the decision-making process of CCUS projects is in accordance with the law.
	LP5: The legal system prevents us from being cheated.
Public Acceptance(PA)	PA1: I think CCUS is acceptable.
	PA2: I support Guizhou's large-scale development of CCUS.
	PA3: I can accept CO2 transportation pipelines through my residential area.
	PA4: Public finances should be used to support CCUS.
	PA5: I'm a proponent of CCUS-related public training.

3.2. Sample and data collection

Before issuing the formal questionnaire, we conducted a semi-structured interview with five experts/scholars to ensure the scientificity and accuracy of the questionnaire, and then further improved the project description. Our sampling strategy focuses on Shougang Shuicheng Iron and Steel (Group) Co., Ltd., teachers and students of Liupanshui Teachers College, teachers and students of Guizhou Business School, teachers and students of Guizhou University, Liupanshui Bureau of Industry and Information Technology, etc. In these units, 90% of the public come from 9 prefectures and cities in Guizhou Province, and they have a clear understanding of CCUS after reading the introduction or guidance training at the beginning of the questionnaire.

Results

4.1 Reliability and validity

Table 3 Factor analysis of power

	Factor loadings							
	Public Cognition	Fairness	Legal Protection	Environmentalism	Perceived benefits	Perceived risks	Trust	Public Acceptance
C1	**0.765**	-0.026	0.045	-0.004	0.048	-0.039	-0.023	-0.031
C2	**0.781**	-0.042	0.018	-0.013	-0.028	-0.003	-0.029	0.068

C3	**0.797**	0.04	-0.042	-0.012	0.021	0.036	-0.019	0.089
C4	**0.658**	-0.019	-0.005	0.047	0.08	-0.126	0.091	-0.164
C5	**0.806**	0.054	-0.02	0.009	-0.02	0.019	0.06	-0.034
R1	0.049	**0.676**	-0.027	-0.095	-0.05	0.017	0.004	0.047
R2	0.024	**0.862**	-0.011	-0.01	0.03	0.02	-0.018	0.027
R3	0.01	**0.725**	0.034	0.023	-0.023	0.002	-0.008	-0.002
R4	-0.071	**0.768**	0.066	-0.015	0.037	-0.037	0.04	-0.077
R5	-0.006	**0.709**	-0.052	0.098	0.002	-0.014	0.042	-0.019
P1	-0.051	-0.005	**0.831**	0.06	0.063	-0.019	0.053	-0.074
P2	0.031	-0.023	**0.753**	0.047	-0.041	-0.005	-0.028	-0.004
P3	-0.019	-0.003	**0.699**	-0.055	0.062	0.049	0.09	0.019
P4	0.074	0.095	**0.737**	-0.009	-0.086	0.028	-0.113	0.086
P5	-0.038	-0.045	**0.798**	-0.031	0.003	-0.054	0.06	-0.014
N1	0.042	-0.024	-0.007	**0.763**	-0.031	-0.028	0.033	-0.025
N2	0.043	-0.003	0.013	**0.696**	-0.033	0.071	-0.105	0.093
N3	-0.116	-0.015	-0.013	**0.752**	0.047	-0.098	0.182	-0.124
N4	0.022	0.055	-0.013	**0.751**	0.014	0.008	-0.063	0.022
N5	0.025	-0.023	0.039	**0.73**	-0.015	0.08	-0.066	0.093
B1	-0.013	-0.004	-0.068	0.013	**0.776**	-0.063	0.025	-0.061
	-	0.	0.03	-0.087	**0.7**	0.0	-	0.07

B2	0.02	024	1		**56**	38	0.035	1
B3	0.08	-0.031	-0.021	0.018	**0.695**	0.094	0.034	0.012
B4	-0.052	0.04	-0.002	0.028	**0.763**	-0.032	-0.037	0.047
B5	0.103	-0.041	0.064	0.014	**0.685**	0.008	-0.047	-0.016
R1	-0.048	-0.01	-0.015	0.034	-0.006	**0.702**	0.01	0.005
R2	-0.007	-0.005	-0.048	0.006	-0.001	**0.755**	0.099	0.001
R3	-0.025	-0.041	0.032	0.004	0.028	**0.751**	-0.001	-0.045
R4	-0.063	0.045	-0.025	-0.004	0.076	**0.753**	-0.021	-0.059
R5	0.054	0.003	0.046	-0.009	-0.051	**0.8**	-0.029	0.002
R1	0.009	0.002	-0.044	0.011	-0.004	0.04	**0.872**	0.037
R2	0.011	0.018	-0.027	0.02	-0.02	-0.034	**0.74**	0.003
R3	0.017	0.018	0.07	0.017	-0.03	0.071	**0.697**	-0.025
R4	0.017	-0.01	0.067	-0.055	0.042	-0.026	**0.668**	0.056
R5	0.018	0.035	0.012	-0.023	-0.041	0.008	**0.738**	0.042
A1	0.046	-0.058	0.045	-0.035	-0.06	0.002	0.016	**0.739**
A2	-0.03	0.053	0.026	0.032	0.001	-0.054	-0.083	**0.708**
A3	-0.057	-0.009	-0.007	0.005	0.006	-0.023	0.094	**0.718**
A4	-0.065	-0.002	-0.03	0.047	0.077	-0.058	0.047	**0.676**
A5	0.044	0.003	-0.031	0.019	-0.015	0.026	0.054	**0.698**

Table 3 shows descriptive statistics and correlation. Exploratory factor analysis (EFA) was tested by principal axis factorization method and optimal skew rotation method, and 8 factors with eigenvalues greater than 1 were generated, and the cumulative variance explanation rate was 66.61%. As shown in Table 3, the factor load of indicators is higher for the structures they are designed to measure than for the structures they are not designed to measure, which indicates that our measurement is one-dimensional. Secondly, we measure the Cronbach alpha value of each scale to ensure the reliability. The Kronbach α value of each scale (Table 4) is higher than 0.70, which is acceptable(Parelius, 1998).

Table 4 Correlation and reliability analysis (N = 415)

		D		R	VE	C	F R	L P	E N	P B	F R	T R	A
C	.260	.844	.886	.887	.611	**.782**							
R	.404	.738	.863	.868	.570	.241***	**.755**						
P	.713	.664	.880	.881	.597	.138*	.350***	**.773**					
N	.762	.708	.850	.859	.549	.144*	.234***	.311***	**.741**				
B	.745	.734	.859	.861	.554	.489***	.025	.123*	.162**	**.744**			
R	.222	.899	.874	.877	.588	-0.501***	-0.057	.029	.023	-0.151**	**.767**		
R	.625	.683	.876	.878	.591	.176**	.534***	.539***	.236***	.003	-0.004	**.769**	
A	.548	.724	.844	.852	.536	.220***	.297***	.354***	.419***	.320***	-0.400***	.410***	**.732**

Note: The diagonal data presented in bold print refer to the square roots of the AVEs.

*p < 0.05, **p < 0.01,***p < 0.001.

Our research tests the content, convergence, and discriminant validity. We use confirmatory factor analysis (CFA) to test the discriminant validity and convergence validity. First, we check the validity of convergence. Each item is related to its corresponding structure, and the covariance between structures can be estimated freely. The model fitting (χ^2 (415) = 804.388, RMSEA= 0.018, CFI = 0.989, TLI= 0.988, IFI= 0.989) proved to be acceptable. In addition, the load of all factors is higher than 0.50, which is statistically significant ($p < 0.01$), and supports the effectiveness of convergence. Next, test the discriminant validity. We establish a restrictive confirmatory factor analysis model for each pair of possible potential structures, in which the correlation between the paired structures is fixed at 1.0. We compare the results with the original unconstrained model, and the correlation is freely estimated. The significant difference of chi-square statistics between constrained and unconstrained models supports high discriminant validity. In our study, all the differences of chi-square test were significant ($p < 0.05$). The discriminant validity is confirmed. In addition, the average variance (AVE) of each structure is greater than the square correlation between this structure and other structures, which also provides discriminant validity (Table 4)(Liu et al., 2021).

4.2. Common method deviation

In this study, Harman single factor test is used to test the possible common method deviation. The results show that the eigenvalues of 8 factors are greater than 1, of which the variance explained by the largest factor is 20.98%, which is far from the critical standard of 40%, so it can be inferred that the probability of common method deviation in this study is small(Podsakoff et al., 2003).

4.3. Structural Equation Model

4.3.1. Fitting test of structural equation model

The research model is estimated by AMOS 26.0. Table 5 gives the results of adaptability evaluation of structural equation model. The results show that the actual values of all fitting indexes exceed the recommended threshold(Beribisky & Cribbie, 2024). The consistency between the model and the data is obvious, indicating a favorable.

Table 5 Results of Fit Test of Structural Equation Model

Test index	Absolute Fit Index					Incremental Fit Index			Minimalist Fit Index		
	χ^2	f	^{2}/df	RMSEA	FI	FI	FI	FI	NFI	CFI	GFI
Standard			~3	≦ 0.08	0.9	0.9	0.9	0.9	0.5	0.5	0.5
Model fit values	854.307	26	.177	0.021	.911	.905	.984	.984	.842	.916	.807
Fit or not	Yes	es	es	Yes	es	es	es	es	es	es	es

4.3.2. Path analysis of structural equation model

The fitting results of the structural equation model are shown in Figure 3, and the main path analysis results of the model are shown in Table 6.

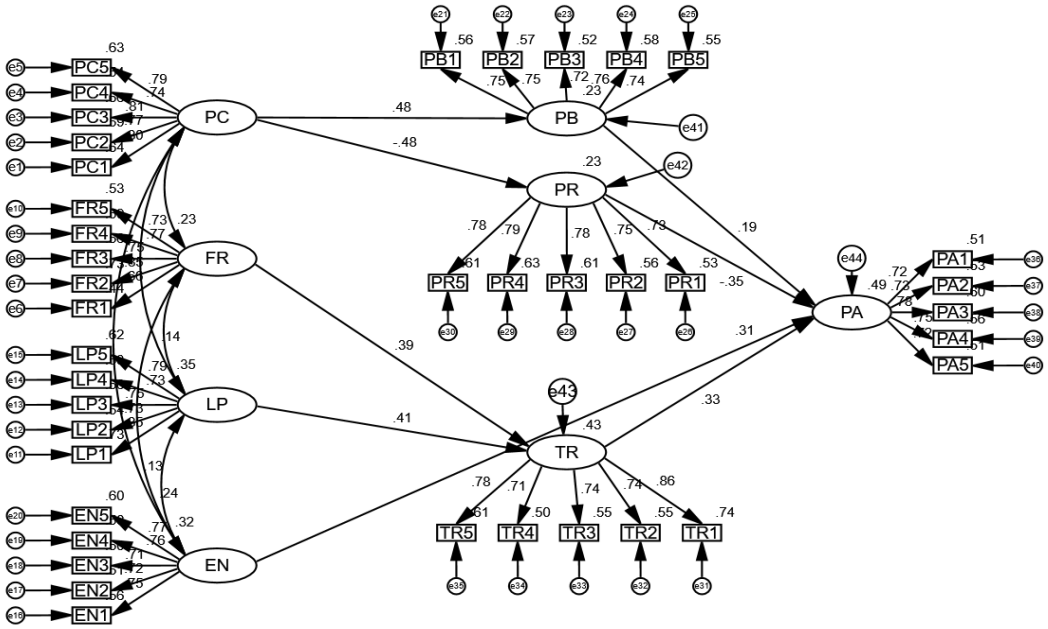

Figure 3 Fitting Results of Structural Equation Model

Table 6 Model Path Analysis Results

Path	Non-standardized Path Coefficient	Standardized Path Coefficient(β)	S.E	C.R	P	R^2
PC→PB	0.365	0.475	0.044	8.233	***	0.226
PC→PR	-0.372	-0.482	0.045	-8.336	***	0.232
FR→TR	0.555	0.393	0.077	7.203	***	0.428
LP→TR	0.392	0.406	0.049	7.974	***	
PB→PA	0.154	0.195	0.038	4.046	***	0.492
PR→PA	-0.278	-0.353	0.041	-6.844	***	
TR→PA	0.235	0.327	0.036	6.614	***	

EN→PA	0.268	0.312	0.044	6.045	***	

Note : C.R. is the test statistic that affects path significance, ***P＜0.001, R^2 is the squared multiple correlation.

PC significantly positively affected PB(β=0.475, C.R.=8.233, P<0.001), which confirmed the validity of hypothesis H1. PC significantly negatively affects PR(β=-0.482, C.R.=-8.336, P<0.001), which confirms the hypothesis H2.

FR significantly positively affects TR(β=0.393, C.R.=7.203, P<0.001), which confirms the hypothesis H3. LP has a significant positive effect on TR(β=0.406, C.R.=7.974, P<0.001), which confirms the hypothesis H3.

PB significantly positively affects PA(β=0.195, C.R.=4.046, P<0.001), which confirms the hypothesis H6. PR significantly negatively affects PA(β=-0.353, C.R.=-6.844, P<0.001), which confirms the hypothesis H7. TR significantly positively affects PA(β=0.327, C.R.=6.614, P<0.001), which confirms the hypothesis H8. EN significantly positively affected PA(β=0.312, C.R.=6.045, P<0.001), and H5 was established.

4.4. The Result of Mediating Effect Test

Bootstrap method was used to assess the mediating role of performance expectancy and effort expectancy in the model. The number of resamples was set at 5000. The verification of the established influence effects using the Bootstrap method hinges on the calculation of 95% confidence intervals for mediated, total, and direct effects. An influence effect is deemed significant when its 95% confidence interval does not encompass zero(Preacher & Hayes, 2008). The results of the mediation effect test are shown in Table 7.

Table 7 Tests of mediating effect of each mediating influence path in the model

Mediated Influence Path	Intermediate coefficient	Standard error	95% Confidence Intervals	
			Lower	Upper
PC→PA	0.263	0.029	0.206	0.320
PC→PB→PA	0.093	0.023	0.048	0.141
PC→PR→PA	0.170	0.024	0.126	0.220
FR→TR→PA	0.125	0.028	0.076	0.186
LP→TR→PA	0.109	0.030	0.057	0.175

The results in Table 7 reveal that the mediating effect of public cognition (PC) on public acceptance (PA) through perceived benefit (PB) is 0.093, which is 95% confidence interval (CI) [0.048, 0.141]. 95% confidence interval does not contain 0, indicating that the mediation effect is effective and H9 is established; The mediating effect of perceived risk (PR) on public acceptance PA is 0.170, 95%CI [0.126, 0.220], so H10 holds; The comprehensive mediating effect of PC on PA through two mediating variables is 0.263.

The mediating effect of fairness (FR) on public acceptance (PA) through trust (TR) is 0.125, 95%CI [0.076, 0.186], so H11 holds; The mediating effect of legal protection (LP) on public acceptance (PA) through trust (TR) is 0.109, with 95% CI [0.057,0.175], so H13 is established.

The research hypothesis test results of the model are shown in Table 8.

Table 8 Result of Testing the Structure Equation Model

Number	Hypothetical content	Decision
H1	Environmentalism is positively affecting the public's acceptance of CCUS.	Supported
H2	Public cognition positively affects the public's perceived interests in CCUS.	Supported
H3	Public cognition positively affects the public's perceived risk of CCUS.	Supported
H4	Fairness positively affects trust.	Supported
H5	Legal protection has a positive impact on trust.	Supported
H6	Perceived benefits positively affect acceptance.	Supported
H7	Perceived risk positively affects acceptance.	Supported
H8	Trust positively affects acceptance.	Supported
H9	Perceived interests play an intermediary role between public cognition and acceptance.	Supported
H10	Perceived risk plays an intermediary role between public perception and acceptance.	Supported
H11	Trust plays an intermediary role between fairness and acceptance.	Supported
H12	Trust plays an intermediary role between legal protection and acceptance.	Supported

5. Discussion and Conclusion

5.1. Discussion of Research Result

The empirical research approach was employed in this study, wherein data were collected through a questionnaire survey. The following conclusions were drawn from the study's empirical outcomes:

Perceived interests and trust have a significant positive impact on public CCUS acceptance. The public's acceptance of CCUS projects in the vicinity depends on the public's comprehensive understanding of CCUS knowledge, the fairness of rules and regulations involved in the construction of CCUS projects, the legal protection against potential risks such as pollution, and people's overall sense of responsibility for environmental protection. When people react to the local CCUS construction,

perceived benefits, perceived risks and environmentalism are the primary considerations (Hurlimann et al., 2008).

Perception of interests and trust has been proved to be an important factor affecting the public's attitude towards the construction of large-scale facilities nearby(Hall et al., 2015).Perceived interests and trust positively affect the public's acceptance of the construction of large-scale facilities nearby(Hall et al., 2015). In addition, fairness significantly affects the public's acceptance of the construction of large-scale facilities nearby through trust(Seigo et al., 2014). The findings of this study are consistent with previous studies, which shows the effectiveness of the research results.

(2) Perceived risk has a significant negative impact on public acceptance. This conclusion is consistent with that of most scholars. However, the positive impact of perceived benefits is lighter than the negative impact of perceived risks, which is contrary to the mainstream results such as (Wallquist et al., 2010).

There are two potential reasons for this result: on the one hand, the public in the investigated provinces are conservative about new things. On the other hand, CCUS, as a new industry in recent years, its benefits have not yet formed a concrete understanding in the public mind.

Legal protection has a significant positive impact on public acceptance of CCUS construction through trust. This study confirmed(Birkle et al., 2022; Hemmert et al., 2016). This conclusion emphasizes that when the legal system of CCUS is more perfect, the protection mechanism is more perfect and the radiation area is wider, it is more conducive to winning the public's trust, and then improving the public's acceptance of CCUS. Therefore, in order to promote the development of CCUS project without man-made obstacles, improve the existing relevant legal system, keep pace with the times, and reduce the public's rejection of CCUS.

(4) Environmentalism has a significant positive impact on public acceptance of CCUS construction. The results show that due to the promotion of the concept of carbon neutrality, the number of hospitals that the public accepts CCUS construction has increased. The government, schools, communities, etc. promote the publicity and promotion of the harm caused by the climate greenhouse effect and the continuous implementation of the carbon neutrality goal, which will help raise the public's awareness of environmental protection, and then enhance the public's acceptance of the CCUS project to reduce the greenhouse gas content in the atmosphere.

5.2 Theoretical Implications

As a new carbon emission reduction project, CCUS has relatively limited exploration of humanistic theory. The existing literature shows that the papers related to CCUS mainly focus on the exploration of CCUS related technologies. Although the study of geological site selection appears slightly, the special study on public acceptance of CCUS rarely appears. In the past, the research mainly focused on the public acceptance of the site selection of nuclear power plants and the health problems of genetically modified products, while the public acceptance of CCUS was rarely investigated and analyzed from the potential risks of geological site selection and the comprehensive wishes of the public on the health and other safety problems of CCU products (Visschers & Siegrist, 2012). From the point of view of the research object, this study is helpful to the development and popularization of CCUS project. In addition, the previous research mainly focused on residents in the neighborhood where CCUS project has been implemented, and there was little research on the public's will in the area where CCUS project will be implemented (Brunsting et al., 2011).This paper discusses the public acceptance

of places where CCUS policy has appeared but has not been implemented, which enriches the theoretical exploration in the field of public acceptance of CCUS projects.

Previous studies on the influence of fairness and trust on public acceptance of CCUS projects mainly focused on the moderating effect(Liu et al., 2021).This study takes trust as an intermediary variable, fairness as an independent variable, and legal protection as an independent variable to investigate the intermediary effect between them. The results show that fairness and legal protection are the main antecedents of trust. In addition, this study also explores the direct influence of environmentalism on CCUS public acceptance. All these extend the previous research.

Another theoretical contribution of this study is to integrate the environmental background of Guizhou, China Province, which is based on coal serving coal, into the research model to explore the influence of perceived benefits and perceived risks. Although Guizhou Province has CCUS related policies to support such projects, the specific implementation projects have not yet landed, and there is still a deviation between public perception and its objective facts, such as which is the dominant factor in perceived benefits and perceived risks, which is the opposite conclusion from the previous research on the local public acceptance of CCUS projects. (Huang et al., 2018). Therefore, this study points out the direction that can be tapped for how to understand the public CCUS acceptance more deeply.

5.3. Managerial Implications

First of all, this study reveals that public cognition is the main antecedent of perceived interests and perceived risks, which in turn affects public acceptance. Therefore, in order to promote the CCUS project more smoothly, it is necessary to fully publicize the basic knowledge of CCUS, so that the public can form a comprehensive and objective understanding of CCUS, so that they can correctly judge the benefits and risks brought by CCUS. At the same time, this study explains that fairness and legal protection affect public trust, and then affect public acceptance. This shows that only by making up the relevant legal gaps of CCUS, perfecting the relevant policies and systems of CCUS and ensuring the fairness of CCUS in the process of promotion can the public trust in CCUS be stimulated and the public acceptance be improved.

Second, the government should play a leading role in the development of CCUS project, and develop CCUS project into a real benefit project. At present, even though there are CCUS macro policies at the national level and CCUS support policies at the provincial level, there is still huge room for development in practice and popularization. This is related to the shortage of local finance, the lack of public support, communication barriers between relevant units and other factors, which leads to the lag of CCUS project. In addition, we should increase the introduction of CCUS-related technicians and give full play to the role of CPPCC in mobilizing people's support for CCUS projects. Attach equal importance to climate-friendly projects such as CCUS project and education, medical care and other fields that benefit the country and people.

Thirdly, we should strengthen the publicity of government-school-enterprise-community and enhance the public's awareness of caring for the environment. When all kinds of extreme natural disasters caused by climate change sweep across mankind, if the public is not aware of these causal relationships, they may turn a blind eye to these disasters. Therefore, how to fundamentally strengthen the public's awareness of environmental protection, we need to instill basic knowledge of climate in small citizens and write the serious problem of climate warming into primary and secondary school textbooks. Increase support for scientific research projects on ecological and environmental protection issues, especially CCUS projects, and strengthen cooperation among universities, enterprises and

governments to jointly solve the bottleneck problem of CCUS projects. Increase the community's popular science action on CCUS knowledge, so that a wider public can understand CCUS, then accept CCUS and finally support its development.

5.4. Limitations and Future Research

This study expands the direct influence of environmentalism on public acceptance, and enriches the direct influence of fairness and legal protection on public acceptance. It fills the research blank of public acceptance of CCUS project in Guizhou, China Province. However, this study still has some limitations.

First of all, this study discusses the influencing factors of public acceptance of CCUS projects, but it does not study the public acceptance of specific CCUS projects, nor does it study the public acceptance of CCUS projects in different categories. Therefore, in the future, researchers can study public acceptance based on specific CCUS projects, or combine with specific groups for analysis.

Secondly, this study is a cross-sectional study(Sitinjak et al., 2023).Only for the public in a certain time period, there is no dynamic research across time periods. Researchers can investigate the changes of the public's acceptance attitude towards CCUS projects in the vertical context, conduct a comparative study, and explore in depth what factors will make the public accept CCUS projects more influential over time, so as to better guide them.

Thirdly, this study does not include all the potential factors that affect the public's acceptance of CCUS projects. Although CCUS project is valuable as a means of carbon emission reduction from the perspective of eco-environment, its public acceptance is still affected by cultural, technical, regional and social factors. This difference is particularly obvious in developed and poor areas(Ashworth et al., 2019; Lima et al., 2021). Therefore, the existing research models can be extended to other fields, such as cultural differences and technological innovation.

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5.5. Conclusion

Based on the regional background of Guizhou, China Province, this study integrates ABC (Emotion, Behavior and Cognition) attitude model, cumulative pyramid model based on social permission, legal network of the influence of institutional power on supplier trust in manufacturing supply chain, TPB (planned behavior theory) expansion model and stakeholder theory, and establishes and discusses a novel model of public acceptance of CCUS project. The results show that public cognition indirectly affects the degree of public acceptance of CCUS projects through perceived risks and perceived benefits. Fairness and legal protection indirectly affect the public's acceptance of CCUS projects through trust; Environmentalism directly and significantly affects the public's acceptance of CCUS projects. Contrary to previous studies, perceived risk has a more significant impact on public acceptance of CCUS projects than perceived benefits (Saito et al., 2019).

This study theoretically verified the applicability of ABC (Emotion, Behavior and Cognition) attitude model, cumulative pyramid model based on social permission, legal network of the influence

of institutional power on supplier trust in manufacturing supply chain, TPB (planned behavior theory) extended model and stakeholder theory in exploring the public acceptance of CCUS project. The findings of this study can provide valuable insights for schools, governments, enterprises and communities. For schools, it is very important to cultivate young citizens to establish good environmental awareness from an early age; And in the research and development of CCUS scientific research projects, we will strive to strengthen cooperation with the government and enterprises and implement the latest practical technologies. The government needs to formulate a more perfect legal system to ensure the smooth progress of CCUS project, so that enterprises have no worries and the public feels that the long-term benefits outweigh the potential risks. Under the guidance of the Chinese People's Political Consultative Conference (CPPCC), the Association for Science and Technology and other departments, the community will strengthen the publicity and popularization of the basic knowledge of CCUS for the local public..

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